RESEARCH PROGRESS REPORT

RESEARCH PROJECT TITLE: Assessing the Impact of No-Till and Conventional-Till on Crop, Variety, Soil, Insect, and Disease Responses

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INTERIM REPORT

PROJECT OBJECTIVES:

1. Evaluate crop and variety performance differences between NT and CT production systems in a replicated tillage trial for winter wheat, spring barley, spring wheat, and dry pea
2. Determine changes in total SOM and quality of the SOM in NT and CT systems on different landscape positions
3. Determine the impact of CT and NT on soil fauna and document changes in total porosity and pore size distribution on different landscape positions
4. Evaluate incidence and severity of insect pests and their natural enemies on wheat, barley and pea grown under NT and CT practices
5. Evaluate root disease incidence and severity of Rhizoctonia root rot, *Fusarium* spp., and *Pseudocercosporella* foot rot in winter and spring wheat and barley under NT and CT. Correlate disease with SOM, pore size distribution, and landscape position.

KEY WORDS: Tillage, Varieties, Soil Dynamics, Insects, No-Till

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. 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 Hessian fly and other crop pests in replicated comparisons between CT and NT cereal production systems in the PNW. The importance and dynamics of insect natural enemies have also not been quantified in replicated NT comparisons in the PNW. There is a lack of critical information relating soilborne cereal pathogens to previous cropping history and soil properties under replicated NT vs CT plots.

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

ABSTRACT OF RESEARCH FINDINGS: Experimental investigations were carried out according to the proposal except for extensive pathological investigations. Funds were finally available in the summer, more than a year late and instrumentation of the site was delayed again because of this funding delay. Winter wheat, pea, spring wheat and barley varieties were evaluated in the NT versus CT comparison. Vole feeding reduced stands and areas in the winter wheat, thus results must be viewed with caution. The NT winter wheat yield was 24 bu/acre less than the CT. Test weight, seed weight, heads/acre, and harvest index were not different between NT and CT, while plant height and biomass were less in NT. There were variety differences for all parameters, but no interactions with tillage. Pea yield, seed weight, plant stand, and canopy height were not different between NT and CT, but vine length was shorter in NT. 'Bluebird' was the highest yielding green pea in NT, 2780 lb/a, and CT, 2080 lb/a, but yielded less in NT. 'Badminton' was the highest yielding yellow variety in NT, 2560 lb/a, and CT, 2390 lb/a. Spring wheat yield, plant stand, and heads/acre were not different between CT and NT. Test weight, seed weight, and harvest index were higher in NT than CT, while plant height and biomass were lower in NT than CT. There were variety differences but not interactions with tillage. Barley was injured by herbicide application followed by freezing. Barley yield, plant height, and plant stand were not different between CT and NT, but test weight and plump seed were higher in NT than CT. Earthworm evaluation shows greater number in NT overall and especially in the NT pea areas that have barley residue. There were also higher earthworm numbers in most winter wheat areas. However, there was no trend in other macrofauna distribution. Total soil carbon was slightly higher in NT than CT for the 0 to 2.5 cm and 2.5 to 5.0 cm depths and the reverse holds below 5 cm depth. Total N shows similar patterns to C distribution. Bulk density, saturated hydraulic conductivity, and plant available water were not different between CT and NT. In reverse of last years numbers, the percentage of wheat plants infested with Hessian fly and number of flies per plant were lower in NT than CT and may be due to increased parasitoids. Resistant varieties are still showing high fly mortality. Further analyses of parasitoid numbers are ongoing. Weekly trapping of ground dwelling arthropods show twice as many in pea compared to wheat that is higher than barley, although numbers were more uniform between crops in the past. More ground beetles were trapped in CT than NT, but species varied in proportion. More spiders were captured in NT than CT. Further investigations will emphasize maximizing pest control potential of the ground dwelling beetles.

RESULTS AND INTERPRETATION:

Experimental Site Management. At the Kambitsch farm north of Genesee, a tillage comparison trial included 15 varieties of spring dry pea, 15 of winter wheat, 6 varieties of spring barley, and 9 varieties of spring wheat and they were evaluated in a replicated no-till (NT) versus conventional till (CT) comparison in 2002. Each crop was part of a rotation of spring wheat-barley-pea from the previous years (2000 and 2001) and winter wheat in 1999. All cereal crops were seeded with fertilizer banded below the seed, but none was applied to the pea area. The winter wheat area had 85-20-0-15 lb/a of nutrients banded in the fall at winter wheat seeding, then in the spring, 40-0-0-6 lb/a was broadcast. The spring wheat and barley area had 92-20-0-4 lb/a applied as a band below the seed at seeding. The tillage treatment included a chisel plow about 8 inches deep in the fall and two cultivations with a field cultivator and harrow prior to seeding. The no-till treatment was not disturbed except for seeding. The entire trial was seeded with a Great-Plains NT drill with turbo-colter and liquid fertilizer with a row spacing of 9 inches. This gave five rows planted per variety plot. Winter wheat was seeded on October 27, 2001 and the spring crops were seeded on April 22 and 24, 2002 and in the bulk areas; 'Brundage 96' winter wheat, 'Karita' peas, and 'Penawawa' spring wheat were seeded. Weed control included Pursuit in the pea area, and Buctril and Harmony Extra in the cereals. A general burn-down herbicide application was made four weeks before spring seeding. In the winter wheat, Downy Brome escapes were hand weeded and prickly lettuce escapes were sprayed pre-harvest with glyphosate and 2,4-D. Overall, weed control was good and had little impact on crop yields. Pea leaf weevil was controlled by an Asana application, and seed weevil and aphids were controlled by an application of Capture at bloom. Insect control was excellent.

Over winter there was vole feeding in the winter wheat area. They preferred the NT area because of ground cover. The heaviest plant loss was in replications two and three. At harvest the areas effected by stand loss were accounted for, but stands were also thinned and delayed in maturity due to the vole feeding and those losses could not be quantified. Because of this feeding effect, the results from the winter wheat need to be interpreted carefully to not draw unwarranted conclusion about performance in NT.

The fall 2002 site management included a burn down herbicide application a short while after some precipitation gave some germination of weeds. The tilled areas were chiseled the beginning of October and the winter wheat planting area was worked with a field cultivator as is past years. Winter wheat varieties and Brundage 96 bulk area was planted on October 9, 2002 after 93-30-0-23 lb/a of nutrients were surface broadcast. Plans are underway to implement vole control over winter.

Variety responses. Winter wheat. Differential vole feeding occurred over winter with greatest impact on stands in the NT areas. NT winter wheat performance suffered as a result. Plot areas affected by vole damage were accounted for before harvest, but decrease in stand density and vigor due to feeding could not be eliminated. This increased the experimental CV and results should not be viewed as conclusive (Table 1). The overall effect of the vole damage should not be considered as a reasonable result on field scale production because smaller plot areas, as in this experiment, concentrate vole pressure.

