Reduced Tillage in a Three Year Potato Rotation

Harold Collins[1], Rick Boydston[1],
Ashok Alva[1], Fran Pierce[2] and Phil Hamm[3]

[1] USDA-ARS Vegetable and Forage Research Unit, Prosser, WA
[2] Center for Precision Agriculture, Washington State University, Prosser, WA
[3]Oregon State University, Hermiston Experiment Station, Hermiston, OR

Introduction

Tillage in most crop rotations is used to prepare seed-beds, control weeds and other pests, manage crop residues, reduce soil compaction, and incorporate fertilizer and pesticides. However, excessive tillage increases soil erosion, reduces soil carbon, increases fuel and labor needs, and reduces soil moisture. Reduced tillage practices in agronomic crops such as cereal grains, corn, soybeans, cotton, and sorghum were introduced over 50 years ago to conserve soil and water. Conservation tillage systems are designed to manage crop residues on the soil surface with reduced or no-tillage. Conservation tillage systems are commonly referred to as stubble mulching, eco-fallow, reduced tillage, minimum tillage, no-tillage and direct seed. The goal of these systems is to maintain sufficient residue on the soil surface to reduce wind and water erosion, reduce energy use, conserve soil and water resources, reduce costly inputs and improve profits. The most complete conservation tillage system, no-tillage, leaves the maximum amount of crop residues on the soil surface and produces the least amount of soil disturbance. Because residue or plant material cover is the key to erosion control, the no-tillage system can reduce soil erosion to near natural levels. These systems are used throughout the United States and can be applied to all kinds of crop residues and many cropping systems.

Adoption in Washington State has been slow compared to the rest of the nation and implementation in irrigated counties is currently small. Limited adoption of reduced tillage in many cropping systems, whether these are irrigated or dryland, has been due to a perception of poor crop stands or delayed emergence due to cool soils, disease and pest problems, poor soil-seed contact, poor weed control, inability to manage crop residues, inability to incorporate fertilizers and pesticides, and the higher cost to replace equipment.

Developments in reduced tillage or no-tillage seeding equipment and field implements that handle crop residues and improved herbicide and fertilizer formulations are now available making it feasible for growers to implement reduced tillage. In vegetable crops, the difficulty of controlling weeds and the need for custom-built equipment continues to slow the acceptance of reduced tillage practices. Commercial seeders which plant into stubble have been developed for most agronomic crops, but are only now becoming available for vegetable crops.

Increasing concern about the sustainability of irrigated crop production systems and environmental quality has emphasized the need to develop and implement management strategies that maintain and protect soil, water and air resources. Production in irrigated regions typically occurs on soils low in organic matter that are highly susceptible to agri-chemical leaching under poor irrigation scheduling, and wind erosion when soils are left fallow. Adopting conservation tillage to reduce erosion, increase N use efficiency, and build organic matter would improve soil and environmental quality under irrigated farming systems. The objectives of this research are to develop a reduced tillage system in potato based rotations using existing field equipment with minor modifications. Specific objectives are to determine the effects of reduced tillage on 1) weed dynamics, 2) soil organisms and their activities (i. microflora, ii. plant pathogens, iii. nematodes, and iv. insects), 3) carbon and nitrogen cycling and trace gas (CO_2, N_2O, CH_4) fluxes, and 4) changes in nitrogen use efficiency. Results presented here describe the current approach taken, identifying the types of equipment and operations used, some preliminary findings related to changes in several soil chemical, physical, and biological properties, as well as, yield.

Field Study

Beginning in 2001 a study was established to evaluate reduced tillage practices in a three-year crop rotation of sweet corn/ sweet corn/ potato. The trials are located at the USDA-ARS research field site located near Paterson, WA on a Quincy loamy sand (mixed mesic Xeric Torripsamments) soil containing 0.4% SOM. These experiments were conducted under solid set irrigation in 2001 and 2002. In 2003, the study was moved under center pivot irrigation with plot size substantially increased to accommodate commercial sized tillage, planting and harvesting equipment. The experimental design is a randomized strip split plot design with four replications that includes four N treatments in each tillage treatment. The treatments consist of pre-plant N application rates of 50 and 100 lbs N ac^{-1} with remaining N (total N at 300 lb N ac^{-1}) applied in-season by center pivot, beginning 3 weeks after emergence. Commercial hilling equipment and potato planters are not currently designed to handle large amounts of crop residues. Therefore, we developed a strategy that uses equipment currently available to growers. The primary pieces of equipment used in these studies include: Flail chopper, Sunflower™-chisel-chopper-packer, Supercoulter™, 13 shank bed splitter mark-out rig, six-row Harriston™ pick potato planter, and twelve-row reduced till corn planter. Tables 1 and 2 provide a listing of field operations, equipment used, in addition to herbicide and pesticide application schedules.

