LONG-TERM EVALUATION OF ANNUAL RYEGRASS CROPPING SYSTEMS FOR SEED PRODUCTION

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Introduction

Annual or Italian ryegrass (*Lolium multiflorum* Lam.) is grown on approximately 124,000 acres in the southern Willamette Valley. Production has occurred mostly on soils too poorly drained for cereal and vegetable crops, and on soils less productive than needed for higher value perennial grass and clover seed crops. This has lead to systems of continuous seed production of annual ryegrass, where some fields have been in production for over 40 years without any crop rotation.

Annual ryegrass seed production systems have changed significantly from the time when open field burning and no-till planting was a common and important practice. Prior to the 1990, over 50% of the acreage was open field burned. In recent years, only about 20% of the acreage was open field burned. Legislation in 2009 further restricted burning and essentially eliminated open field burning for annual ryegrass seed production.

Currently, a majority of the annual ryegrass seed crop acreage is successfully managed with conventional tillage and planting systems. However, the cost of tillage is expensive; thus, alternative no-till and volunteer systems are being tested and used. In the volunteer system, a seed crop is produced from seed shattered from the previous crop and is essentially a no-till and no-plant system of production for un-certified seed production (less than 5% of Oregon annual ryegrass is certified). In the volunteer system, grazing and strip or row spraying with herbicides are used to control stand density. When no-till planting is used, a sprout of volunteers and weed seeds are first sprayed with glyphosate herbicide. These systems offer a way to reduce tillage and fuel expenses, and reduce concerns about dust and air quality. Previous field work demonstrated that seed yields under the volunteer and no-till systems decline significantly over time if used more than one year in a row (Young et al., 1997). In the first year of production though, no-till and volunteer methods have been comparable to conventional methods of planting, suggesting a system of alternate year tillage may be a feasible way to maintain seed yields over time. This study was designed to evaluate the long-term economics of these various cropping systems in a continuous annual ryegrass monoculture over multiple years. A secondary objective was to measure the impact on soil properties, especially carbon sequestration, of reduced tillage systems of seed production.

Material and Methods

This study was established at the Hyslop Crop Science Farm in the fall of 2005. The field had been planted to 'Gulf' annual ryegrass the previous two years, and we continued with the same variety. Soil was a moderately well-drained silt loam soil with a pH of 5.4 and soil test levels of P, K, Ca, and Mg above levels considered adequate for seed production. Six treatments were included in a Randomized Complete Block design, and replicated three times with plots 25 feet x 125 feet.. The resulting treatments included:

1. Continuous conventional tillage and planting system.
2. Continuous no-till planting system
3. No-till/conventional tillage rotation (alternate year tillage)
4. Volunteer/conventional tillage rotation (alternate year tillage)
5. Burn and no-till/ conventional tillage rotation (alternate year tillage)
6. Volunteer/no-till/conventional tillage rotation (tillage every 3rd year)

In all except the burn treatment, residue from the previous year's crop was flail chopped and left on the field. Tillage included plowing to a depth of 8 to 10 inches, disking, and pulvi-mulching. A final seedbed was prepared by harrowing and rolling. All treatments except the volunteer included at least one preplant application of glyphosate to control volunteer seedlings. A preplant fertilizer of 200 lb/acre of 16-16-16 was applied to all treatments. A Great Plains no-till drill was used to seed all treatments except the volunteer at a planting rate of 17 lb/acre. The volunteer plots were established by allowing the seeds left on the surface the previous year to germinate and grow. Rows in the volunteer plots were established by spraying out 7 inches of every 10 inches of crop with glyphosate at 40 oz/acre. All herbicide use, pest control and spring fertilization were performed according to OSU recommendations and industry standards.

Plots were harvested by swathing in late June, using a modified John Deere 2280 swather (6 foot cutting width) and combined in mid-July with a Hege 180 plot combine. Seed was cleaned using a Clipper M2B cleaner and clean seed yields, cleanout percentage and seed weight determined. Seed yield results were analyzed as a Randomized Complete Block using treatment means over four years as replications or blocks.

