LONG-TERM EFFECTS OF TILLAGE AND ESTABLISHMENT SYSTEMS ON SEED YIELD OF ANNUAL RYEGRASS

T.G. Chastain, W.C. Young III, C.J. Garbacik, and M.E. Mellbye

Introduction

Annual ryegrass was grown on 125,790 acres in Oregon in 2013, making it one of the most widespread seed crops in the state. The acreage of annual ryegrass has been among the most stable of the grass seed crops over the past 35 years, and this crop is an important contributor to the economic welfare of Oregon seed producers. But this stability and need for a crop on low-productivity soils means that annual ryegrass has been grown on some land continuously for decades without rotation.

Long-term annual ryegrass cropping systems trials were initiated in the 2005–2006 crop year by former OSU Extension agent Mark Mellbye. His vision was for a 9-year project to study the long-term effects of several cropping practices on annual ryegrass seed production. While there are several long-term cropping systems practices studies in field crops such as wheat at a variety of locations around the world, no long-term studies in grass seed crops, and annual ryegrass in particular, have been conducted.

In this article, we will examine the long-term effects of cropping systems practices on seed yield in annual ryegrass through year 8.

Methods

Trials have been conducted at the long-term study site located on OSU's Hyslop Farm for the past eight years. 'Gulf' annual ryegrass has been used throughout the study. The experimental design for the trials is a randomized complete block with three replications of the following six tillage and crop establishment systems:

1. Continuous conventional tillage (CT)
2. Continuous no-till (NT)
3. NT/CT cycle (alternate-year tillage)
4. Volunteer/CT cycle (alternate-year tillage)
5. Burn + NT/CT cycle (alternate-year tillage)
6. Volunteer/NT/CT cycle (tillage every third year)

Each of the plots was 25 feet x 125 feet. Conventional tillage involved primary tillage by moldboard plow followed by disking and other secondary tillage operations as needed to produce a seedbed for planting. No-till planting of the annual ryegrass crop was made with a Great Plains no-till drill. The same drill was used to plant the CT stands, although with different settings. In the volunteer treatment, seed shed from the previous crop was the source of seed for establishment of the stand, and rows were created by row-spray removal of approximately 75% of the stand. No tillage was done in the volunteer treatment.

Tillage, residue chopping, herbicide applications, fertilizer applications, and other field activities were conducted according to OSU recommendations and standard grower practices. Crop residues were flail-chopped but not removed from plots. In the burn and NT treatment, residues were not flailed prior to burning.

Seed was harvested with a small-plot swather (modified JD 2280) and threshed with a Hege 180 small-plot combine. Harvested seed was processed through an M2-B Clipper cleaner, and clean seed yield was determined.

Seed weight was measured by using an electronic seed counter to count two 1,000-seed samples from harvested, cleaned seed material and determining the weight on a laboratory balance. Seed number was calculated based on seed yield and 1000-seed weight values obtained from each plot.

Results and Discussion

After eight years of the trials, significant differences among the tillage and stand establishment system practices are emerging (Table 1). Results to date indicate that the lowest seed yields were observed when continuous NT practices were employed. Seed yield in continuous NT was 15% lower than in continuous CT, the predominant system employed by Valley annual ryegrass seed growers. In fact, over the eight-year period, the loss in seed yield in the continuous NT plots was 1,632 lb/acre. Thus, a grower employing continuous NT would have lost a bit more than one year of seed yield over the period as compared to continuous CT.

Increasing the frequency of tillage in the system from zero in the continuous NT plots to once every other year (NT/CT) boosted seed yields so that they were statistically equivalent to yields in the continuous CT plots (Table 1). Alternating volunteer crop

Table 1. Effect of tillage and stand establishment systems for annual ryegrass over an eight-year period on seed production characteristics.

System	Frequency of tillage	Seed production characteristics[1]		
		Seed yield	Seed weight	Cleanout
	(years)	(lb/acre)	(mg)	(%)
Continuous CT	8	1,541 b	3.17 b	2.19 b
Continuous NT	0	1,337 a	3.05 a	2.44 c
NT/CT cycle	4	1,489 b	3.05 a	2.16 ab
Volunteer/CT cycle	4	1,487 b	3.06 a	2.18 b
Burn + NT/CT cycle	4	1,701 c	3.08 a	1.93 a
Volunteer/NT/CT cycle	2	1,491 b	3.04 a	2.29 bc

[1]Means in columns followed by the same letter are not significantly different (*P* = 0.05).

establishment with CT produced seed yields over the eight-year period that were not statistically different from the NT/CT system, without increasing the frequency of tillage. Volunteer and NT establishment had similar effects on seed yield. Volunteer establishment was used in two systems, and NT establishment was used in four systems. The average seed yields in years of volunteer establishment across two systems (1,280 lb/acre) were essentially the same as the average obtained with NT establishment across four systems (1,292 lb/acre). A three-year cycle of volunteer establishment and NT/CT also produced seed yields that were similar to the NT/CT and continuous CT systems, but the frequency of tillage was reduced to once every three years. Disturbance of the residue in preparation of the seedbed in any alternate-year cycle produced an overall increase in seed yield over the continuous NT system.

Highest seed yields over the eight-year period were found in the burn + NT/CT cycle (Table 1). Removal of straw and stubble by burning was accompanied by disturbance of residues in seedbed preparation in the CT portion of the alternate-year cycle. This combination of residue management on an alternate year basis produced an average 10% increase in seed yield over the continuous CT system. The increased seed yield in this system did not primarily come from the burn + NT portion of the cycle (1,563 lb/acre). Rather, the CT portion (yield = 1,839 lb/acre) was greatly improved by having the burn + NT present in the cycle.