Table 1. Timing of field operations and equipment used in the 2003-2004 tillage trials at Paterson, WA. Trials conducted in a three year rotation (sweet corn/ sweet corn/ potato).

Date	Operation	Conventional tilled	Reduced till
Potato			
Oct, 2003	Residue Management	Flail chop corn residues	Flail chop corn residues
March 13, 2004	Pre-plant fertilization	Valmar™ spreader, (100 lbs N, 29.5 lbs P, 98.4 lbs K)	Valmar™ spreader, (100 lbs N, 29.5 lbs P, 98.4 lbs K)
March 16, 2004	Primary tillage	JD8760™ & 13’ **2-passes** Sunflower™ chisel/ chopper/ packer	**None**
March 16, 2004	Mark-out	13-shank bed splitter	13-shank bed splitter
March 17, 2004	Plant	6-row Harriston™ pick planter	6-row Harriston™ pick planter
April 5, 2004	Drag-off	6-row rodweeder	**None**
April 22, 2004	Dammer dike	Dammer diker	Dammer diker
Sept 1, 2004	Harvest	3-row potato digger	3-row potato digger
Sweet Corn yr 1 and 2			
March 31, 2004	Pre-plant fertilization	Valmar™ spreader (48 lbs N/A, 48 lbs P, 54 lbs S, 0.95 lbs B)	Valmar™ spreader (48 lbs N/A, 48 lbs P, 54 lbs S, 0.95 lbs B)
March 31, 2004	Primary tillage	**2 passes**/plot with JD 8760™ & 13’ Sunflower™/packer.	None
April 7, 2004	Plant	12-row John Deere/ Orthmann™ Minimum Tillage planter UN32 applied at-plant at 10.3 gpa (36 lbs N/A).	12-row John Deere/Orthmann™ Minimum Tillage planter UN32 applied at-plant at 10.3 gpa (36 lbs N/A).
July 24, 2004	Harvest		

In season fertilizer applied through center pivot.

Table 2. Herbicide and pesticide applications used in the 2004 tillage trials at Paterson, WA.

Date	Operation	Conventional tilled	Reduced till
Potato			
April 24, 2004	Herbicide post-emergence	Matrix™ @ 1.5 oz/A Sencor™ @ 0.5 lbs ai/A, NIS @ 0.5% v/v.	Matrix™ @ 1.5 oz/A Sencor™ @ 0.5 lbs ai/A, NIS @ 0.5% v/v.
May 27, 2004	CPB†	Novodor™ (Bt) @ 4 qts/A	Novodor™ (Bt) @ 4 qts/A
June 2, 2004	CPB†	Entrust™ (Spinosad) @ 2 oz/A	Entrust™ (Spinosad) @ 2 oz/A
June 4 – July 17	Late blight control	Alternate Bravo WS™ 1 pt/A and Dithane F45™ @ 1.6 qts/A	Alternate Bravo WS™@ 1 pt/A and Dithane F45™ @ 1.6 qts/A
July 6, 2004	CPB†	Entrust™ @ 2 oz/A	Entrust™ @ 2 oz/A
July 9, 2004	Herbicide	Poast™ @ 2.5 pts/A	Poast™ @ 2.5 pts/A
August 4, 2004	Dessicant	Reglone™ @ 2 pts/A + NIS @ 0.5% v/v	Reglone™ @ 2 pts/A + NIS @ 0.5% v/v
Sweet Corn yr 1			
March 22, 2004	Remove winter cover crop	2003 wheat cover removed with Glystar Plus™ @ 1 lb ai/A	2003 wheat cover removed with Glystar Plus™ @ 1 lb ai/A
April 13, 2004	Herbicide	Lasso™ @ 2 lbs ai/A. herbicide incorporated with 0.35” irrigation	Lasso™ @ 2 lbs ai/A. herbicide incorporated with 0.35” irrigation
May 10, 2004	Herbicide	Aatrex™@ 1 lb ai/A , COC	Aatrex™ @ 1 lb ai/A , COC
Sweet Corn yr 2	No cover crop		
April 13, 2004	Herbicide	Glystar Plus™ @ 1 lb ai/A. Lasso™ @ 2 lbs ai/A. Herbicide incorporated with 0.35” irrigation	Glystar Plus™ @ 1 lb ai/A. Lasso™ @ 2 lbs ai/A. Herbicide incorporated with 0.35” irrigation
May 10, 2004	Herbicide	Weedar 64™ @ 1 lb ai/A	Weedar 64™ @ 1 lb ai/A
Jun 1, 2004	Herbicide	Accent™ 0.66 oz/A, COC 1% v/v, UN32 2.5% v/v	Accent™ 0.66 oz/A, COC 1% v/v, UN32 2.5% v/v

†CPB – Colorado potato beetle control.

