DEFINING OPTIMUM NITROGEN FERTILIZATION PRACTICES FOR GRASS SEED PRODUCTION SYSTEMS IN THE WILLAMETTE VALLEY

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Introduction

Oregon grass seed growers typically do not monitor crop or soil nitrogen (N) levels during the growing season and often apply fertilizer N in excess of recommended rates. Excessive fertilizer N use may result in leaching losses. This study has three objectives: 1) Determine the level of spring applied nitrogen fertilizer needed for optimizing both crop and economic returns; 2) Update OSU Extension Service Fertilizer Guidelines; and 3) Develop educational programs to reduce excessive N fertilization.

Large scale on-farm plots were established in three perennial ryegrass and three tall fescue fields in 1998, two fine fescue fields in 1999 and two annual ryegrass fields in 2000. The fields were selected to represent soil types typically used for seed production in the Willamette Valley. Spring fertilizer was applied using precision application equipment. Perennial ryegrass and tall fescue received treatments of 0, 45, 90, 135, 180, 225, and 270 lb N/a as a split application (50/50). Annual ryegrass received single applications of 0, 45, 90, 135, 180, 225, and 270 lb N/a and fine fescue received single applications of 0, 30, 50, 70, 90, 110, and 140 lb N/a. Normal grower equipment was used to swath and combine plots. Seed yields were measured using a weigh-wagon. Crop and soil samples were obtained for yield components, N uptake, and soil N levels following harvest.

Results from the first two years (1998-1999) crop indicated N levels above 135-180 lb N/a for perennial ryegrass and 90-135 lb N/a for tall fescue did not statistically increase seed yield. Perennial ryegrass was able to take up more N in above-ground biomass than tall fescue. First year results in fine fescue (1999) showed little response to spring N applications above 50 lb/a. Levels of soil NO_3-N were increased by the highest N rate (270 lb N/a) but were at low levels. Based on sampling in the fall, the potential for leaching losses of N from normal application rates of N fertilizer does not appear to be a problem. Results presented below are from the third (and final year) for perennial ryegrass and tall fescue, the second year (of at least three) for fine fescue and the first year (of two) in annual ryegrass.

Procedure

Large scale on-farm plots averaging 5 acres per site were established at 9 locations (2 perennial ryegrass, 3 tall fescue, 2 fine fescue and 2 annual ryegrass) prior to fertilizer applications. Specific information for each site is shown in Table 1.

Plots were approximately 22 ft wide by 300 ft long (depending on fit in the field and grower equipment size). Spring fertilizer treatment rates of 0, 45, 90, 135, 180, 225, and 270 lb N/a were used except for the fine fescue which had rates of 0, 30, 50, 70, 90, 110, and 140 lb N/a. The seven treatments were replicated three times in a randomized complete block. Data were analyzed using appropriate statistical analyses (e.g., ANOVA, Regression).

Table 1. Site information for all locations.

Location	County	Planted	Year trial started	Soil type
PERENNIAL RYEGRASS				
L3 Farms	Linn	Fall 97	Spring 98	Concord and Amity silt loam
Venell Farms	Benton	Fall 97	Spring 98	Dayton silt loam
TALL FESCUE				
Malpass Farms	Linn	Fall 96	Spring 98	Bashaw silty clay
Nixon Farms	Lane	Spring 97	Spring 98	Malabon silty clay loam
Roselawn Farms	Marion	Fall 98	Spring 98	Woodburn silt loam
FINE FESCUE				
Sherman Farms	Marion	Spring 98	Spring 99	Jory silty clay loam
Taylor Farms	Marion	Spring 98	Spring 99	Nekia silty clay loam
ANNUAL RYEGRASS				
Michael Hayes Farm	Linn	Fall 99	Spring 00	Dayton/Clackamas
Tim VanLeeuwen Farm	Linn	Fall 99	Spring 00	Dayton silt loam

All sites were fertilized between March 15 and April 20 at the pre-determined rates using a split application (50/50) about four weeks apart. Applications were done between approximately 400 and 800 growing degree days (GDD) as is generally recommended. The 400 GDD and 800 GDD points were March 14 and April 24, 2000, respectively. Accumulated GDD using the T_{sum} method was calculated by summing the daily degree day values obtained by adding the maximum and minimum temperatures for the day, dividing by two and subtracting the base temperature, which for temperate grass is 0°C. Accumulated GDD was calculated beginning January 1. Additional details regarding calendar dates of N application and harvest at each site are shown in Table 2. Fertilizer was applied using a Gandy Orbit-air spreader pulled by a four-wheeler or small Kubota tractor. In addition to fertilizer N treatments, each site was also fertilized with 275 lb/a of 0-15-20-10 at the same time as the first N application to ensure there were no other nutrient limitations. The plots were managed the same as the rest of the field for all other cultural management practices (weed control, fall fertilizers, disease control, etc.) by the grower-cooperator.