When yield was combined over varieties, CT produced 96 bu/acre and NT was significantly lower at 72 bu/acre (Table 1). This difference should be weighed is view of the vole damage. There was no interaction of tillage and variety and all varieties yielded less in NT than CT. There were differences for varieties and 'Hubbard' and 'Beamer' were highest yielding in CT, while ‘Rod’ and ‘Lambert’ were highest in NT. Grain test weight averaged 61.2 lb/bu across the trial with no differences between tillage or interaction of tillage and variety. ‘Promontory was outstanding in test weight in both tillages and averaged 64.3 lb/bu. Seed weight was also not different between CT, 7.4 g/200 seed, and NT, 7.1 g/200 seed. There was not an interaction, but seed weights were different among vareities. Lambert and ‘Stephens’ were the largest seeded varieties.

As found for the spring cereals in previous trials, there were shorter plants, 30 inches, in NT than in CT, 33 inches (Table 2). Variety response to tillage was consistent for plant height and all varieties were taller in CT than NT. Growth analysis showed no significant difference for number of heads between CT, 47 heads/ft^2, and NT, 44 heads/ft^2. Crop biomass was 1350 lb/acre lower in NT than CT and when the crop is shorter, as in NT, usually biomass will be less too. Biomass samples are variable due to their size, but there were significant differences among varieties. Harvest index was calculated based on sample grain weight divided by sample biomass weight. Harvest index was 0.50 for both CT and NT, and that means half of the biomass weight was grain. Differences among varieties show Hubbard and ‘Madsen’ low at about 0.45 and while ‘Hiller’ was 0.53 and ’Temple’ was 0.54. Further results for winter wheat are needed to obtain any consistent responses to tillage. Protein and seed hardness data are not yet available at the time of this report.

Table 1. Performance† of Winter Wheat Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002.

	Seed Yield		Test Weight		Seed Protein		Seed Hardness		Seed Weight	
Variety	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till
White Wheat	---bu/acre---		-----lb/bu-----		----- % -----		----0-100----		----g/200----	
Beamer	108	78	61.6	61.5					8.1	7.8
Brundage 96	99	74	60.2	59.9					7.2	6.8
Cashup	87	59	60.9	61.4					6.8	6.9
Finch	97	79	61.4	61.5					6.5	6.5
Hubbard	109	68	61.6	61.4					7.2	6.9
Lambert	91	80	61.1	61.2					9.5	8.7
Madsen	98	73	60.3	60.3					7.6	6.6
Rod	100	88	59.9	60.4					6.8	6.6
Stephens	94	69	60.6	60.5					9.3	9.0
Red Wheat										
Boundary	84	61	61.0	60.8					7.6	7.4
Promontory	89	65	64.2	64.4					7.5	7.3
Club Wheat										
Coda	97	69	62.6	61.8					6.5	6.3
Hiller	92	70	59.6	58.6					6.6	6.3
Rohde	94	73	62.6	62.8					6.8	7.0
Temple	94	72	61.3	61.1					6.9	6.9
Average	96	72*	61.3	61.2					7.4	7.1
LSD (0.05)	15	15	0.9	0.9					0.6	0.6
CV	13	13	1	1					6	6

* NT values followed by an asterisk are significantly different than the CT value.

† Differential vole feeding occurred over winter with greatest impact on stands in the NT areas. NT winter wheat performance suffered as a result. Plot areas affected by vole damage were accounted for, but decrease in stand density and vigor due to feeding could not be eliminated. This increased the experimental CV and results should not be viewed as conclusive.

Table 2. Performance† of Winter Wheat Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002.

Variety	Seed Yield		Plant Height		Heads		Biomass		Harvest Index	
	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till
White Wheat	---bu/acre---		----inches----		---no./sq. ft.---		----lb/acre----		----0.0-1.0----	
Beamer	108	78	35	32	49	40	12700	9600	.50	.49
Brundage 96	99	74	32	28	50	46	12550	10200	.51	.53
Cashup	87	59	31	28	43	46	10450	9850	.48	.48
Finch	97	79	33	33	46	54	10450	12900	.50	.47
Hubbard	109	68	40	35	46	41	12750	11650	.44	.45
Lambert	91	80	34	33	46	40	13800	10900	.49	.49
Madsen	98	73	34	30	41	40	10250	9100	.45	.45
Rod	100	88	32	30	56	45	12750	11000	.50	.48
Stephens	94	69	32	29	41	37	9950	8800	.50	.50
Red Wheat										
Boundary	84	61	33	29	63	53	12700	10200	.52	.52
Promontory	89	65	33	32	44	40	10700	8250	.47	.51
Club Wheat										
Coda	97	69	34	30	43	42	11600	10900	.49	.52
Hiller	92	70	31	28	46	43	11950	10950	.53	.53
Rohde	94	73	32	29	47	40	12000	9050	.49	.51
Temple	94	72	31	27	45	48	10650	11550	.54	.54
Average	96	72*	33	30*	47	44	11700	10350	.50	.50
LSD (0.05)	15	15	2	2	13	13	3800	3800	.03	.03
CV	13	13	5	5	21	21	24	24	5	5

* NT values followed by an asterisk are significantly different than the CT value.
† Differential vole feeding occurred over winter with greatest impact on stands in the No-till areas. No-till winter wheat performance suffered as a result. Plot areas affected by vole damage were accounted for, but decrease in stand density and vigor due to feeding could not be eliminated. This increased the experimental CV and results should not be viewed as conclusive.

Dry pea. The tillage comparison trial yielded 2130 lb/acre in CT and 1850 lb/acre in NT averaged across pea varieties, although not statistically different (Table 3). Bluebird was the highest yielding variety, 2780 lb/acre, in CT and second only to Badminton, 2390 lb/acre, in NT and significantly lower yielding at 2080 lb/acre. Plant stands averaged 9.2 plants/ft^2 in CT and 9.7 plants/ft^2 in NT, not significantly different. However, there were differences among varieties for stand establishment. Seed weights averaged 21.9 g/100 seed in both CT and NT. However, Rex had higher seed weights in NT, 26.7 g/100 seed, than in CT, 23.8 g/100 seed. Vine lengths were significantly less in NT than in CT for 'Cruiser' and Rex, and averaged three inches less across varieties. There were no differences for canopy height.

Table 3. Performance of Pea Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002.