Reduced Tillage in Potato Rotations

Minor modifications to equipment and cultural practices to maintain residue cover by reduced tillage were implemented in these trials. Reduced tillage has had limited testing in potato production under center pivot irrigation. Tillage is primarily used in potato production to control weeds, facilitate planting, and increase the ease of later cultivation and harvest. Compared to conventional tilled systems that leave little crop residue on the soil surface, our system maximizes residue retention and requires fewer trips across the field thereby saving time, labor, capital, and energy. As the study progresses we will include economic assessments of this approach. Within the potato reduced tillage treatments, the majority of soil disturbance resulted from the 13-shank bed splitter used in hill formation, the six-row planter and at harvest the unavoidable disturbance resulting from the potato digger. This strategy reduced the total number of passes from nine to six and soil disturbance operations from seven to four, including harvest, compared to those used in conventional tilled treatments. For sweet corn, field operations were reduced 50%. We are planning to eliminate the dammer diker operation in the 2005 crop year. Herbicide and pesticide treatments were similar between both treatments (Table 2). Except for the fungicide used as a seed treatment (Alderbark MZ™), no in furrow systemic pesticides were used. Bt (Novodor™ @ 4 qts/A) and Spinosad (Entrust™ @ 2 oz/A) formulations were used for Colorado potato beetle control.

The following series of photos show the residue distribution following harvest in 2003 (Fig 1), the residue remaining in the reduced tillage treatments after hilling 2004(Fig 2) and the

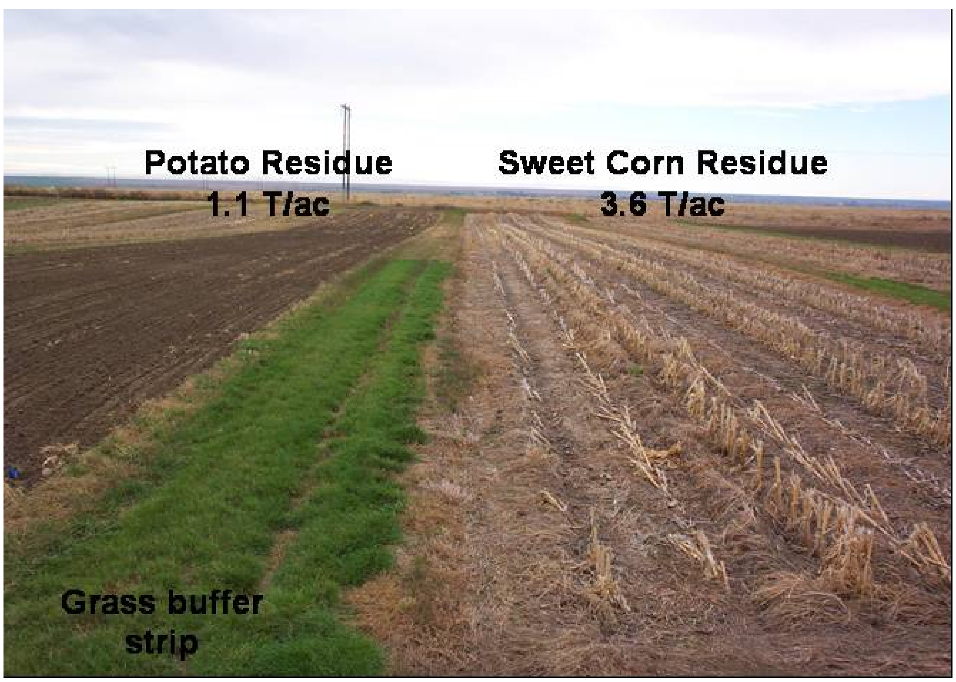


Figure 1. Residues remaining following harvest of potatoes and sweet corn at the Paterson, WA field site, fall 2004. Photo by S. Haile-Mariam, WSU.

soil protection by residues observed in the reduced tillage plots after a wind storm in April 2004 following emergence (Fig 3). Note the shifting of hills in the conventional tilled treatment vs. the effect of residues on hill integrity in the reduced till treatment. Potato plants were damaged by the blowing sand in the conventional tilled but recovered, with minimal damage observed in the reduced till.

Figure 2. Residue distribution in the reduced tillage plots following potato hilling operations prior to planting. Photo by M. Seymour, USDA-ARS.

Figure 3. Potatoes emergence from conventional tilled and reduced tilled plots. Both treatments were dammer diked in 2004. Picture taken following a period of high winds in April, 2004. Photo by M. Seymour, USDA-ARS.