Table 2. Dates of fertilization, windrowing, and combining for optimum N studies, 2000.

Location	Variety	Fertilizer application 1st date	Fertilizer application 2nd date	Windrow	Combine
		PERENNIAL RYEGRASS			
L3 Farms	DLF-1	3/24	4/18	7/12	8/1
Venell Farms	SR 4200	3/23	4/18	7/12	8/8
		TALL FESCUE			
Malpass Farms	Kittyhawk SST	3/23	4/20	6/30	7/14
Nixon Farms	Duster	3/23	4/18	6/30	7/15
Roselawn Farms	Tomahawk	3/20	4/15	7/8	7/21
		FINE FESCUE			
Sherman Farms	Brittany	3/17	N/A	7/8	7/17
Taylor Farms	Shademark	3/15	N/A	7/11	7/19
		ANNUAL RYEGRASS			
Michael Hayes Farm	Gulf	4/19	N/A	6/27	7/11
Tim VanLeeuwen Farm	Gulf	4/20	N/A	6/29	7/20

Plant samples were taken at maturity (during June). Yield components samples were obtained at or following pollination. Plots were swathed into windrows between June 27 and July 12 and combined between July 11 and August 8 using grower equipment (Table 2). Seed yield from each plot was measured using a Brent YieldCart and adjusted for clean seed yield following an assessment of percent cleanout from sub-samples taken at harvest. Sub-samples taken at harvest were also used to determine seed size and are currently at the OSU Seed Testing Laboratory for purity and germination analysis.

Results and Discussion

Crop yield and response

*Perennial ryegrass***:** Seed yield (Table 3) in perennial ryegrass increased as fertilizer rates increased up to the 135 lb N/a rate at the Venell Farms site and up to 180 lb N/a at the L3 Farms site. The third site (J Bar V Farms) was taken out of production in 1999 after two years. The L3 site had a full straw load flail chopped for post-harvest residue management and could be a reason for the higher optimum N level responses as heavy straw loads can tie up nitrogen until it is decomposed completely. At the Venell Farms site, yield decreased considerably at the highest rate of N (270 lb N/a) showing a negative effect of excessive N rates. Regression analysis of these data (Table 4) resulted in the response curves (not shown) which will be used for economic analysis at the completion of these studies. Higher spring N application rates resulted in more biomass, higher tissue N concentration, and increased N uptake by the crop as shown in Table 5, 6 and 8. With harvest index remaining constant (Table 7), increased biomass generally increased seed yield. Table 8 shows the average of both perennial ryegrass sites had increased fertile tillers, increased 1000 seed weight and some increases in spikelet and floret numbers all of which made contributions to higher seed yield potential and thus higher yields. The statistics of the yield components measured for all sites are presented in Table 7.

Table 3. Seed yield (lb/a) of perennial ryegrass following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	L3 Farms	Venell Farms	2-site average
0	797 d	506 d	652
45	1167 c	1038 c	1102
90	1350 c	1484 b	1417
135	1595 b	1736 a	1666
180	1704 ab	1662 ab	1683
225	1746 ab	1634 ab	1690
270	1790 a	1470 b	1630
LSD 0.05	191	224	---

*Means in columns followed by the same letter are not significantly different by Fisher's protected LSD values (p=0.05).

Table 4. Seed yield statistical summary for all 9 locations, 2000.

Location (variety)	ANOVA	Regression analysis Linear (=r^2)	Regression analysis Quadratic (=r^2)
PERENNIAL RYEGRASS			
L3 Farms	**	**(0.84)	**(0.94)
Venell Farms	**	**(0.52)	**(0.93)
TALL FESCUE			
Malpass Farms	NS	*(0.21)	NS
Nixon Farms	**	**(0.78)	**(0.92)
Roselawn Farms	**	**(0.64)	**(0.78)
FINE FESCUE			
Sherman Farms	**	NS	**(0.62)
Taylor Farms	**	NS	NS
ANNUAL RYEGRASS			
Michael Hayes Farm	**	**(0.54)	**(0.82)
Tim VanLeeuwen Farm	**	**(0.48)	**(0.76)

NS = not significant P value 0.05
* = P value < 0.05
((= P value <0.01

Table 7. Statistical summary of yield component responses to varied spring applied nitrogen for all locations, 2000.

