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Defining Optimum Nitrogen Fertilization Practices for Fine Fescue Seed Production Systems in the Willamette Valley

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ABSTRACT

Oregon grass seed growers 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 two fine fescue fields (one chewings type and one creeping type). The fields were selected to represent soil types typically used for fine fescue seed production in the Willamette Valley. Spring fertilizer treatments of 0, 30, 50, 70, 90, 110, and 140 lb N/a were applied in one application using precision application equipment. Normal grower equipment was used to swath and combine plots. Yields were measured using a weigh-wagon. Crop samples were obtained for N uptake, soil N levels, and yield components. Results from the first-year crop indicated N levels above 70-90 lb N/a did not statistically increase seed yield. Although soil NO_3-N concentrations were increased to about 10 ppm by the highest N rate, this NO_3-N concentration is still considered low. 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. These results are from the first year of a multi-year study.

INTRODUCTION

Improved environmental quality, energy and resource conservation, and increased economic sustainability through better nitrogen use is the long-term goal of this project. Oregon's Willamette Valley is one of the premier grass producing areas in the United States. Nitrogen (N) is the most critical nutrient affecting grass seed yield. The timing, rate, and type of N material used are all factors under the control of land managers. Traditionally, Oregon grass seed growers do not monitor crop or soil N during the season and often apply fertilizer N in excess of recommended rates. Mismanagement of fertilizer N could result in high N losses through leaching, thus, impacting water quality. Excessive N rates also may be detrimental to seed yield and quality.

Several studies during the last decade by the research and Extension faculty committed to this proposal have addressed N fertilization in grass seed production systems. However, some grass seed growers continue to use N fertilizer rates in excess of that recommended by OSU soil fertility guides for seed crops. Horneck and Hart[1] reported results from a grass grower survey in which the average

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[1]Horneck, D.A. and J.M. Hart. 1988. A survey of nutrient uptake and soil test values in perennial ryegrass and turf type tall fescue in the Willamette Valley. p. 13-14. In H.W. Youngberg (ed.) 1988 Seed Production Research. Dept of Crop Sci., EXT/CrS 74. Oregon State University, Corvallis.

N application rates for perennial ryegrass and tall fescue were 29% greater than OSU Extension Fertilizer Guide recommendations. We estimate that fertilizer rates between 90 and 120 lb N/a for fine fescue may be sufficient for maximum seed yield. Rates higher than current OSU Extension guidelines have shown in previous research to reduce grass seed yields or have a null affect. Furthermore, excessive fertilizer use contributes to economic losses.

In addition, public concern for water quality in agricultural systems has pointed out the need to re-examine and improve current fertilizer recommendations for grasses grown for seed. These intensely managed grass cropping systems are suited for soils types ranging from poorly drained to well drained. The extent to which they affect water quality is poorly understood. To gain better understanding of soil-fertility effects on groundwater, a major USDA-ARS, USEPA, and OSU collaborative research project headed by S.M. Griffith is currently underway. This study is to determine long term impacts that grass seed production has on surface and ground water quality in poorly-drained soils. In addition to the water quality project, a long-term grass seed cropping system project that Griffith, Young, and Chastain serve as cooperators is studying the fertility of tall fescue, perennial ryegrass, and fine fescue under non-thermal residue management conditions and legume rotations. Recent changes in residue management to non-thermal systems; a desire to improve grower economic yields; and better understanding of water quality impacts must be connected to current farming practices.

Culminating from the projects listed above, and other studies using small plots, information on N fertility management of grasses grown for seed is available. This information needs to be demonstrated with large scale on-farm plots for the purpose of revising fertilizer guides and demonstrating to producers the need to carefully monitor and/or reduce their annual N inputs. We feel that this can be accomplished through the revised fertilizer guides and educational outreach programs. Possible reductions in the average grower annual N input could be 30% or more.