Soil Characteristics

A reduction in tillage changes the distribution of crop residues, reduces soil disturbance, and alters the decomposition rate resulting in increased biological activity and increased soil organic matter. All these lead to increased soil aggregation and therefore improved soil structure. Table 3 provides values of selected soil physical, chemical and biological properties in conventional tilled and reduced tilled potato and sweet corn treatments.

Table 3. Selected soil physical, chemical and biological properties in conventional tilled and reduced tillage treatments the USDA-ARS, Paterson field site.

Crop	Potato		Sweet corn yr1		Sweet corn yr2	
	Conv. Till	Reduced	Conv. Till	Reduced	Conv. Till	Reduced
Soil density (g cm^{-3})	1.20 (0.02)	1.24 (0.02)	1.26 (0.02)	1.32 (0.02)	1.39 (0.03)	1.48 (0.03)
pH	6.2	6.3	6.2	6.2	6.2	6.2
Soil respiration (lbs C ac^{-1} soil)	578 (32)	646 (54)	626 (55)	602 (46)	676 (29)	684 (41)
Microbial Biomass (lbs C ac^{-1} soil)	614 (48)	640 (64)	635 (64)	593 (44)	714 (45)	756 (49)
N-mineralization (lbs NO_3ac^{-1} soil)	21.5 (1.5)	21.5 (2.3)	20.0 (2.1)	21.5 (1.2)	23.0 (1.6)	20.0 (2.3)

Conv. – Conventional. Values in parentheses are standard error of the mean. N-mineralization based on 21-day incubation.

Organic C and N concentrations and microbial biomass and activity are known to increase greatly in the surface layer of soils under reduced tillage, much more than under conventional inversion tillage. Tillage affects the amount of soil organic matter (SOM) buildup in two fundamental ways, (1) through the physical disturbance and mixing of soil and the exposure of soil aggregates to disruptive forces and (2) through controlling the incorporation and distribution of plant residues in the soil profile. Of the many biological processes influenced by conservation tillage, mineralization and immobilization of plant nutrients are most important. Mineralization is the process regulating the release of plant nutrients through microbial decomposition of crop residues or soil organic matter. Immobilization is the process where released nutrients are incorporated into the soil micro-flora during decomposition and are temporarily rendered unavailable to plants. At this early point in the study there are no significant differences in any of the parameters listed in Table 3, except for soil density.

Compaction is a downside to reduced tillage at least in the short term. This can be especially true of no-tillage which by definition does not allow any tillage other than that needed to place and cover the seed. If a soil is compacted before the start of no-tillage, there is nothing mechanical that can alleviate the compact soil condition. Soil density showed an increase from 1.20 g cm^{-3} in potatoes to 1.48 g cm^{-3} in the second year of sweet corn. This higher density should be reduced in the 2005 crop year because the reduced tillage potato treatments include the operation using the 13-shank bed splitter at hilling. The shanks of the bed splitter rip to a depth of 30 cm (12 in.), which reduces compaction.

Soil moisture and temperature were measured daily from May 7th through August 20th, 2004. Figure 4 shows soil temperature and moisture profiles for the 2004 crop year. Field water