Location	Total above ground biomass (tn/a)	Harvest index (%)	1000 seed weight (g/1000 seed)	Fertile tiller density (no./sq ft)	Spikelets per inflorescence (no.)	Florets per spikelet (no.)
PERENNIAL RYEGRASS						
L3 Farms	**[1]	NS	*	*	NS	**
Venell Farms	**	NS	*	*	(*)	NS
TALL FESCUE						
Malpass Farms	(*)	NS	NS	NS	(*)	NS
Nixon Farms	*	NS	*	**	*	*
Roselawn Farms	NS	NS	**	NS	NS	NS
FINE FESCUE						
Sherman Farms	*	NS	**	(*)	NS	(*)
Taylor Farms	NS	NS	**	(*)	NS	NS
ANNUAL RYEGRASS						
Michael Hayes Farm	NS	NS	NS	NS	NS	NS
Tim VanLeeuwen Farm	NS	NS	NS	NS	NS	**

[1]NS = not significant P value 0.05, * = P value < 0.05, ((= P value <0.01

Table 5. Average tissue N concentration (%) in above ground biomass at maturity in perennial ryegrass, tall fescue, and annual ryegrass species following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	Tissue N concentration (%) Perennial ryegrass	Tall fescue	Annual ryegrass
0	0.8	1.0	0.7
45	0.8	0.9	0.9
90	1.0	1.2	1.0
135	1.0	1.5	1.3
180	1.4	1.7	1.1[1]
225	1.5	1.5	1.3
270	1.6	1.8	1.4

[1] data from one location for this treatment

Table 6. Average equivalent N uptake (lb N/a) in above ground biomass at maturity in perennial ryegrass, tall fescue, and annual ryegrass species following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	N uptake at maturity (lb N/a) Perennial ryegrass	Tall fescue	Annual ryegrass
0	41	75	66
45	63	95	102
90	105	144	116
135	111	179	126
180	177	218	138
225	201	180	152[1]
270	224	230	154

[1] data from one location for this treatment

Table 8. Average aboveground biomass, 1000 seed weight, spikelet number per inflorescence, and floret number per spikelet of perennial ryegrass (2 sites) following varied rates of spring applied N, 2000.

Spring N rate	Total biomass	Fertile tillers	1000 seed weight	Spikelets per infl.	Florets per spikelet
(lb N/a)	(tn/a)	(no./sq ft)	(g)	(no.)	(no.)
0	2.6	113	1.761	19.2	5.0
45	4.0	173	1.785	20.3	5.5
90	5.4	209	1.775	19.8	5.8
135	5.5	215	1.798	21.6	6.8
180	6.4	249	1.867	21.8	7.2
225	6.8	226	1.885	20.9	7.1
270	6.9	271	1.851	22.8	7.5

Tall fescue: Seed yield responses in tall fescue were more dependent on location when compared to perennial ryegrass. At the Malpass Farms site, seed yield (Table 9) was not statistically different though there was a trend of yield increase up to the 90 lb N/a rate. At the Nixon Farms site there was a seed yield response up to 225 lb N/a, which is a little higher than the previous year (1999) and much different from the first year (1998) when there was no seed yield response to increased N. The Roselawn Farms site responded up to 135 lb N and had no further response with higher N levels. Crop nitrogen uptake was similar to perennial ryegrass (Tables 5 and 6), which demonstrate the ability of the grass seed crops to take up considerable nitrogen into the biomass. Yield components in tall fescue also varied by location (Table 7) as indicated by the 1000 seed weight, fertile tiller density, spikelet and floret number. This may be a combination of both variety and location response which emphasizes the need to make recommendations site specific. Generally, fertile tiller density, spikelet number and floret number were improved by increasing N rates up to recommended levels thereby increasing yield potential and thus yields. 1000 seed weight tended to decrease slowly as the N rates increased and subsequent yields improved. This may be a result of yield component compensation as the yield increased, the individual seed size decreased. Yield response to nitrogen in tall fescue changed as the stands aged and will be analyzed across years and sites to determine the effect of age and soil types. Regression analysis of these data (Table 4) resulted in response curves (not shown) which will be used for economic analysis at the completion of this study.