Variety	Seed Yield		Seed Weight		Plant Stand		Vine Length		Canopy Ht.	
	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------		---No./sq.ft.--		----inches----		----inches---	
Columbian	1900	1650	19.1	18.5	11.4	10.9	43	37	15	18
Cruiser	2250	1860	18.8	19.0	8.7	7.1	33	21*	25	21
Joel	1810	1710	20.9	19.4	11.6	12.2	41	42	19	17
Karita	2110	1970	24.0	21.6	7.1	8.3	23	22	23	22
Bluebird	2780	2080*	22.0	21.6	11.6	13.1	22	18	22	18
Lifter	2020	1760	20.0	20.6	10.6	12.7	30	27	17	18
Hero	2020	1580	21.1	22.9	10.3	9.6	19	23	19	16
Ariel	2210	1900	16.5	17.4	8.5	10.2	25	22	24	22
Supra (MF)	1720	1560	32.3	32.5	9.0	10.1	20	21	20	21
Average	2090	1790	21.6	21.5	9.9	10.5	28	26	20	19
Yellow Pea										
Badminton	2560	2390	21.5	21.3	9.5	9.8	22	18	22	18
Fallon	2270	1920	22.6	22.7	7.4	8.6	25	19	24	19
Jasmine	1830	1790	25.8	24.1	6.6	6.3	26	21	26	21
Rex	1960	1800	23.8	26.7*	5.4	6.0	27	31	22	19
Shawnee	2050	1800	19.8	19.6	9.9	10.1	45	31*	16	18
Swing	2460	1940	19.7	21.3	10.5	9.7	28	24	28	23
Average	2190	1940	22.2	22.6	8.2	8.4	29	24	23	20
Overall Average	2130	1850	21.9	21.9	9.2	9.7	28	25*	21	19
LSD (0.10)	280	280	2.4	2.4	2.9	2.9	7	7	4	4
CV	10	10	8	8	22	22	18	18	14	14

*NT values followed by an asterisk are significantly different than the CT value.

Spring Wheat. Spring wheat grain yield was 62 bu/a in CT, not different than NT at 58 bu/a (Table 4). There were variety differences with tillage treatments and 'Hank' gave the highest yield in CT and 'Jefferson' was highest in NT. As in previous years, grain test weight was higher in NT, 60.6 lb/bu, than in CT, 59.2 lb/bu. All varieties had higher test weights in NT than in CT with no interaction of variety and tillage. Seed weights were also higher in NT, 6.3 g/200 seed, than in CT, 5.7 g/200 seed. Seed from all varieties was heavier in NT than in CT with no interaction of tillage and variety. Plant height was slightly less in NT than CT, as in the past, and no variety was taller in NT than CT (Table 5). Plant stands averaged 33 plants/ft^2 and the only differences for plant stand are among varieties, but all stands were good. Head density was not different between tillage treatments, but was highest for 'Scarlet' and lowest for 'Westbred 936'. The differences in seed weight and kernels/head would account for the higher yield of Westbred 936 than Scarlet in CT. Biomass was slightly lower in NT than CT as seen in the winter wheat and previous comparisons, and is consistent with shorter plants in NT. I believe this lower growth in NT is due to cooler, delayed conditions in the spring that carries through the growing season. Harvest index is lower in spring wheat than the winter wheat, and is higher in NT than CT averaged across varieties. Among varieties, the lowest harvest index was for Scarlet, at 0.40, and highest was Westbred 936, at 0.47.

Table 4. Performance of Spring Wheat Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002.

Variety	Seed Yield		Test Weight		Seed Protein		Seed Hardness		Seed Weight	
	Conv -Till	No-Till	Conv -Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till
White Wheat	---bu/acre---		------lb/bu------		------ % ------		----0-100----		----g/200----	
Penawawa	53	58	58.0	60.2					5.2	5.6
Wawawai	62	60	59.8	61.3					5.9	6.3
Zak	63	60	59.7	60.3					5.5	6.0
IDO 377s	58	60	59.2	61.3					5.3	5.7
Red Wheat										
Hank	71	59	58.5	60.0					6.2	7.1
Jefferson	66	61	60.4	61.3					5.6	5.9
Scarlet	57	57	57.7	59.3					5.3	6.0
Westbred 926	63	55	59.4	60.4					6.1	7.0
Westbred 936	67	54	60.0	60.9					6.6	7.0
Average	62	58	59.2	60.6					5.7	6.3*
LSD (0.05)	10	10	1.4	1.4					0.7	0.7
CV	11	11	2	2					8	8

* NT values followed by an asterisk are significantly different than the CT value.

Table 5. Performance of Spring Wheat Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002.

Variety	Plant Height		Plant Stand		Heads		Biomass		Harvest Index	
	Conv -Till	No-Till	Conv -Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till	Conv-Till	No-Till
White Wheat	----inches----		plants/sq.ft.		---no./sq. ft.---		----lb/acre----		----0.0-1.0----	
Penawawa	31	27	28	34	36	36	6020	5750	0.41	0.44
Wawawai	34	33	33	31	35	31	6220	6060	0.43	0.43
Zak	32	31	24	31	37	34	6570	6390	0.41	0.43
IDO 377s	31	30	35	36	31	28	6070	6240	0.44	0.43
Red Wheat										
Hank	29	29	35	35	30	31	6720	6140	0.44	0.44
Jefferson	31	31	32	35	36	35	6000	6480	0.40	0.42
Scarlet	31	31	34	38	40	41	6180	6000	0.39	0.40
Westbred 926	31	29	33	33	31	31	5850	6270	0.45	0.44
Westbred 936	29	27	36	30	27	27	6410	5460	0.45	0.48
Average	31	30	32	34	34	33	6230	6090	0.42	0.43*
LSD (0.05)	3	3	7	7	9	9	NS	NS	0.04	0.04
CV	7	7	16	16	19	19	15	15	6	6

* NT values followed by an asterisk are significantly different than the CT value.

Spring Barley. Spring barley growth and yield was severely reduced because the herbicide application, including Puma, was applied and then freezing temperatures followed. This caused visual injury symptoms, stunting, and delayed growth. The variety ‘Harrington’ appears to be most susceptible to this herbicide injury (Table 6). There was no difference in yield between NT and CT or interaction with variety, but Harrington did yield least. Test weights were higher in NT than CT, as was seed plumpness and lower for the converse seed thins. I believe this is due to greater moisture availability in NT that allows an advantageous grain filling period. Plant height and biomass were slightly less in NT, but plant stands were similar between tillage treatments. Numbers of heads and harvest index were slightly higher in NT than CT. Head count was lower and harvest index was higher for 6-row than for 2-row varieties, possibly due to the herbicide-freezing effects that were greater on the 2-row varieties.

Table 6. Performance of Spring Barley Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002. Plants were injured when an herbicide application was followed by freezing temperature.

Variety	Seed Yield		Test Weight		Plump Seed		Thin Seed		Seed weight	
	Conv -Till	No-Till	Conv -Till	No-Till	Conv -Till	No-Till	Conv -Till	No-Till	Conv -Till	No-Till
2-**ROW**	---bu/acre---		-----lb/bu-----		-- % <6/64”--		-- %>5.5/64”--		----g/200----	
Baronesse	60	63	50.4	51.0	75	86	7	3	6.7	7.1
Camas	61	63	51.5	52.6	75	87	7	3	7.5	7.7
Harrington	45	38	50.0	51.1	71	75	8	7	6.6	6.7
Xena	60	57	50.7	51.2	84	89	4	2	7.8	8.2
6-ROW										
Excel	64	63	50.5	51.1	75	86	5	3	6.8	7.1
Morex	56	53	50.7	50.4	69	79	9	4	6.5	6.7
Average	58	56	50.6	51.2	75	84*	7	4*	7.0	7.3
LSD (0.05)	7	7	2.1	2.1	11	11	4	4	0.6	0.6
CV	9	9	3	3	10	10	53	53	6	6

*NT values followed by an asterisk are significantly different than the CT value

Table 7. Performance of Spring Barley Varieties Under Replicated Conventional-Tillage and No-Till Management near Genesee, ID, 2002. Plants were injured when the wild oat herbicide Puma application was followed by freezing temperatures.

