Tillage and Establishment System Effects on Annual Ryegrass Seed Crops

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Background

- Annual ryegrass is one of Oregon's most important seed crops with yearly production averaging 123,461 acres and value at the farm gate of $80 million.
- Annual ryegrass has been produced on some farms continuously for decades without rotation of crops or farming practices.
- The long-term influences of continuous cropping of annual ryegrass have not been examined nor have any long-term practices been evaluated in this crop.
- Our objective was to determine the effects of tillage and establishment systems on annual ryegrass seed crops over a 9-year period.

Annual ryegrass spike (TG Chastain photo)

Long-term Trials

Six tillage and establishment systems were employed in the study:

- **CT** - Continuous conventional tillage
- **NT** - Continuous no-till
- **NT/CT** - NT/CT cycle alternate year tillage
- **Vol/CT** - Volunteer/CT cycle alternate year tillage
- **Burn + NT/CT** - Burn and NT/CT cycle alternate year tillage
- **Vol/NT/CT** - Volunteer/NT/CT cycle with tillage every 3rd year

Ryegrass seedling (TG Chastain photo).

Long-term Trials

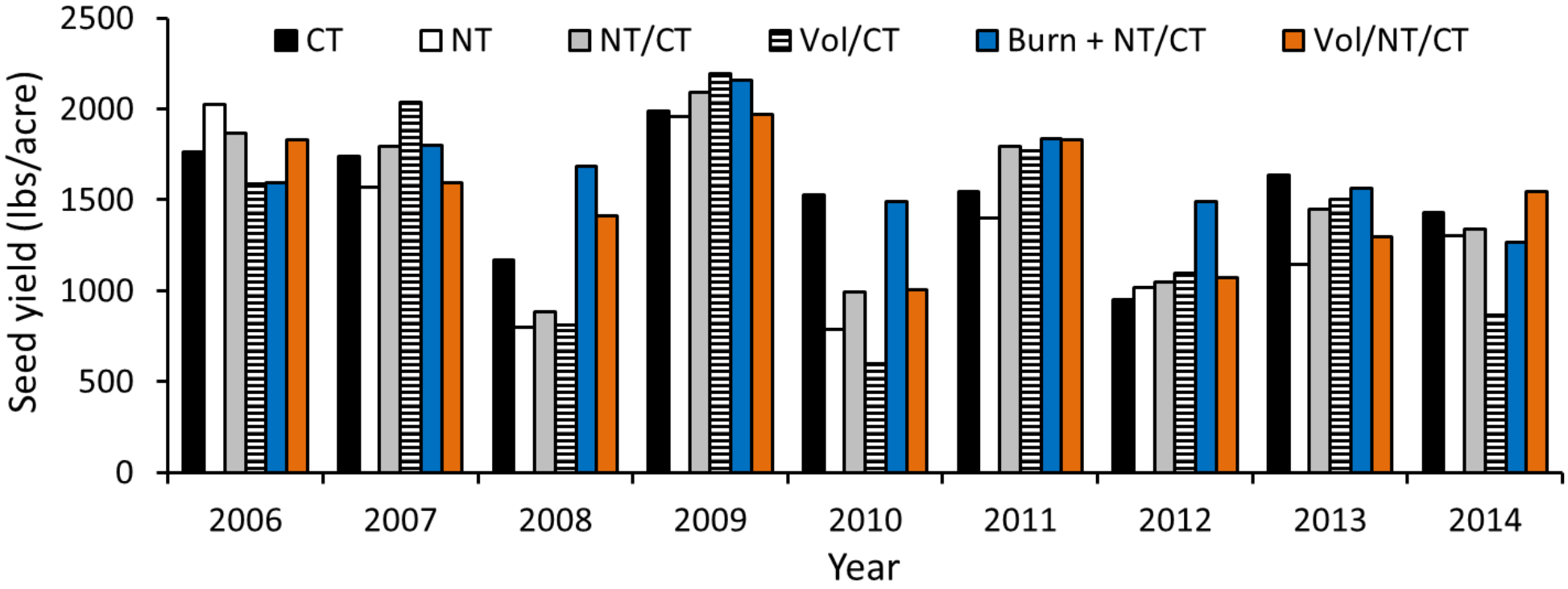
- Trials were conducted at Hyslop Farm from 2005 to 2014.
- Planted ‘Gulf’ except Vol where shed seed formed the stand.
- Rows were created in Vol by row-spray removal of 75% of stand
- Small-plot swather and combine were used for seed harvest, seed cleaned before yield determination