Table 9. Seed yield (lb/a) of tall fescue following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	Malpass Farms	Nixon Farms	Roselawn Farms	3-site average
0	1117	390 e	1546 c	1018
45	1272	661 d	1834 b	1256
90	1403	1009 c	1844 b	1419
135	1389	1117 abc	2239 a	1582
180	1368	1093 bc	2232 a	1594
225	1413	1226 ab	2372 a	1670
270	1366	1228 a	2201 a	1598
LSD 0.05	NS	134	235	---

*Means in columns followed by the same letter are not significantly different by Fisher's protected LSD values (p=0.05).

Table 10. Average aboveground biomass, 1000 seed weight, spikelet number per inflorescence, and floret number per spikelet of tall fescue (3 sites) following varied rates of spring applied N, 2000.

Spring N rate	Total biomass	Fertile tillers	1000 seed weight	Spikelets per infl.	Florets per spikelet
(lb N/a)	(tn/a)	(no./sq ft)	(g)	(no.)	(no.)
0	3.7	61	2.323	41.9	4.6
45	5.1	65	2.287	47.8	4.8
90	6.0	65	2.238	53.2	5.4
135	6.0	70	2.211	55.8	5.5
180	6.4	74	2.202	64.0	5.7
225	5.6	73	2.165	64.5	5.5
270	6.4	76	2.167	61.5	5.6

Fine fescue: Seed yield responded to spring nitrogen at both sites. Optimum yield was obtained with the 30-50 lb spring N/a rate (Table 11). Higher applications did not increase seed yield and even showed a decline in yield as the application rate exceeded 70 lb N/a as was the case in 1999. The Taylor site was optimized at 30 lb N/a and the Sherman site at 50-70 lb N/a. Seed yield at both locations was well above the 2000 average yields of about 750 lb/a for these species. Fertile tiller densities (Table 12) were improved by the increased N rates as well as the floret number at the Sherman Farms site. 1000 seed weight followed yield by decreasing some as yields increased, then increasing as the N rates increased and yields decreased. This reflects similar responses in the tall fescue trials regarding yield component compensation. Total biomass increased some as well. The cause of decreased yield from higher N rates may be from excessive plant growth resulting in early lodging and shading of the crop thereby diminishing the realized yield potential. Tissue N concentration and N uptake both reflected increased N application rates (Table 13). The 0 N rate resulted in an average of 53 lb N/a in the plant as a result of soil mineralization and any fall applied fertilizer.

Table 11. Seed yield (lb/a) of fine fescues following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	Sherman Farms	Taylor Farms	2-site average
0	1304 c	1304 c	1304
30	1623 ab	1477 a	1550
50	1688 ab	1353 bc	1520
70	1699 a	1388 b	1543
90	1606 ab	1369 b	1488
110	1563 b	1386 b	1475
140	1560 b	1362 b	1461
LSD 0.05	129	56	----

*Means in columns followed by the same letter are not significantly different by Fisher's protected LSD values (p=0.05).

Table 12. Average aboveground biomass, 1000 seed weight, spikelet number per inflorescence, and floret number per spikelet of fine fescue (2 sites) following varied rates of spring applied N, 2000.

Spring N rate	Total biomass	Fertile tillers	1000 seed weight	Spikelets per infl.	Florets per spikelet
(lb N/a)	(tn/a)	(no./sq ft)	(g)	(no.)	(no.)
0	3.4	251	1.135	25.1	4.8
30	4.6	327	1.105	27.6	5.1
50	4.7	288	1.105	30.2	5.0
70	6.2	359	1.126	29.2	5.4
90	5.2	335	1.135	31.7	5.1
110	6.5	359	1.144	30.0	6.1
140	5.2	280	1.147	30.1	6.2

Table 13. Average tissue N concentration (%) and equivalent N uptake (lb N/a) in above ground biomass at maturity in fine fescue following varied rates of spring applied N, 2000.