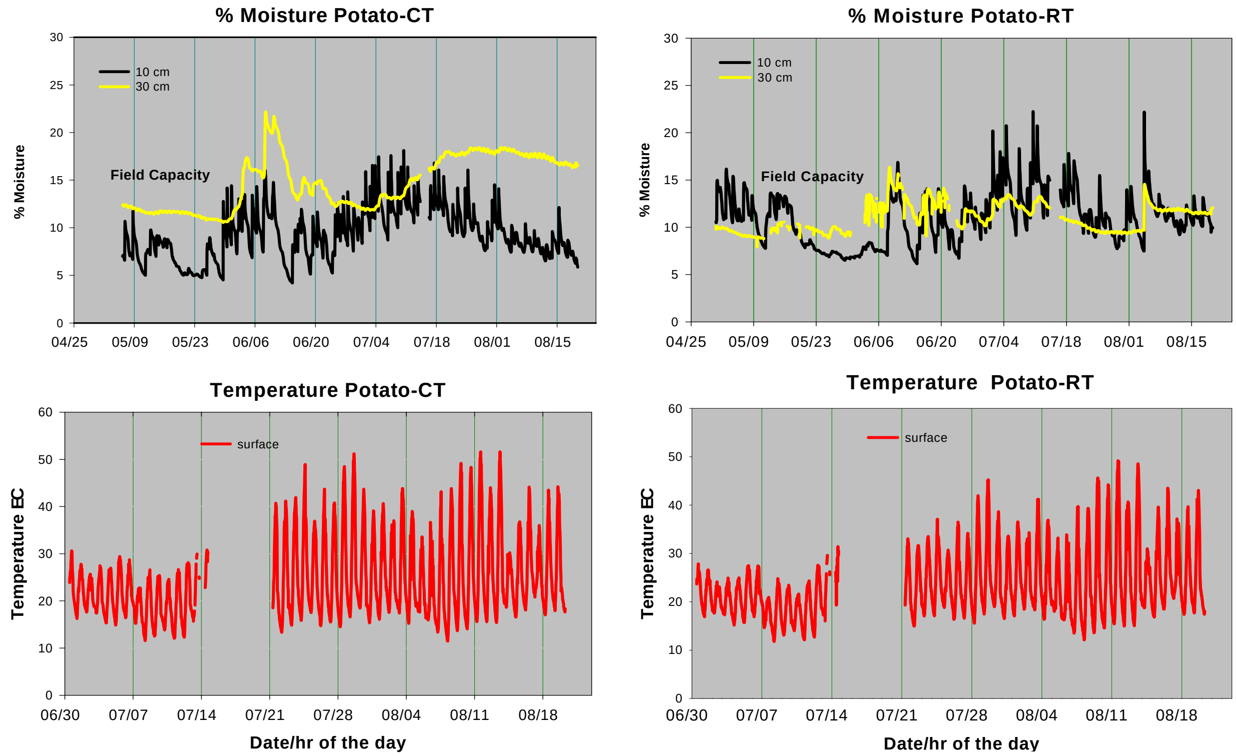


Fig 4. Soil moisture and temperature for tillage treatments during the 2004 CY.

holding capacity for the Quincy soil at this location has been determined to be 13% by volume. Fluctuations of soil moisture in the surface 30 cm (12 in.) were greatest in the conventional tilled compared to the reduced tillage treatments. The reduced tillage treatments showed a greater maintenance of soil moisture near field capacity throughout the growing season that is attributed to surface residues reducing the evaporative loss from soil. Soil temperature in the reduced tillage were 2-3 degrees cooler than the conventional tilled treatments with lower incidence of soil temperatures exceeding 40^{o}C (105^{o}F) in July and August.

Crops grown under reduced tillage use water more efficiently. The water-holding capacity of the soil increases, and water losses from runoff and evaporation are reduced. For crops grown with irrigation in drought-prone soils, this more efficient water use can translate into higher yields.

Soilborne Pathogens

Reduced tillage and large amounts of residues create a new environment or habitat. Both insects and plant pathogen communities react and adapt to the new environment. In general, a reduced tillage environment favors soil-dwelling and litter-dwelling insects and soil-borne diseases over foliar-feeding insects and foliar diseases. Abundant crop residues on the soil surface favor pathogens that over winter in infested crop residue. This infested residue can serve as a source of inoculum (or spores) for pathogen survival and also maintains favorable moisture and temperature conditions in the top 6 inches of a soil where pathogens are most active. Table 4 provides counts of three potential soilborne pathogenic fungi. In general, populations of these fungi trended to increase with higher fertilization rates under both tillage regimes. *Pythium* and *V. dahliae* populations within the conventional tilled potato treatment were greater than the reduced tillage treatment. Whereas, *Fusarium* populations were greater under reduced tillage for potato as well as the two corn treatments.

Table 4. Counts of *Pythium, Fusarium* and *V. dahliae* in conventional and reduced till potato and corn trials at Paterson WA, 2004.

		Conventional Tillage			Reduced Tillage		
Crop	***Fert.†***	***Pythium***	***Fusarium***	***V. dahliae***	***Pythium***	***Fusarium***	***V. dahliae***
		------------------ Cfu's g-1 soil -------------------------					
Potato	1	128	1237	30	38	1856	21
	2	167	1437	42	81	2365	30
	3	89	1641	54	73	1932	46
	AVG	**128**	**1439**	**42**	**64**	**2051**	**32**
Corn-1yr	1	80	1242	11	131	1482	14
	2	125	1423	11	103	1191	27
	3	101	1107	8	127	1538	18
	AVG	**102**	**1257**	**10**	**120**	**1404**	**20**
Corn-2yr	1	94	1334	13	86	1247	28
	2	100	963	17	95	1362	26
	3	101	1076	10	113	1294	12
	AVG	**98**	**1124**	**13**	**69**	**1301**	**22**

†Fertilizer. Pre-plant/In season: 1 - 50/250; 2 -100/200; 3 – 100/300.