Small-plot swather

Plot drill

Small-plot combine

Seed Yield



- Tillage and establishment system x environment interaction effects governed seed yield in annual ryegrass over the 9 years.

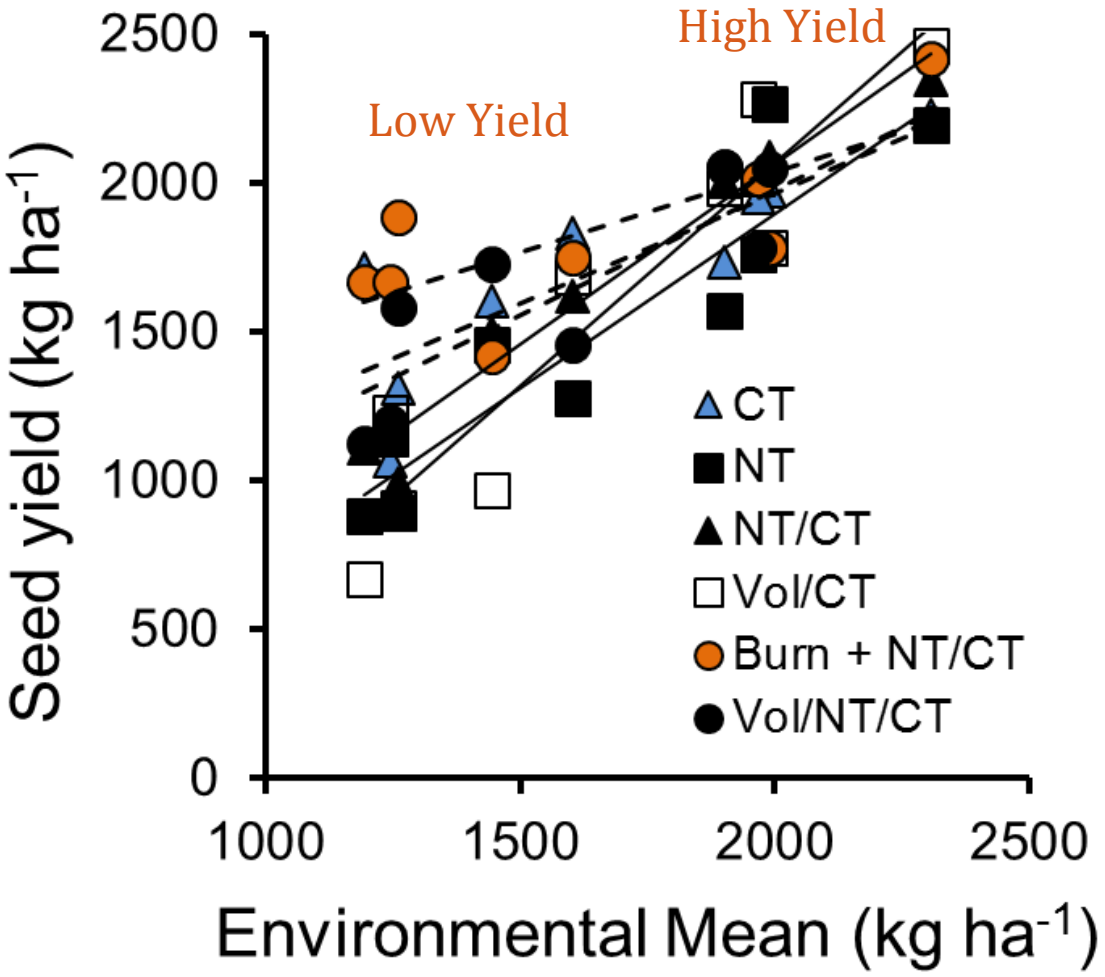
Seed Yield Environments

Yield Environment	April-June		Seed Yield
	Temperature	Rainfall	
	°F	inches	lbs/acre
High	57.1	5.9	1822
Intermediate	55.4	6.1	1362
Low	54.1	7.9	1101

- Three seed yield environments were identified over the 9 years.
- High yield environments had higher temperatures and lower precipitation in April-June (stem elongation to flowering) than other environments.

Stability Analysis

- Yields of the tillage and establishment systems were regressed on environmental means over the 9-year period.
- Low yield environments had greater variation in yield among systems than high yield environments.
- Burn + NT/CT, CT, and Vol/NT/CT systems produced up to 40% greater yields in low yield environments.



Stability analysis results. Fitted lines for CT, Vol/NT/CT, and Burn + NT/CT are dashed.

System Effect on Seed Yield

- Across environments, yield was greatest with Burn + NT/CT, CT, and Vol/NT/CT and lowest with NT.
- NT yield was 13% lower than CT.
- NT yield losses compared to CT were equivalent to one year's yield after 9 years.
- Increased tillage frequency from zero in NT to once every other year in NT/CT increased yields.

Effects of tillage and establishment systems on seed yield after 9 years

System	Tillage Frequency	Seed Yield
	years	lbs/acre
CT	9	1530 b
NT	0	1334 d
NT/CT	4	1473 bc
Vol/CT	4	1387 cd
Burn + NT/CT	4	1654 a
Vol/NT/CT	3	1507 b

Means followed by the same letter are not different

System Effect on Seed Yield

- Straw and stubble removal by burning in Burn + NT/CT was accompanied by disturbance of residues in seedbed preparation in CT portion of the cycle.
- This combination in Burn + NT/CT produced an average 8% increase in yield over CT.
- Increased yield in Burn + NT/CT did not primarily come from Burn + NT portion of the cycle, rather CT was improved by having Burn + NT in the cycle.

Seed bed (TG Chastain photo)