Spring N rate	Tissue N Concentration	N uptake
(lb N/a)	(%)	(lb N/a)
0	0.8	53
30	1.0	87
50	1.0	89
70	0.9	108
90	0.9	88
110	1.1	148
140	1.3	134

Annual ryegrass: This is the first year in a two year trial with annual ryegrass. The two locations reflect both volunteer and planted crop N management. Seed yield responses to spring N in annual ryegrass was similar to first year perennial ryegrass reported in 1998 Seed Production Research. Seed yield (Table 14) was optimized at the 90 – 135 lb N/a rate at both locations. Using rates greater than this range did not result in increased seed yield. No significant yield component effects were measured (Table 15). Fertile tiller density tended to decrease as nitrogen was applied but the unfertilized tillers were smaller and lighter than plots from the fertilized tillers (data not reported here).

Table 14. Seed yield (lb/a) of annual ryegrass following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	Michael Hayes Farms	Tim VanLeeuwen Farms	2-site average
0	1252 d	2133 c	1693
45	1835 c	2918 b	2377
90	1958 bc	2959 ab	2459
135	2143 ab	3041 ab	2592
180	2162 ab	3138 a	2650
225	2191 a	3076 ab	2633
270	2089 ab	3081 ab	2585
LSD 0.05	211	185	----

*Means in columns followed by the same letter are not significantly different by Fisher's protected LSD values (p=0.05).

Table 15. Average aboveground biomass, 1000 seed weight, spikelet number per inflorescence, and floret number per spikelet of annual ryegrass (2 sites) following varied rates of spring applied N, 2000.

	Annual ryegrass				
Spring N rate	Total biomass	Fertile tillers	1000 seed weight	Spikelets per infl.	Florets per spikelet
(lb N/a)	(tn/a)	(no/sq ft)	(g)	(no.)	(no.)
0	4.5	208	2.864	22.0	7.5
45	5.4	190	2.853	22.0	9.5
90	5.1	177	2.823	21.6	10.4
135	4.6	172	2.811	20.9	8.7
180	5.0	156	2.812	19.7	10.1
225	5.4	175	2.747	20.0	9.8
270	5.0	183	2.778	21.1	10.4

Crop nitrogen uptake

The data presented here are from tissue uptake levels obtained in samples taken during pollination or just pre-bloom. Tissue N% (Tables 5 and 13) varied from 0.8% to 1.8%. N concentrations closely followed N application rates as expected. The average amount of nitrogen in the aboveground biomass by species is reported in Tables 6 and 13. The highest N rates ranged from 148 to 230 lb N/a uptake in the above ground biomass demonstrating the ability of these grasses to take up a large amount of N. Mineralized N is available for uptake by the plant in the spring as indicated with the 0 N rate. The 0 spring applied N still resulted in N uptake levels in the plant ranging from 41 lb N/a (perennial ryegrass) to 75 lb N/a (tall fescue).

Soil NO_3-N

Soil samples were obtained in the fall from three treatments: 0, 135, 270 lb N/a (0, 70, 140 in fine fescue) and at three depths: 0-1, 1-2, 2-3 ft. These results are detailed in Tables 16-19. At all locations except the Hayes annual ryegrass site, the highest fertilizer rate (twice a normal rate) increased the levels of NO_3-N in the top 12 inches of soil. The top one-foot concentrations ranged from 4.6 ppm at fine fescue site to 26.7 ppm at an annual ryegrass site. The normal rates of 135 lb N/a were all around 10 ppm or less. In addition, the lower profiles also increased in NO_3-N at most locations. The amount of NO_3-N in the lower two feet was very minimal with the highest concentration at 7.0 ppm and most < 5 ppm. similar to last year, this year the 1-2 ft and 2-3 ft profiles had increased levels of NO_3-N from the 270 lb spring N rate. According to OSU guidelines[1] actual residual concentrations are considered low (<10 ppm), medium (10 to 20 ppm), high (20-30 ppm) or excessive (>30 ppm) levels. Using this criteria, all the sites had low to barely medium levels at normal rates of N fertilization and three were in the high range at the doubled N rate. Even though there is efficient soluble nitrogen removal by the fibrous root systems of these perennial grass seed crops during crop growth, excessive levels of applied nitrogen can increase the concentrations of NO_3-N in the soil following harvest and be available for leaching in the fall if the plant is unable to utilize it when the rains start. Use of recommended N rates will result in little potential for leachable N being available in the soil after harvest.

Table 16. Soil NO_3-N concentrations (ppm) at three soil depths of perennial ryegrass following varied rates of spring applied N, 2000.