Variety	Plant Height		Plant Stand		Heads		Biomass		Harvest Index	
	Conv -Till	No-Till	Conv -Till	No-Till	Conv -Till	No-Till	Conv -Till	No-Till	Conv -Till	No-Till
2-**ROW**	----inches----		--plants/sq.ft--		---no./sq. ft.---		lb/acre		----0.0-1.0----	
Baronesse	23	22	31	38	55	68	5830	5580	0.44	0.49
Camas	24	22	25	28	53	52	5890	5380	0.51	0.54
Harrington	24	23	31	29	49	52	4910	4690	0.46	0.47
Xena	24	25	30	36	49	50	5320	5360	0.50	0.52
6-ROW										
Excel	26	25	33	29	31	34	5620	5570	0.62	0.59
Morex	29	28	33	35	31	32	5610	5030	0.56	0.54
Average	25	24	32	32	45	48	5530	5260	0.51	0.52
LSD (0.05)	2	2	5	5	12	12	n.s.	n.s.	0.05	0.05
CV	7	7	20	20	18	18	13	13	6	6

* NT values followed by an asterisk are significantly different than the CT value

Soil and Biological. *Earthworm and Other Macrofauna*. Although there is a relatively high degree of variability in earthworm populations, results from the first two years of this three-year study indicate that the distribution of earthworms is influenced by tillage despite the relatively short period of time these NT plots have been established (Figure 1). In addition to tillage, data collected in 2001 and 2002 indicate that crop rotation influences macrofaunal populations. Both 2001 and 2002 data show that the strongest response to tillage occurs in plots planted to pea. Data from 2001 are shown in the 2001 research report and 2002 data are shown in Figure 2. Since earthworms are sampled in the spring when the plants are very young, this is likely caused by the plentiful food source and favorable microclimate provided by the barley residue in the no-till plots. Except for within the pea plots that were previously planted to barley, earthworm numbers in the lower landscape position do not reflect tillage treatment. Data from the spring sampling show that other macrofauna, which included centipedes, weevils, and spiders, showed no significant response to tillage (Figure 3).

Earthworm and other macrofauna sampling was repeated in summer 2002 (data not shown). Like the 2001 data, 2002 data show that earthworm numbers decrease between spring and summer. The influence of tillage on earthworm numbers is not clear from summer 2002 data, indicating that other factors such as landscape position play a more important role in earthworm survival when the soil is dry. Between the spring and summer samplings the number of other macrofauna increased dramatically. Within the pea plots, this was mostly due to presence of large numbers of weevil larvae.

Soil Physical Properties. Despite the alteration of earthworm populations by tillage, there have been no measurable changes in bulk density (2001 report), saturated hydraulic conductivity, or plant available water (Figure 4).

Total Soil Carbon and Nitrogen. Samples collected in 2001 were analyzed for total C and N content (Figure 5). Total C data show that NT plots have slightly higher C contents in the 0 to 2.5 and 2.5 to 5 cm depths. Below the 5 cm depth, NT plots have slightly lower C levels. Total N data show the same pattern as C. Within the 0 to 2.5 cm depths, where the majority of C is being accumulated in NT plots, the response to tillage is variable with respect to plot location. Since C is expected to change over longer time scales than a year, this is likely do to differences in soil properties and moisture contents driven by topography. These preliminary data indicate that crop rotation and landscape position will modify the effects of tillage practices on earthworm populations and C distribution.

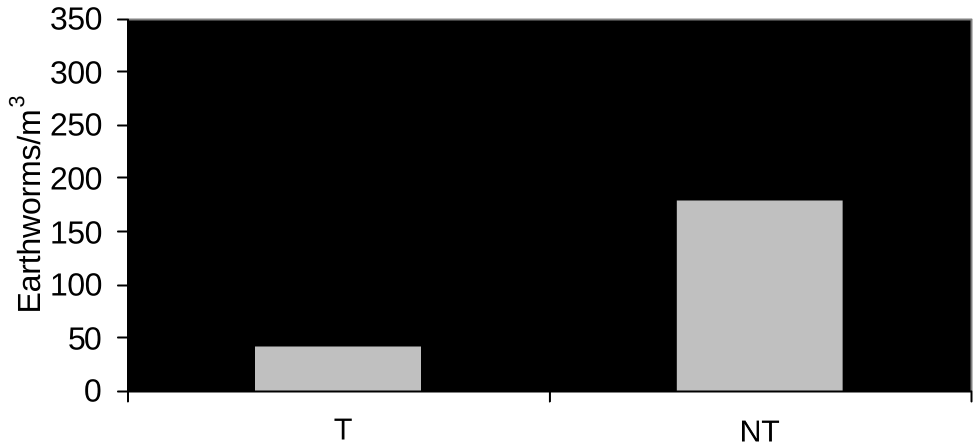


Figure 1. Number of earthworms per m^3 of soil in conventionally tilled (CT) and no-till (NT) plots.

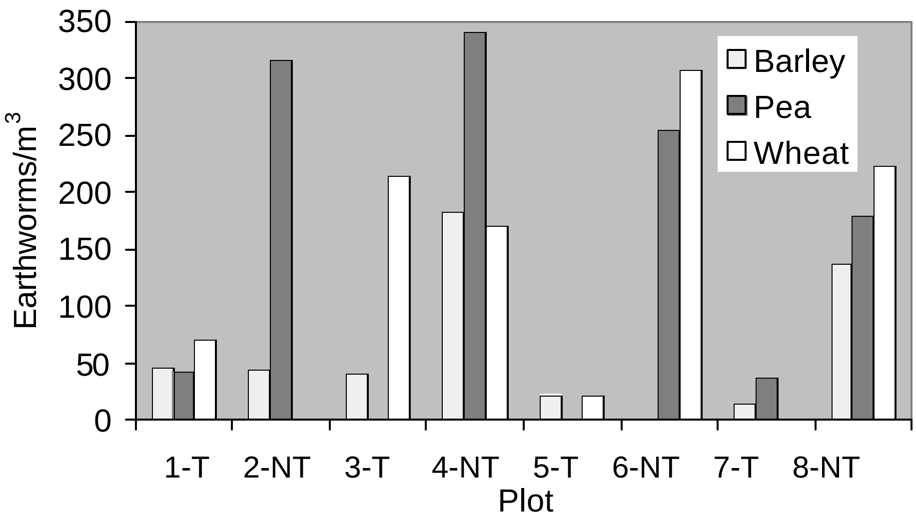


Figure 2. Earthworm distribution in each plot. Earthworms were collected in May 2002. The lack of a bar indicates that no earthworms were found. Plot 1 is located at the footslope position and plot 8 is at the shoulder position.