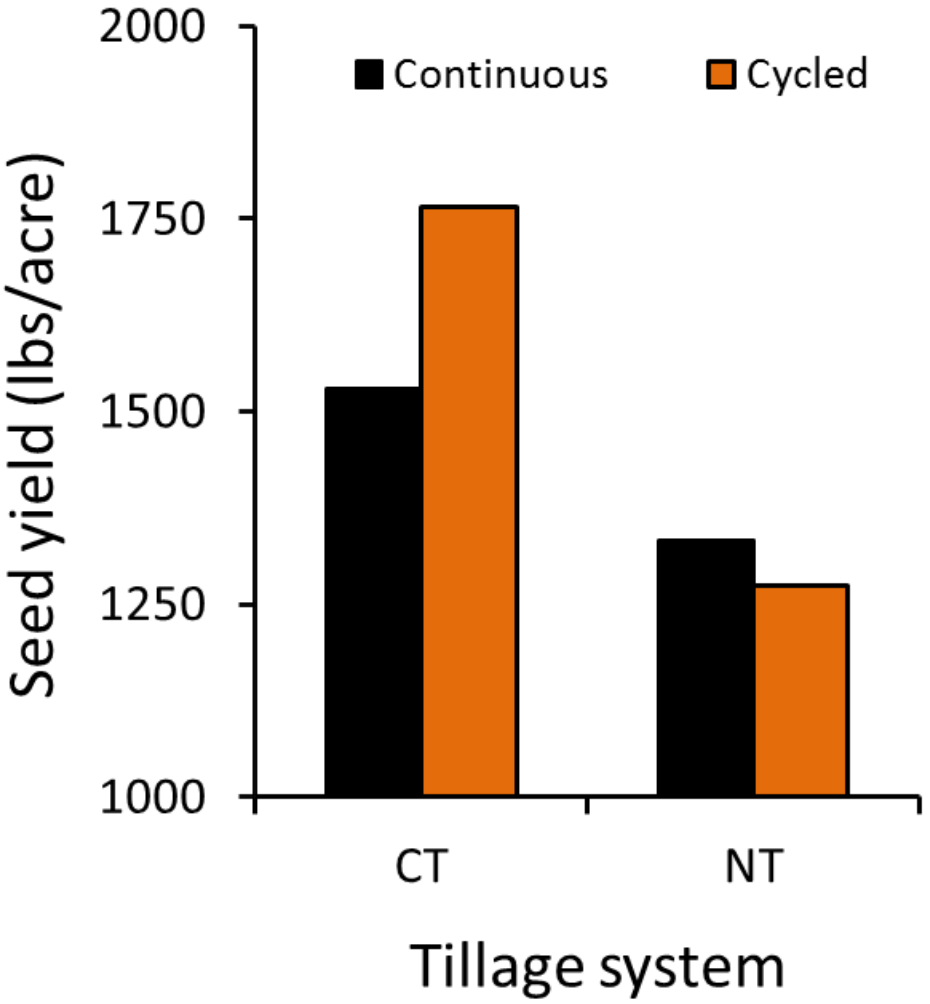
System Effect on Seed Yield

- Mixing in volunteer establishment and alternating with CT (Vol/CT) produced yields similar to NT/CT without increasing the frequency of tillage over NT/CT.
- A 3-year cycle of Vol/NT/CT produced yields similar to NT/CT and CT but tillage frequency was reduced to once every 3 years.
- Disturbance of residue in seedbed preparation in an alternate-year cycle increased yield over NT alone.

Crop residue (TG Chastain photo)

System Effect on Seed Yield

- Yield from the two tillage systems varied with frequency of use.
- **CT yields -** increased by 15.5% when cycled with NT, Vol, or Burn + NT over CT.
- **NT yields -** were not different whether continuous or cycled with other practices. Yields in NT were lessened because of predation by slugs.
- Best yield performance of NT came when coupled with burning.