The seed yield results attained by the two tillage systems varied with frequency of use (Figure 1). Compared to continuous CT, seed yields were increased by an average of 16% when CT was cycled with NT, volunteer, or burn + NT. On the other hand, seed yields from NT were the same regardless of whether NT was continuous or cycled with other practices. In other words, seed yield of CT was increased by the presence of NT or other practices in the system as part of a farming cycle, but yields of NT were not influenced by CT or other practices in the cycle. Seed yields in NT fields were reduced by slug predation. The best seed yield performance of NT occurred when the practice was coupled with residue burning. These results suggest that a moderate frequency of tillage with disturbance of crop residues and occasional removal of crop residues are required to produce the best seed yield results over time in annual ryegrass cropping systems.

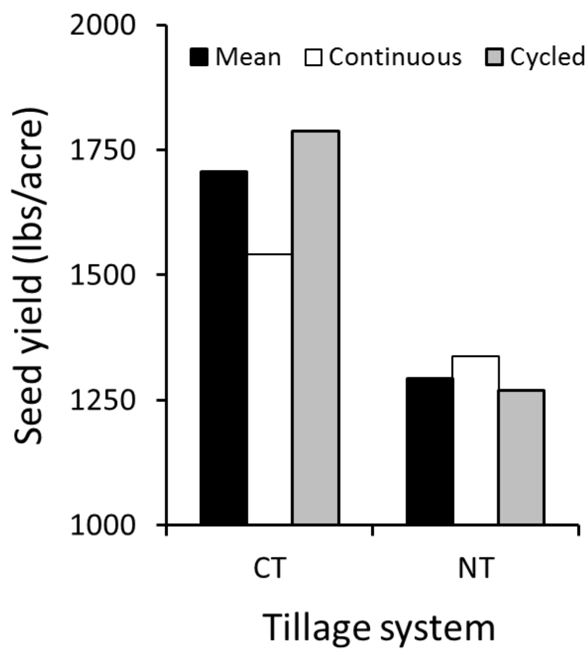

Figure 1. Effect of tillage systems practices (continuous or cycled to other practices) over an eight-year period on seed yield in annual ryegrass.

Seed weight was greatest in the continuous CT system (Table 1). However, the differences observed among the tillage and crop establishment systems tested in this study were primarily attributable to seed number rather than seed weight (Figure 2).

Cleanout is the quantity of non-seed plant material harvested at the time of combining. An increase in cleanout poses an economic hardship for seed growers because this material must be removed in post-harvest conditioning of the seed. Cleanout was lowest in the burn + NT/CT system and greatest with continuous NT (Table 1). These two treatments represent the greatest range of differences in residue disturbance and removal. These differences were reflected most in higher cleanouts of the continuous NT system and to a lesser extent in cleanouts of other systems where burning was not used. Increases in cleanout in the absence of burning may have resulted from a change in partitioning of dry matter to non-reproductive structures that were captured in the harvest process.

Because changes in soil carbon, organic matter, nitrogen, and pH are relatively small each year, the observed differences in the sampled soil profile were also small across tillage and establishment systems. Nevertheless, there were definite trends for increased carbon and organic matter in the continuous NT system over other practices. These effects were most pronounced in the uppermost portion of the soil profile. Anticipated benefits of reduced tillage in annual ryegrass seed production enterprises include improved soil quality and carbon sequestration.

This is the fourth in the series of reports on the long-term effects of tillage and crop establishment systems on annual ryegrass seed production. The fifth and final installment will report how these cropping systems practices affected seed productivity and soil characteristics over the nine-year span of the study.

Acknowledgments
The authors wish to thank the Oregon Ryegrass Growers Seed Commission and the Hyslop Professorship for support of this work.

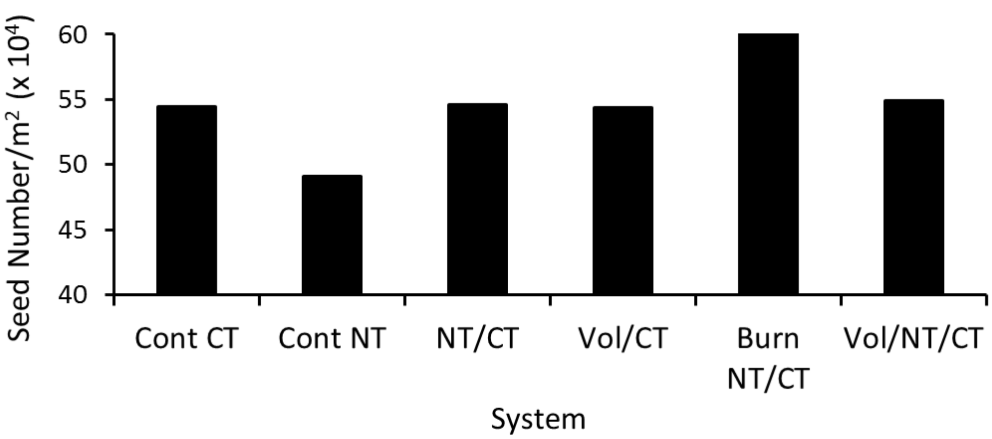

Figure 2. Effect of tillage and establishment systems over an eight-year period on seed number in annual ryegrass.