Fusarium counts include both pathogenic and non-pathogenic species/strains and typically show an increase in population with increasing residues. *V. dahliae* numbers decreased in subsequent corn crops following potatoes as expected since corn is not a host for *V. dahliae*. Pathogens that have been shown to increase in crops currently grown under reduced tillage conditions include Fusarium head blight, tan spot, leaf blotch, Cephalosporium stripe, take-all and Rhizoctonia root rot in wheat, flax wilt, white mold on canola and legumes, and Ascochyta blight of chickpea. Some pathogens are actually eliminated or cause less disease in reduced tillage. Prominent examples include foot rot and common root rot of wheat, and blackleg of canola. Some diseases, such as white mold on canola and potato can be increased or decreased depending on the rotation. For some diseases, such as stem or leaf rusts, crop residues have little or no influence on infections because the source of these diseases are spores that are carried long distances in the wind. These infections originate from spores coming from diseased plants and not from spores arising from the residue. However, the intensity or severity of diseases caused by some other foliar pathogens may increase with the presence of residues because the residue also serves as an inoculum source and because the stubble modifies the microclimate.

Generally, the amount of residue does not influence which disease is most common or the ratio of the pathogens that might be present. The amount of residue only contributes to the intensity of a disease potential. For example, common scab in potatoes is commonly associated with high residue conditions. Although not measured in previous years, we will monitor this pathogen in future analyses. Seed-treatment fungicides are not effective generally against soil-borne diseases with the exception of damping-off diseases that act directly on the seed or emerging seedling caused by *Pythium* or *Rhizoctonia,* or when the pathogen is transmitted by seed, such as *Rhizoctonia*-caused black scurf or silver scurf. Thus, management of these diseases relies heavily on good cultural management and host resistance.

Weeds

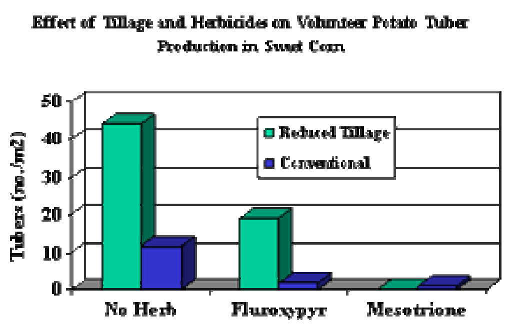
Changes in herbicide selection, timing of application, and interactions of herbicides with crop residues can also result in specific weed species shifts under various tillage systems. Crop residues left on the soil surface can adsorb herbicides, reducing the amount reaching the soil surface. Changes in soil micro-environment due to crop residues can also affect persistence of herbicides in the soil and length of residual weed control. Crop residues can impact the establishment and growth of weed seedlings. Heavy residues shade the soil creating a moist and cool micro-site, which can delay or prevent germination of weed species that require warmer temperatures, greater fluctuation in temperatures, or light for germination.

Establishment of some weed species is favored by these conditions and weed species shifts can result. Decaying crop residues may tie up soil nitrogen in the top several centimeters of soil where most weed seeds germinate and may release allelochemicals that delay or prevent weed seed germination. Decaying cover crop residues of cereal rye, white mustard, and hairy vetch have all been shown to reduce weed density in the following crop. How various weed species respond to reduced nitrogen or allelochemicals results in weed species shifts. Many studies have measured increases in annual grass weeds in reduced or no till systems. We will be addressing some of these issues in the future.

Weed control in potatoes is accomplished primarily with a combination of herbicides and cultivation. A common weed control system in potato production in the Western United States is a combination of a timely harrow (drag off) and hilling operation plus a herbicide application. Herbicides are available that reduce the need for cultivation to control annual weeds after planting. Yield of potato was increased by eliminating post plant cultivation and controlling weeds with herbicides alone in North Dakota.

Volunteer potato is the most common perennial weed problem in Pacific Northwest potato rotations. Un-harvested tuber density following a commercial potato harvest ranges from 1.5 to10 times the number of potato tubers typically planted for a potato crop. In some potato growing regions, potato tubers left in the ground freeze and do not present a problem in the following crop. However, in the mild winter climate of the Columbia Basin of Washington, soil temperatures at the 10 cm depth, reach -2 C (required to kill tubers) only 4 in 10 years, and only 1 in 10 years at the 20 cm depth. Volunteer potato can be suppressed in corn with a combination of herbicides and cultivation. Herbicides alone are able to suppress vegetative growth of volunteer potato and tuber mass in corn, but do not often reduce the number of new tubers produced. Cultivation one week following post-emergence applied Fluroypyr (Starane™) or dicamba (Clarity™) herbicides greatly reduces the number of new tubers produced. Mesotrione (Callisto™) was recently registered for use in corn production and suppresses volunteer potatoes when applied either pre-emergence or post-emergence. Mesotrione has not been tested for volunteer potato control under reduced tillage systems in corn but preliminary research suggests mesotrione may adequately reduce new tuber production without subsequent cultivation. Many benefits can be derived from reducing tillage in PNW irrigated cropping systems. Shifts in weed species should be expected whenever altering tillage or cropping practices. Dependence on effective herbicides and crop residues to suppress weeds is increased as tillage is reduced. Many effective herbicides are available in corn, wheat, and potatoes to manage most weeds that are currently present in PNW crop rotations. Integrating many weed control strategies such as, cover crop use, herbicide use, and cultural practices can help delay or prevent the selection of dominant weed species in any cropping system.