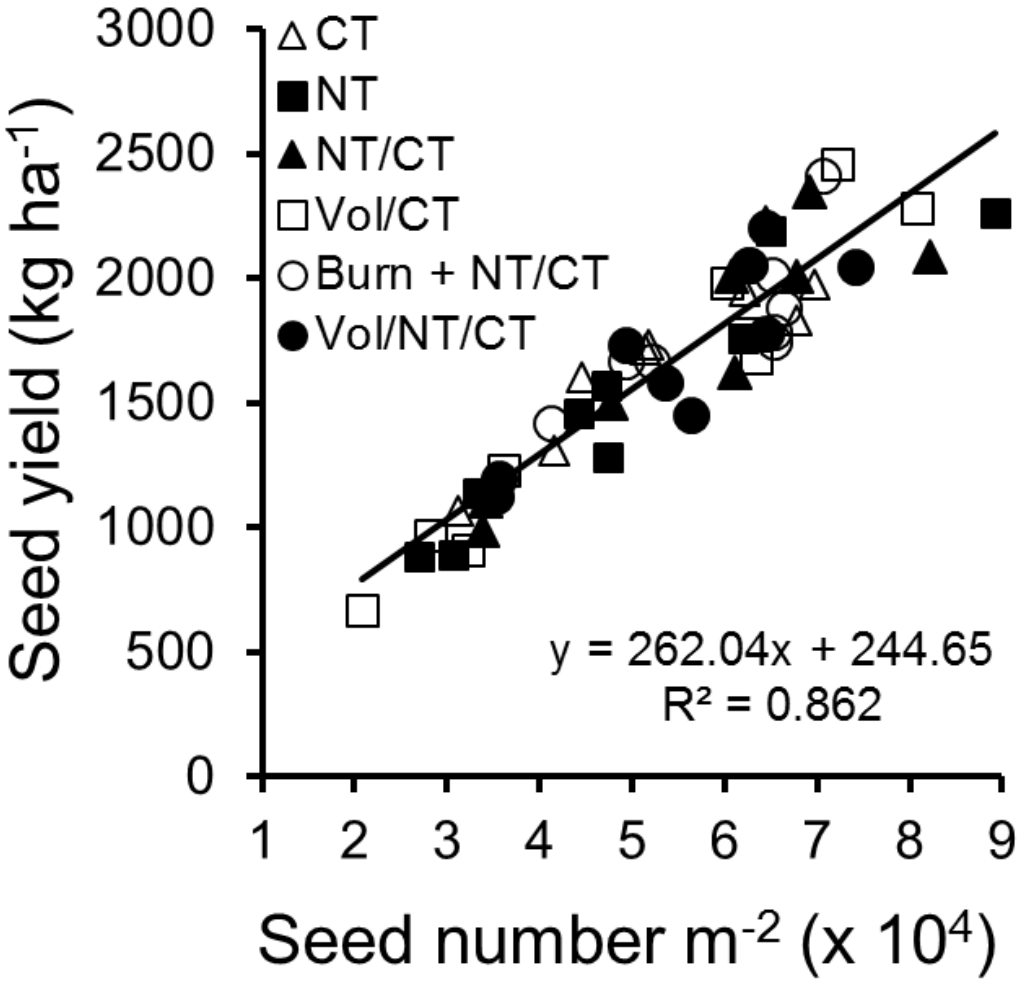


Effects of tillage systems on seed yield after 9 years

Seed Yield Relationships

- Seeds number m^{-2} was related to seed yield across environments and systems
- Seed weight was not related to seed yield (r = -0.077, P>0.05)

Annual ryegrass seed (USDA photo)



Relationship of seeds m^{-2} and seed yield in annual ryegrass grown in six tillage and establishment systems over 9 years.

System Effect on Cleanout

- Cleanout is the quantity of non-seed material that is removed in post-harvest conditioning of harvested seed.
- Cleanout was lowest in Burn + NT/CT and was greatest with NT. These systems represent the greatest range of differences in residue disturbance and removal.
- Increased cleanout without burning may have resulted from a change in dry matter partitioning to non-reproductive structures that were captured at harvest.

System	Cleanout
	%
CT	2.2 bc
NT	2.4 c
NT/CT	2.1 ab
Vol/CT	2.3 bc
Burn + NT/CT	1.9 a
Vol/NT/CT	2.3 bc

Means followed by the same letter are not different

System Effect on Soil

- Organic matter was up slightly in two of the systems: NT and Vol/CT.
- The lowest OM was in the system that included burning.
- No differences among systems in carbon were observed after 9 years.