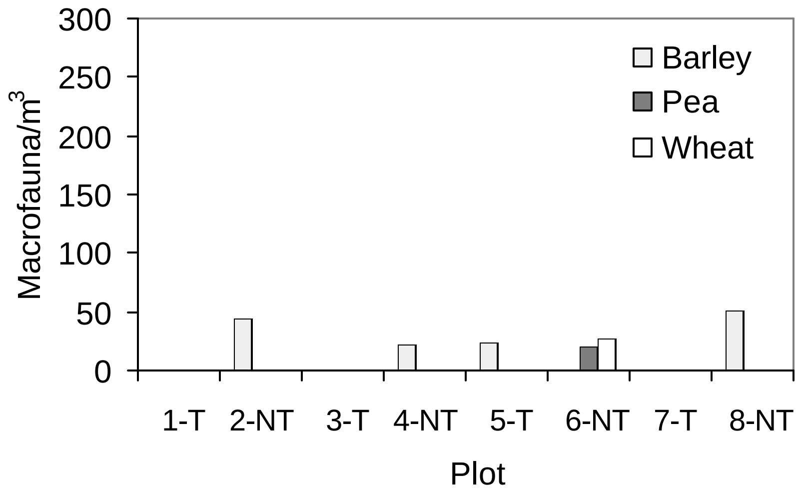


Figure 3. Other macrofauna (centipedes, weevils, and spiders) distribution in May 2002. Lack of bar indicates that no macrofauna were found.

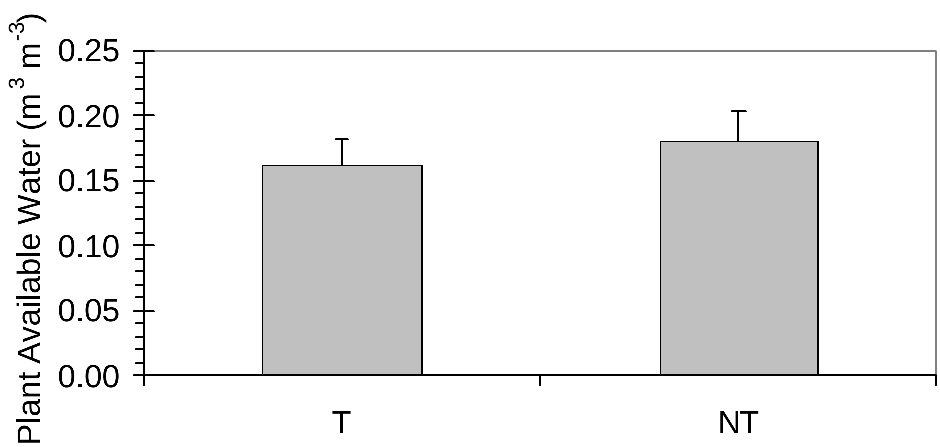


Figure 4. Although plant available water contents (calculated by subtracting the difference between volumetric water contents between field capacity and permanent wilting point) tend to be somewhat higher under NT, there is no significant difference between tillage treatments after 3 years of NT.

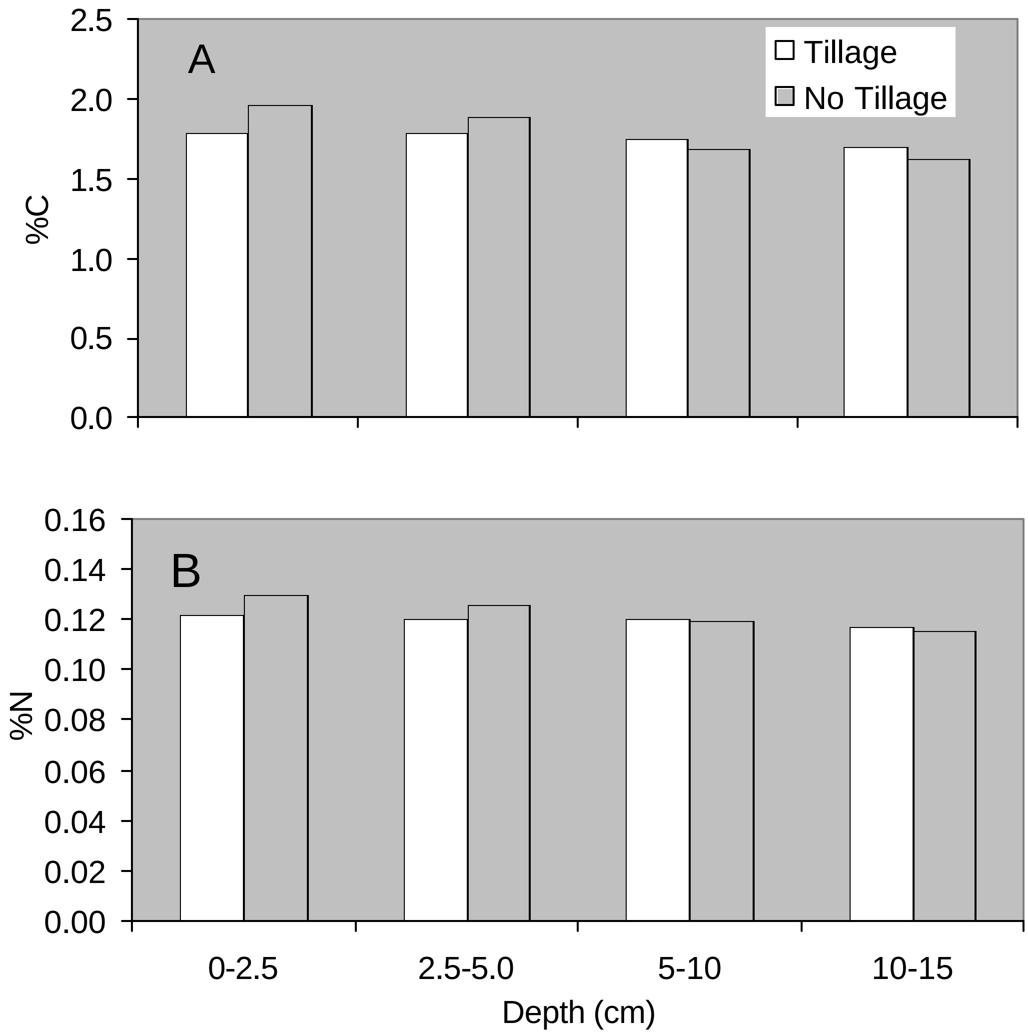


Figure 5. Average total carbon (A) and total N (B) content of soil with depth under conventional tillage and no-till.

Entomology. Samplings were conducted at the Kambitsch experimental farm in 2002 to continue evaluating the incidence and abundance of insect pests and their natural enemies on wheat, barley and pea grown under NT and CT practices. Sampling for Hessian fly was carried out throughout the growing season in large, replicated plots of the fly susceptible spring wheat variety Penawawa. Plants were examined for presence of Hessian fly eggs, larvae and puparia, and number of insects per plant and percentage of plants infested determined. In general, the percentage of wheat plants infested with Hessian fly was lower in NT, than on CT plots. The mean number of flies per plant was also lower in NT compared to CT plots. This is in contrast to last year's findings, when fly populations were greater on NT plots. More studies are required to determine if Hessian fly parasitoids play a greater role in suppressing fly populations in NT plots compared to CT ones.