Therefore the objectives in this study are:

A. Use large scale on-farm plots fine fescue seed production to determine the optimum economic N fertilizer rate.

B. Update OSU Extension Service Fertilizer Guidelines for fine fescue.

C. Develop educational programs to reduce potential N source pollution by curtailing excessive N fertilization practices.

MATERIALS AND METHODS

Large scale on-farm plots were established at two locations: one Chewings type (*Festuca rubra var. commutata*) and one creeping type fine fescue (*Festuca rubra var. rubra*). All sites were in their first crop year and specific information for each site is shown in Table 1. Plots were approximately 23 ft wide by 600 ft long (depending on fit in the field and grower equipment size). Spring fertilizer treatment rates of 0, 30, 50, 70, 90, 110 and 140 lb N/a were used. The seven treatments were replicated three times in a randomized complete block design. Experimental data was analyzed using appropriate statistical analyses (ANOVA).

Table 1. Site information for the fine fescue locations.

Location	County	Variety	Planted	Soil type
Chewings fine fescue				
Chuck Sherman Farm	Marion	Brittany	Spring 98	Jory silty clay loam
Creeping red fescue				
Denny Taylor Farm	Marion	Shademark	Spring 98	Nekia silty clay loam

Both sites were fertilized between March 19 and 22 at the pre-determined rates using a single application. 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 tractor. In addition to fertilizer N treatments, each site also fertilized with 275 lb/a of 0-15-20-10 at the same to ensure adequate P, K, and S levels in the soil. 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.

Yield component samples were obtained at or following pollination during June. Plots were swathed into windrows July 5 and July 22 and combined July 23 and August 10 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.

Table 2. Dates of fertilization, windrowing, and combining for optimum N study, 1999.

Location	Variety	Fertilizer application	Windrow	Combine
Chewings fine fescue				
Chuck Sherman Farm	Brittany	3/19	7/5	7/23
Creeping red fescue				
Denny Taylor Farm	Shademark	3/22	7/22	8/10

RESULTS AND DISCUSSION

Crop yield and response

Seed yield responded to spring nitrogen only at the Chuck Sherman site. Optimum yield at that site was obtained with the 50 lb N/a rate (Table 3). Higher applications did not increase seed yield and even showed a decline in yield as the application rate exceeded 70 lb N/a. In contrast to this, yields at the Taylor site were unaffected by any of the spring N applications. Yields at both locations were well above the 1999 average yields of about 750 lb/a for these species. Total dry matter accumulation and harvest index (Table 4) were not affected by increased nitrogen rates. Components of yield that reflect general increases in seed yield at the Sherman site were an increase in fertile tillers (Table 5) and more florets per spikelet (also at the Taylor site, Table 6). Other factors (seed size and spikelet number) did not give as strong an indication of higher potential yield. Plant height and spike length were increased by higher rates of nitrogen (Table 7). The longer stems and higher yield at the Sherman site also increased lodging (data not presented). This may have had a detrimental affect on seed yield as reflected by the decreased seed yield in the higher rates at the Sherman location.

Table 3. Seed yield of fine fescue following varied rates of spring applied N, 1999.

Spring N rate (lb/a)	Sherman Farm		Taylor Farm	2-site average
	(lb/a)		(lb/a)	(lb/a)
0	1211	c	1497	1354
30	1683	b	1530	1607
50	1848	a	1484	1666
70	1831	a	1509	1670
90	1792	ab	1479	1636
110	1728	ab	1494	1611
140	1662	b	1445	1554
LSD 0.05	140		NS	---
P-value	0.000			