A study was initiated in 2004 to evaluate volunteer potato control and new tuber production with fluroxypyr and mesotrione applied postemergence in reduced and conventionally tilled sweet corn. Sweet corn, var. Seneca 1861, was planted April 7, 2004. Twenty whole seed potatoes were hand planted near the two center rows of four-row corn plots April 8, 2004. Dimethenamid-P was applied preemergence to control all weeds other than volunteer potato. Postemergence herbicides were applied May 17, 2004 with a backpack sprayer delivering 20 GPA. Fluroxypyr was applied at 0.25 lb ae/a and mesotrione at 0.094 lb ai/a. Fluroxypyr treatments included nonionic surfactant at 0.5% (v/v) spray solution. Mesotrione application included COC at 1% and UAN32 at 2.5% (v/v) spray solution. Volunteer potatoes were 8 inches tall and sweet corn 7.5 inches tall when herbicides were applied. Conventional tilled plots were cultivated by hand at 10 days after herbicide applications by removing the foliage of potatoes with a hoe, 1 to 2 inches below the soil surface. Potato control, tuber production, and sweet corn yield were determined. Potato tubers were dug by hand on July 12, 2004. Fluroxypyr injured sweet corn from 3 to 5% and mesotrione injured sweet corn from 15 to 30% at 10 DAT. Fluroxypyr caused slight bending of stalks at the base, whereas mesotrione caused chlorosis (white bleaching of leaves). Injury was short lived with both herbicides and by early June was less than 10% with mesotrione. In plots that received no postemergence herbicide, cultivation in late May greatly increased potato control in late June to 88%. Potato control in late June was not improved by cultivation in mesotrione treated plots and ranged from 97 to 100% control. Cultivation improved potato control in late June in fluroxypyr treated plots, which averaged 89% control in reduced tillage plots and 96% control in conventional tilled plots.



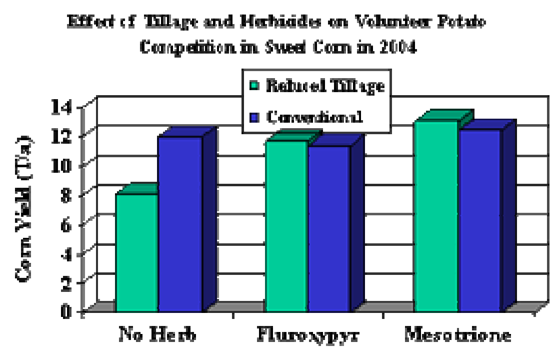


Fig. 5. Effect of mesotrione and fluroxypyr on volunteer potatoes in corn.

Sweet corn yield was reduced by 5 ton/acre by volunteer potato in reduced tillage plots when no herbicide was used compared to mesotrione treated plots. In conventionally tilled plots, sweet corn yielded similar among all treatments, averaging 12 ton/acre. Volunteer potato produced 44, 19, and 0.3 tuber/m^2 in reduced tillage plots treated with no herbicide, fluroxypyr, and mesotrione, respectively. Volunteer potato produced 18, 1.8, and 1.1 tuber/m^2 in conventionally tilled plots treated with no herbicide, fluroxypyr, and mesotrione, respectively.

Yields

Solid set irrigation, 2001-2002 crop years

Under solid set irrigation, potato yields averaged 32.5 t ac^{-1} for both years, with no significant yield difference between conventional tilled and reduced tilled treatments. Sweet corn yields declined in the second year of the study. Nitrogen immobilized in the previous year's residue is the suspect cause. We are currently initiating studies to determine the degree of fertilizer nitrogen interception by residues during fertigation and the length and extent of the immobilization. The timing of release of the immobilized N will be important to issues of maturity and tuber quality.