Results and Discussion

The seed yields obtained during the first four years of this long-term study ranged from a high of 2061 lb/acre in 2009 to a low of 1126 lb/acre in 2008. Seed yields in 2008 were significantly affected by slug and vole damage. For this reason, composite yields for the treatments over the four years were below normal for annual ryegrass seed fields in the Willamette

Valley. However, there were significant differences between treatments ($P = 0.08$) averaged over years (Table 1). The continuous no-till treatment had the lowest yield of the six different systems of production. The burn and no-till planting method alternated with conventional tillage had the greatest mean seed yield. All systems of establishment that included alternate year tillage provided 4-year mean seed yields comparable to or greater than the conventional tillage method of establishment.

Among the six systems of establishment, the continuous conventional tillage and planting approach had the highest cost of production, based on the Oregon State University Enterprise Budget for annual ryegrass (Eleveld et al., 2007). The conventional system was $51to $90/acre more than methods of establishment that used reduced tillage. Continuous no-till provided the lowest cost of production, but also had the lowest seed yield and the highest risk of establishment under Western Oregon conditions. Stand reduction due to slugs was a major reason for poorer yields in the continuous no-till treatment. Slug damage to seedling crops in the region is a common problem and a significant economic risk. Slug numbers in no-till annual ryegrass fields can be 14 to 29 times greater than in plowed and conventionally worked plots (Fisher et al., 1996). Systems that alternate no-till or volunteer methods with tillage have less risk of damage from this widespread and common pest, and over the course of this study to date, the alternate year tillage systems were more profitable than continuous conventional tillage.

One of the reasons for using reduced tillage systems is to maintain soil organic matter levels and potentially increase carbon storage in the soil. After three years, soil samples taken in this study showed that soil organic matter and soil carbon levels were similar under conventional or alternate year tillage systems in the 0-8 inch depth (Table 2). Soil organic matter and carbon were stratified under continuous no-till due to accumulation of soil organic matter in the surface layer (0-2 inch depth). Below 2 inches, soil carbon in the continuous no-till was significantly less. Soil organic matter and nutrient stratification have been observed in previous no-till trials (Mellbye et al., 1999). Despite differences in tillage and organic matter distribution, total accumulation of soil carbon among treatments to date was similar (assuming similar soil bulk density). Results may change over time, but these data suggest alternate year tillage or plowing in annual ryegrass cropping systems can maintain soil carbon at levels similar to those achieved with continuous no-till, at least over a short period of time.

Table 1. Seed yields and economic comparisons of annual ryegrass establishment systems after four years, 2006-2009.

Establishment system (2006-2009)	Total cost	Seed yield 4-year average	Seed yield 4-year average
	($/acre)	(lb/acre)	(% conventional)
Continuous conventional tillage	612	1666 bc[1]	100
Continuous no-till	522	1587 c	95
No-till / conventional tillage rotation	567	1659 bc	100
Volunteer / conventional tillage rotation	528	1731 ab	104
Burn and no-till / conventional tillage rotation	561	1809 a	109
Volunteer / no-till / conventional tillage rotation	526	1680 bc	102
LSD (0.10)	--	115	--

[1]Means followed by the same letter do not differ significantly

Table 2. Soil organic matter, soil carbon, and soil nitrogen levels from selected annual ryegrass establishment systems May 2009.

Selected treatments	Soil depth	Soil organic matter	Soil carbon	Soil nitrogen
	(in)	(%)	(%)	(%)
Continuous tillage	0-8	3.83	1.59	0.090
Continuous no-till	0-8	3.35	1.62	0.107
	0-2	4.32	1.92	0.103
	5-8	3.61	1.48	0.077
Volunteer /conventional (Tillage alternate years)	0-8	3.95	1.63	0.083
Volunteer / no-till / conventional (Tillage every third year)	0-8	3.58	1.64	0.080
LSD (0.05)		0.27	0.10	0.017

Preliminary results after four years demonstrate that alternating a conventional tillage system with a no-till or volunteer method of establishment can provide seed yields comparable to continuous conventional tillage, but at a lower cost of production. In addition, alternate year tillage appears to maintain soil carbon levels comparable to continuous no-till. This trial is designed to last a minimum of 9 years, and a more thorough economic analysis of results will be presented in the future. The take-home message at this time is alternatives to annual conventional tillage exist in annual ryegrass production that reduces costs while maintaining yields.

References

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