In addition to monitoring fly populations in the large plots described above, six spring wheat, one winter wheat, and two spring barley varieties were evaluated under natural pressure from Hessian fly. Several samplings were conducted during the growing season. The mean number of Hessian fly eggs per spring wheat plant during the first sampling period indicated that there was a relatively uniform infestation across the field in both NT and CT plots. High mortality of first instar larvae was detected in the resistant genotypes. By the fourth sampling, the mean number of flies per plant was higher in the susceptible spring wheat varieties WB936 and Penawawa than in the resistant varieties Hank, Jefferson and WPB 926, in both NT and CT plots. The resistant wheat genotypes evaluated carry the H3 gene for resistance, and this gene continues to exhibit effectiveness in controlling Hessian fly in the Palouse region. Spring barley and winter wheat plots were also examined for presence of Hessian fly. Fly populations were negligible on both crops.

Although NT can potentially increase pest problems, it may also increase populations of natural enemies of pests including ground beetles and parasitoids of Hessian fly and other pests that may over-winter in their hosts. We have continued samplings to assess the importance and dynamics of insect natural enemies in our Kambitsch trials. Hessian fly puparia were collected throughout the growing season from stubble of the fly susceptible spring wheat variety Penawawa planted in 2001. Parasitoids were reared from the puparia in the laboratory and identified to species. The most abundant parasitoid species were *Homoporous destructor* and *Pediobius epigonus*. The incidence and abundance of Hessian fly parasitoids under NT and CT systems were monitored also. Percentage of Hessian fly infested with parasitoids was determined. Data are still being analyzed, but our results suggest Hessian fly parasitoids are important in Hessian fly population regulation.

Ground-dwelling arthropods (primarily springtails, insects and spiders) have been sampled weekly during three cropping seasons (2000-2001). This report summarizes data from 2000 and 2001. The 3rd year of data are still being analyzed. In 2000, the sampling period extended from June until early August, while in 2001 it extended from May until mid-August. To capture the arthropods, two, 6-cm-diameter pitfall traps were placed in each main experimental plot. The traps consisted of 9 oz. plastic drink cups placed in the soil so that the mouth of each cup was flush with the soil surface. Each trap was filled weekly with 1 to 2 oz. of low-toxicity antifreeze. Arthropods that fell in the traps were preserved by the antifreeze and subsequently collected. Trap contents were processed by transferring all specimens into 70% methanol. Adult beetles were subsequently extracted and identified to the most accurate taxonomic level feasible, or pending identification sorted to morphospecies (morphospecies = individuals that are very similar based upon size, shape and color). Spiders, on the other hand, were sorted to order only.

Analysis of trap contents reveals interesting patterns in the gross number of beetles trapped (˜ abundance), the number of species trapped (richness), the composition of the community, and the structure of the community in response to different crop and tillage treatments. During both crop years, over twice as many beetles were trapped in the pea plots than in wheat, and considerably fewer still were trapped in barley (**Figure 6**). In contrast**,** in 2000 more beetle species were trapped in the wheat plots (59 species) than in the pea (54) or barley (53), while in 2001 more were trapped in barley plots (97) than in the pea (94) or wheat (94). In **Figure 7** the dominant taxa found in these crops is presented. It can be seen that predator taxa such as the ground beetles (Carabidae), rove beetles (Staphylinidae), spiders (Araneae) and lady bugs (Coccinelidae) made-up 58 to 65% of all individuals captured. One herbivore taxon, the weevils (Curculionidae, which was comprised almost entirely of one pest species, the pea-leaf weevil *Sitona lineata*) comprised well over 50% of the remaining individuals. The scavenger ant-like flower beetles (Anthicidae) and the fungivorous minute brown scavenger beetles (Lathridiidae) comprised the remainder. Many other taxa were collected, but compared to those listed above, they were quite rare (<1% of total). In 2001, the composition of the community was similar to that found in 2000, with the exception of lady bugs, which were more rare in 2001 and the ant-like flower beetles, which were more common in 2001. This latter group comprised up to 34% of all beetles captured in 2001. As in 2000, over 50% of all captures in 2001 were predators of the 4 taxa listed above, with the ground beetles being 4 times more abundant than any other predator taxon.

The analysis by tillage treatment across crops reveals that the relative proportions of several taxa are influenced by tillage (**Figure 8**). For instance, in the CT plots ground beetles were captured much more commonly than in NT, contributing from 49 to 54% of all captured beetles. In contrast, in the NT plots, ground beetles comprised only 36 to 38% of all captures. Despite this ground beetle response to tillage, the relative proportion of all predators found in CT and NT was not much different, due primarily to the greater number of spiders trapped in NT (roughly 3 times) than in CT plots.

Although overall ground beetle abundance at Kambitsch was greater in CT, individual species responded differently to tillage treatments. Of the 11 morphospecies common to both tillage treatments, 7 were more abundant in NT during crop year 2000, and 6 of 13 were more abundant in NT during 2001 (**Figure 9**). Furthermore, of all ground beetle species captured at Kambitsch, only four (*Poecilus scitulus*, *Poecilus lucublandus*, *Pterostichus melanarius* and *Calosoma cancellatum*) comprised over 80% of all individuals captured. In 2000, 3 of these 4 were more abundant in NT, while in 2001 the opposite pattern was observed. With regard to the spiders, as they were only sorted to order, we can say nothing about species proportions or individual response to tillage. It appears, however, that spiders as a group responds very favorably to reduced tillage.

In the more recent literature, researchers have emphasized the need to learn more about the pest control potential of ground beetles in arable lands, particularly the most dominant species. Following this line of reasoning, it is our intention to focus future research on the dominant ground beetles found at Kambitsch. In other words, now that we know which species are present, and which are the most dominant, we now need to pose questions concerning their behavior, diet, phenology and pesticide tolerance. Placing emphasis on such questions, and on these dominant species, will provide the best opportunity for maximizing the pest control potential of these important biological control agents.

Figure 6. Total number of beetles collected in wheat, pea and barley plots at the Kambitsch Research Farm during 2000 and 2001.