Spring N Rate (lb/a)	Post harvest sample depth 0-12 in.	13-24 in.	25-36 in
	L3 FARMS		
0	0.7	0.5	0.4
135	3.8	0.9	0.4
270	24.3	2.7	1.8
LSD 0.05 (0.10)	(14.8)	1.5	1.2
	VENELL FARMS		
0	1.0	0.4	0.5
135	4.2	1.1	0.8
270	7.6	2.4	2.3
LSD 0.05	2.2	0.5	0.6
	AVERAGE		
0	0.8	0.5	0.4
135	4.0	1.0	0.6
270	16.0	2.6	2.0

[1]Marx, E.S., J. Hart and R.G. Stevens. 1996. Soil Test Interpretation Guide. Table 1. Oregon State University Extension Service, EC 1478.

Table 17. Soil NO_3-N concentrations (ppm) at three soil depths of tall fescue following varied rates of spring applied N, 2000.

Spring N rate (lb/a)	Post harvest sample depth 0-12 in.	13-24 in.	25-36 in
	MALPASS FARMS		
0	3.2	1.8	1.5
135	9.2	3.3	2.7
270	15.0	5.0	3.8
LSD 0.05 (0.10)	(7.8)	(2.2)	NS
	ROSELAWN FARMS		
0	0.4	0.4	0.4
135	6.1	0.9	0.6
270	12.9	2.3	1.3
LSD 0.05	3.4	0.6	0.3
	AVERAGE		
0	1.8	1.1	0.9
135	7.6	2.1	1.6
270	14.0	3.6	2.6

Table 18. Soil NO_3-N concentrations (ppm) at three soil depths of fine fescue following varied rates of spring applied N, 2000.

Spring N Rate (lb/a)	Post harvest sample depth 0-12 in.	13-24 in.	25-36 in
	SHERMAN FARMS		
0	3.4	0.8	1.4
70	5.5	1.9	1.8
140	12.0	2.5	4.5
LSD 0.05	5.8	1.5	1.7
	TAYLOR FARMS		
0	1.2	0.5	0.6
70	2.9	1.1	0.9
140	4.6	1.5	1.8
LSD 0.05	0.9	0.4	0.6
	AVERAGE		
0	2.3	0.7	1.0
70	4.2	1.5	1.4
140	8.3	2.0	3.2

Table 19. Soil NO_3-N concentrations (ppm) at three soil depths of annual ryegrass following varied rates of spring applied N, 2000.

Spring N Rate (lb/a)	Post harvest sample depth 0-12 in.	13-24 in.	25-36 in
	MICHAEL HAYES FARMS		
0	11.8	3.1	2.4
135	10.8	3.5	2.7
270	21.5	4.9	4.6
LSD 0.05 (0.10)	NS	NS	(1.7)
	TIM VANLEEUWEN FARMS		
0	7.6	1.6	1.3
135	8.8	1.8	1.1
270	26.7	7.0	3.3
LSD 0.05	10.3	1.9	1.4
	AVERAGE		
0	9.7	2.4	1.9
135	9.8	2.7	1.9
270	24.1	6.0	4.0

Summary

Optimum levels of spring applied N for seed production were 135-180 lb N/a in the perennial ryegrass, 90-135 lb N/a in the tall fescue and annual ryegrass, and 30-70 lb N/a in the fine fescue. Applying more than the optimum rates did not ensure increased yield and it is difficult to predict if the added input will result in a better yield as was the situation at the Nixon Farms site. Seed yields at the normal N rates were a little above 2000 state averages of 1456 lb/a (perennial ryegrass) and 1421 lb/a (tall fescue) as reported in estimates by OSU. Soil test results show efficient use of applied N and potential for leaching losses reported appear very low for recommended use rates. The perennial ryegrass and tall fescue sites are finished, the fine fescue sites are in their third year in 2001 and the annual ryegrass sites will be continued in 2001 for a second year of data. These results from multi-year trials will be used to establish better economic and production recommendations for optimizing inputs in grass seed crops.

Acknowledgments:

This project was supported by the following: Oregon Tall Fescue Commission, Oregon Ryegrass Growers Seed Commission, and the Oregon Department of Agriculture. In addition, USDA-CSREES has supported other aspects of this research through the Grass Seed Cropping Systems for a Sustainable Agriculture (GSCSSA), Special Grant.