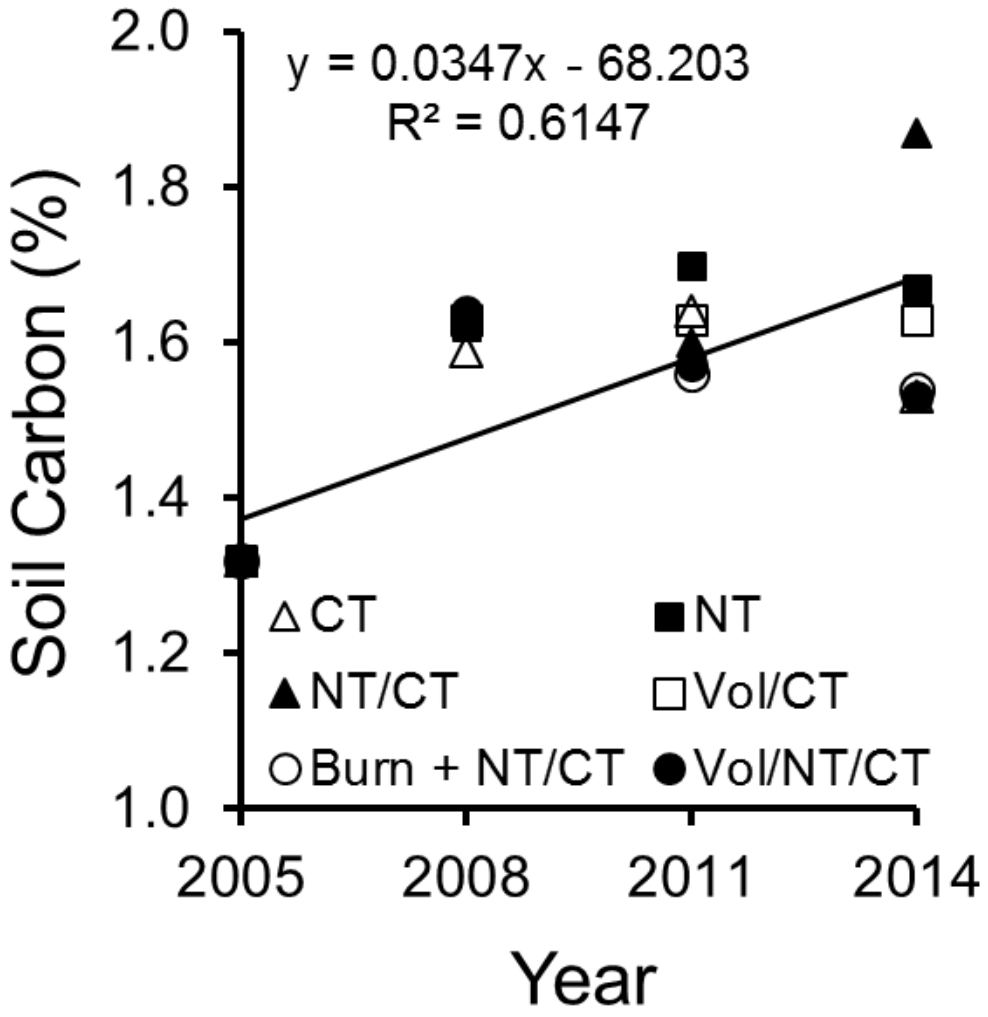
Effects of tillage and establishment systems on soil characteristics after 9 years

System	OM	C
	------ % ------	
CT	2.99 abc	1.53
NT	3.16 c	1.67
NT/CT	3.09 bc	1.87
Vol/CT	3.19 c	1.63
Burn + NT/CT	2.88 a	1.54
Vol/NT/CT	2.89 ab	1.53

Means followed by the same letter are not different

System Effect on Soil

- While there were no differences among systems in soil carbon, there was a small but significant increase in soil carbon over the 9 years.



System Effect on Soil

- Highest pH was found in Burn + NT/CT and Vol/NT/CT systems.
- Soil P was greatest with Burn + NT/CT.
- Soil K was highest with NT.

Effects of tillage and establishment systems on soil characteristics after 9 years

System	pH	P	K
		----- ppm -----	
CT	5.20 bc	116 b	142 a
NT	5.16 b	115 b	178 c
NT/CT	5.01 a	114 b	163 bc
Vol/CT	5.22 bc	107 a	137 a
Burn + NT/CT	5.28 c	125 c	153 ab
Vol/NT/CT	5.31 c	114 b	137 a

Means followed by the same letter are not different

Conclusions

- Annual ryegrass yield varied with environment and system with highest yields observed in warm, dry springs and with Burn + NT/CT.
- Among systems, Burn + NT/CT produced greater yields than CT. Lowest yields were observed with NT.
- Some tillage accompanied by disturbance of residues and occasional residue removal are needed to sustain yields in annual ryegrass.

Annual ryegrass seed field (TG Chastain photo)