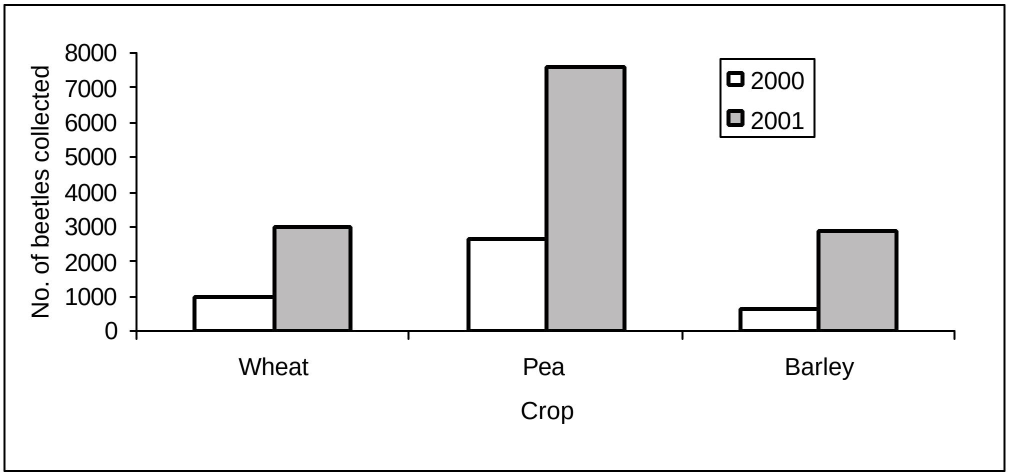


Figure 7. Relative abundance of beetles by family found on the soil surface in wheat, pea and barley plots. Abundance of spiders (Araneae) is also presented. Taxon followed by the letter "p" identify the group as primarily predaceous, "h" as herbivorous, "f" as fungivorous and "s" as scavengers.

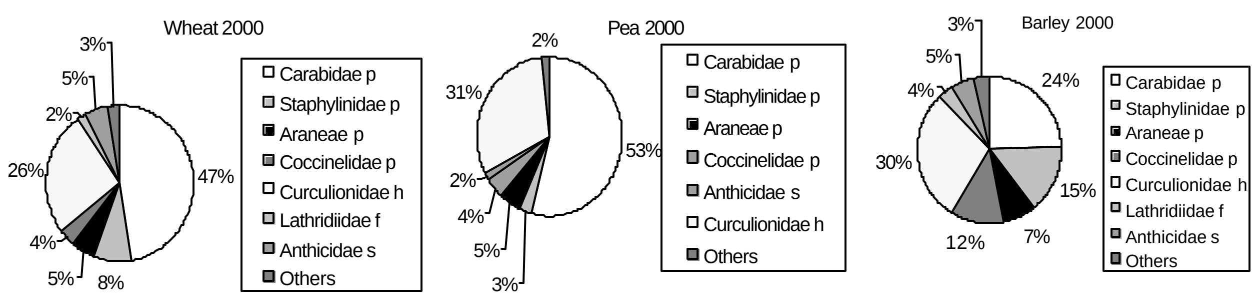


Figure 8. Relative abundance of beetles by family, and spiders found on the soil surface in CT and NT wheat, pea and barley plots. Taxon followed by the letter "p" identify the group as primarily predaceous, "h" as herbivorous, an"f" as fungivorous and "s" as scavengers.

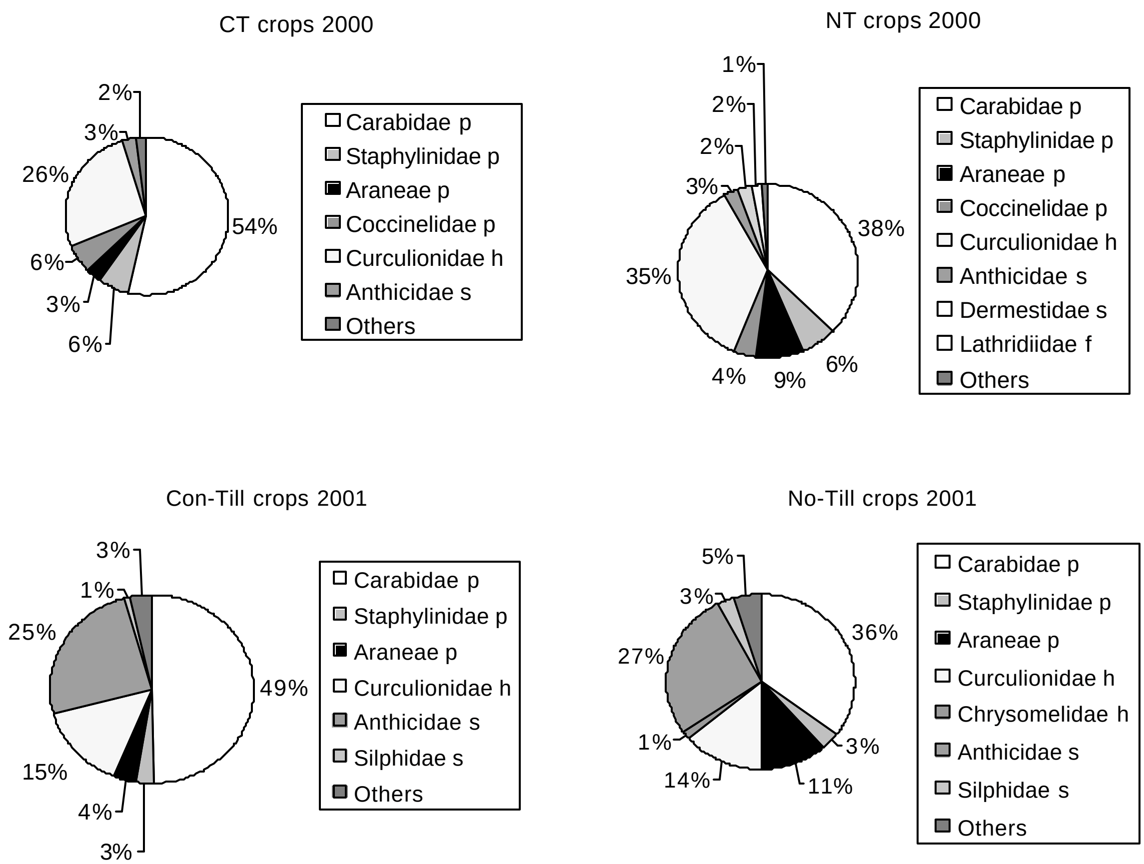
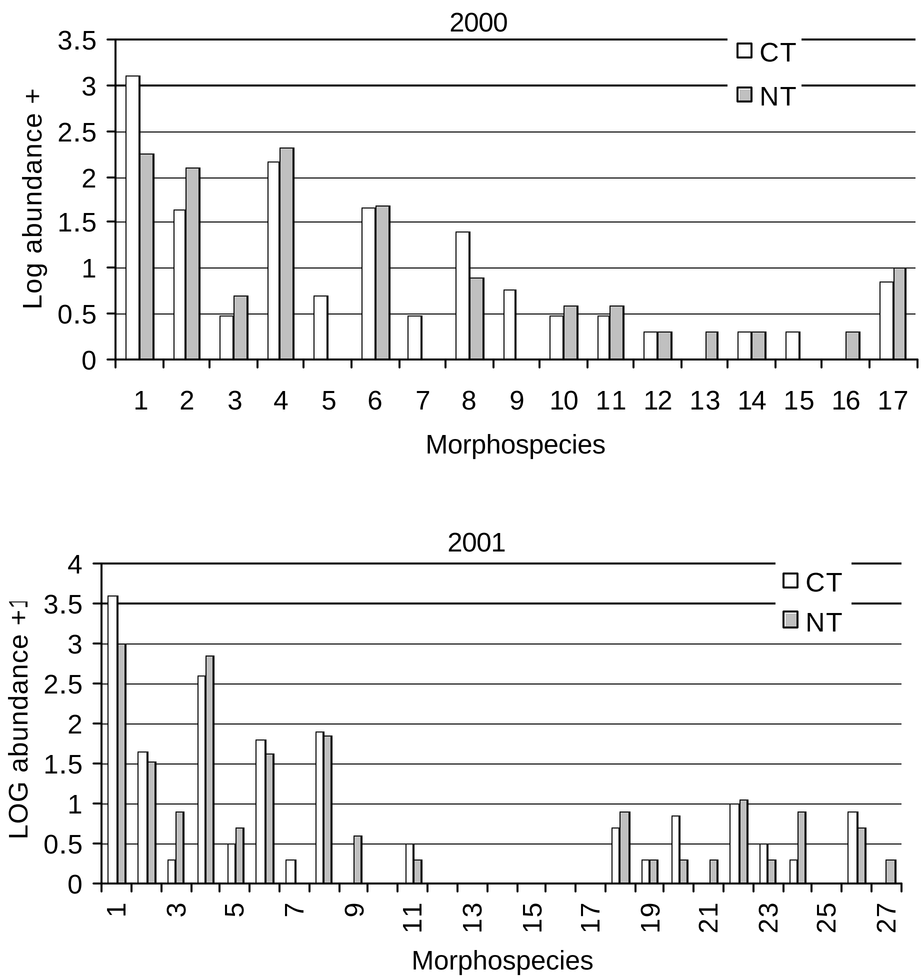