Center pivot irrigation, 2003-2004 crop years

There were no significant differences found in potato, sweet corn or field corn yields between treatments receiving variable fertilizer rates or timing of fertilizer applications under center pivot irrigation, so only treatment averages are presented (Table 5). Field corn was initially planted in the 2003 crop year. However, because of difficulties in managing variable water requirements between field corn and potatoes, we changed to sweet corn to better control water needs. We also changed to sweet corn because of its greater market value and higher rate of decomposition than field corn that would reduce difficulties with marking out, planting and harvesting equipment. Potato yields averaged 31.8 and 30.7 t ac^{-1} for the conventional and reduced tillage plots, respectively. There was a decline in potato yield in 2004, which was attributed to an infestation of leafhoppers. Figure 5 provides a comparison of tuber size distribution for the conventional (CT) and reduced tillage (RT) potato plots during the 2004 crop year. There is a trend for 2-3 t ac^{-1} increase in the >8 ounce size classes for the reduced tilled potato plots. Sweet corn yields average 10.2 and 9.4 t ac^{-1} for the conventional and reduced tillage plots, respectively, but were not significantly different.

Table 5. Potato, sweet corn and field corn yields for tillage trials at Paterson, WA.

	Sweet Corn yr1		**Sweet Corn yr2**		**Potato**	
Year	**CT**	**RT**	**CT**	**RT**	**CT**	**RT**
	----------------------- **T/acre** -----------------------					
Solid set						
2001	**8.8**	**8.8**	**8.8**	**8.8**	**33.5**	**32.1**
2002	**7.5**	**7.4**	**6.5**	**6.7**	**32.6**	**32.5**
Center Pivot						
2003	**†4.5**	**†4.1**	**†4.7**	**†4.4**	**33.1**	**31.2**
2004	**9.9**	**10.4**	**9.3**	**9.4**	**27.8**	**27.0**
4 yr Average	**8.7**	**8.9**	**8.2**	**8.3**	**31.8**	**30.7**

CT- Conventional tillage, RT-Reduced tillage. †Field Corn. (150-180 bu/ac).
Potato variety – Ranger Russet.

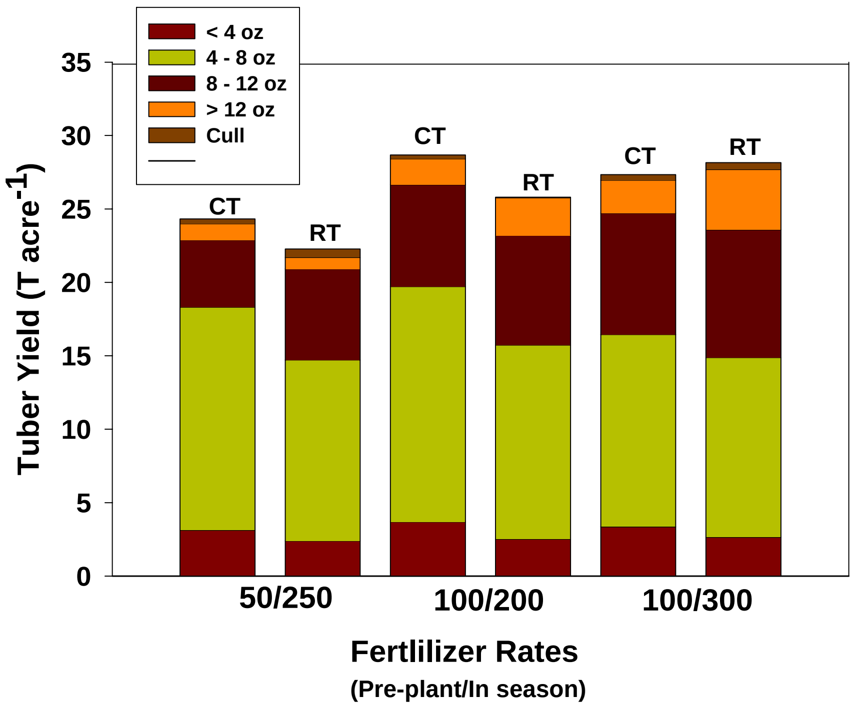


Figure 6. Comparison of tuber size distribution for the conventional (CT) and reduced tillage (RT) potato plots during the 2004 crop year.

Conclusion

We have shifted our focus from small plot research to one incorporating commercial sized equipment to better represent industry practices. Thus far we have found no significant differences in soil properties, pathogens, weeds and yields between the conventional tilled and reduced tillage treatments. These studies will continue to evaluate long-term changes in soils, weeds and disease. The decrease in field operations should (will) result in reductions in production costs to growers. We realize that the approach taken here may not be acceptable to all growers because of equipment limitations or perceptions of "how a potato field should look." Each system will have to be fine tuned to fit soils, growing conditions, grower management constraints, different potato varieties, length of rotation and crop selection within a rotation. We encourage growers to modify this approach and incorporate strategies that fit their unique situations and soils. Findings related to the economics of our trials will be presented in the near future, possibly as early as the end of the 2005 cropping season.

Acknowledgments

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