Figure 9. Ground beetle abundance in CT and NT plots.



PUBLICATIONS AND PRESENTATIONS:

Publications.

Guy. S.O. and D.B. Cox. 2002. Reduced tillage increases residue groundcover in subsequent dry pea and winter wheat crops in the Palouse region of Idaho. Soil and Tillage Res. 66:69-77.

Guy, S.O., N.A. Bosque-Perez, S.D. Eigenbrode, J. Johnson-Maynard, and L.M. Dandurand. 2002. Assessing the impact of no-till and conventional-till on crop, variety, soil, insect, and disease responses. p. 36-49. *In* STEEP 2001 annual report. Spokane, WA, 16-18 Jan., Univ. of Idaho, Oregon St. Univ., Wash. St. Univ., USDA-ARS, and NRCS.

Guy, S.O., K. McPhee, and D. Huggins. 2002. Evaluation of wheat and pea varieties under direct and conventional seeding in Washington, Idaho, and Oregon. p. 28-35. *In* STEEP 2001 annual report. Spokane, WA, 16-18 Jan., Univ. of Idaho, Oregon St. Univ., Wash. St. Univ., USDA-ARS, and NRCS.

Guy, S.O. and Y. Wu. 2002. No-till and conventional till comparisons of wheat, barley, and pea varieties. *In* 2002 Agronomy Abstracts. ASA, Madison, WI.

Smith, L.J., S.O. Guy, Y. Wu, and K.N. Hart. 2002. North-Central Idaho Cooperative Extension Crop Management Trials 2001. Progress Report 358. Univ. of Idaho Coop. Ext., Moscow, ID.

Guy, S.O. and Y. Wu. 2002. Northern Idaho Extension Small Grain and Legume Variety Performance Trials 2000-2001. Progress Report 355. Univ. of Idaho Coop. Ext., Moscow, ID.

Guy, S.O. 2002. Performance Shown. Article by S. Allen. *In* Agri-Times Northwest. 1 February, 2002.

Presentations.

Castle, S. C., D. J. Schotzko, J. B. Johnson, S. O. Guy, and N. A. Bosque-Pérez. 2002. Species composition, incidence, and relative abundance of Hessian fly, *Mayetiola destructor* (Say) parasitoids in northern Idaho. Annual Meeting Entomological Society of America, Fort Lauderdale, Florida (poster presentation).

Hatten, T., N. Bosque-Pérez, S. D. Eigenbrode, and G. Chang. 2002. Influence of management practices on abundance and diversity of soil-surface Coleoptera in the Palouse. Annual Meeting Entomological Society of America, Fort Lauderdale, Florida (poster presentation).

Hatten, T., G. Chang, N. Bosque-Pérez, and S. D. Eigenbrode. 2002. Crop and cultural practices influence the abundance and diversity of soil-surface Coleoptera in the Palouse. Entomological Society of America Pacific Branch Meeting, Lake Tahoe, Nevada (oral presentation).

Guy, S.O.. 5 Nov., 2001. 2001 North Idaho Extension Variety Cereal and Legume Studies. NezPerce Co. Crop Advisory Comm. Lewsiton, ID. 14 attended.

Guy, S.O., 6 Dec., 2001. 2001 N. Idaho Legume Variety Trials. USA Dry Pea and Lentil Assoc. Annual Grower's Meeting. Moscow, ID. 105 attended.

Guy, S.O., 8 Jan., 2002. Pea, Wheat and Barley Variety Response to Tillage. Clearwater Direct Seeders, Lewiston, ID. 30 attended.

Guy, S.O. and Y. Wu. 16 Jan., 2002. Variety Performance of Dry Pea, Spring Wheat, and Barley in a No-till and Conventional Till Comparison. Poster. 2002 PNW Direct Seed Conference. Spokane, WA. 850 attended.

Johnson-Maynard, J. K. Umiker, and S. Guy. 16 Jan., 2002. Changes in Soil Biota and Soil Physical Properties in the Early Stages of No-Till. Poster. 2002 PNW Direct Seed Conference. Spokane, WA. 850 attended.

Schotzko, D., S. Castle, S. Guy, and N.A. Boxque-Perez. 16 Jan., 2002. Effect of Tillage Practices on Incidence and Abundance of Hessian Fly in Northern Idaho. Poster. 2002 PNW Direct Seed Conference. Spokane, WA. 850 attended.

Guy, S.O. 5 Feb., 2002. Variety Performance in Northern Idaho and Variety Response to Tillage. Idaho Co. Crop School. Greencreek, ID. 75 attended.

Guy, S.O. 6 Feb., 2002. Variety Performance in Northern Idaho and Variety Response to Tillage. Latah Co. Crop School. Moscow, ID. 40 attended.

Guy, S.O. 7 Feb., 2002. Variety Performance in Northern Idaho and Variety Response to Tillage. NezPerce Co. Crop School. Lewiston, ID. 63 attended.

Guy, S.O. 21 Feb., 2002. Variety Performance in Northern Idaho and Variety Response to Tillage. Boundary Co. Crop School. Bonners Ferry, ID. 24 attended.

Guy, S.O. 22 May, 2002. Six Years of Crop Production Research and Extension Work. UI/PSES Promotion Meeting. Moscow, ID. 45 attended.

Guy, S.O. 23 July, 2002. Idaho Barley Production and Varieties. Taiwan Trade Team Meeting. Moscow, ID. 11 attended.

Guy, S.O. 25 July, 2002. Idaho Barley Production and Varieties. Japanese Trade Team Meeting. Moscow, ID. 10 attended.