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

Soil NO_3-N

Soil samples were taken in the fall (mid November). Samples taken post-harvest were obtained from three treatments: 0, 70, 140 lb N/a and at three depths: 0-1, 1-2, 2-3 ft. Results are detailed in Tables 8 and 9. At both sites the highest nitrogen rate (about 2 times normal N rates used) generally increased NO_3-N in the 0-12 in. zone (Tables 8 and 9). The same results were apparent in the 13-24 in. zone but at much lower concentrations. Even though there are higher NO_3-N concentration levels due to the higher nitrogen rates, the actual residual concentrations are all low (<10 ppm) to medium (10 to 20 ppm) according to OSU guidelines[2] with no high (20-30 ppm) or excessive (>30 ppm) levels. These data show efficient soluble nitrogen removal by the fibrous root systems of these perennial grass seed crops during crop growth and development for seed production. At the Taylor Farm site, there was a slight increase in NO_3-N at the 25-36 in zone. This may indicate a buildup of mineralized N occurring during the summer that the plant was unable to scavenge or movement of soluble N may be past the effective root zone for the crop. At a typical grower rate 70 lb N/a the overall averages of the whole profile (0-36 in) were low concentrations of 2.8 ppm and 4.0 ppm (Sherman and Taylor Farms respectively) as shown in Table 9. Use of recommended N rates will result in low levels of leachable NO_3-N being available in the soil after harvest.

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

SUMMARY

Optimum levels of spring applied N for fine fescue seed production were 50-70 lb N/a at these sites. Applying more than the optimum rates did not ensure increased yield. It must be noted that these results are from first-year seed crops, and only by continuing these trials for 2-3 years will we be able to provide data over the life of these stands. Seed yields for all locations, as indicated in Table 3, were well above Willamette Valley average yields for 1999. Soil test results show efficient use of applied N and little potential for leaching losses at recommended use rates. These sites are being continued for a second year (and possibly a third year) to determine the long-term economic and agronomic effects of these treatments.

Presentations to date:

1) Fine Fescue plot tour for seed growers and company field representatives on June 1, 1998. G.A. Gingrich. (30 attendees)
2) ODA Groundwater Research and Development Conference, January 20, 2000. W.C. Young III (90 attendees)
3) Grass Seed Seminar - A Years Management Options, Washington County Extension Office, February 16, 2000. W.C. Young III. (80 attendees)
4) Oregon Fine Fescue Commission Meetings.

These type of presentations of results will continue in the coming year as well as be reported in the annual Seed Production Research Extension publication.

Table 4. Harvest index and total biomass at maturity of fine fescue following varied rates of spring applied N, 1999.

Spring applied N (lb/a)	Harvest index			Total biomass		
	Sherman Farm	Taylor Farm	2-site average	Sherman Farm	Taylor Farm	2-site average
		(%)			(ton/a)	
0	27.2	11.8	19.5	2.4	6.4	4.4
30	21.2	11.1	16.2	4.0	6.9	5.5
50	21.7	13.1	17.4	4.4	5.7	5.1
70	15.1	11.5	13.3	6.1	6.7	6.4
90	19.5	10.5	15.0	4.7	7.0	5.9
110	19.8	11.9	15.9	4.8	6.4	5.6
140	14.6	10.6	12.6	6.1	6.9	6.5
LSD 0.05 (0.10)	NS	NS	---	NS	NS	---
P value						

Table 5. Fertile tiller density and spikelets per tiller in fine fescue following varied rates of spring applied N, 1999.

Spring applied N (lb/a)	Fertile tiller density			Spikelets		
	Sherman Farm	Taylor Farm	2-site average	Sherman Farm	Taylor Farm	2-site average
	(no./sq. ft.)			(no. per tiller)		
0	198 b	314	256	33.6 bc	37.2	35.4
30	271 ab	337	304	33.3 bc	32.8	33.1
50	272 ab	291	282	26.5 d	44.2	35.4
70	346 a	249	298	37.7 ab	31.5	34.6
90	330 a	330	330	31.0 cd	33.6	32.2
110	333 a	288	311	41.7 a	35.0	38.4
140	340 a	318	329	38.8 ab	40.2	39.5
LSD 0.05 (0.10)	85	NS	---	6.6	NS	---
P value	0.021			0.005		

Table 6. Floret number and 1000 seed weight of fine fescue following varied rates of spring applied N, 1999.

Spring applied N (lb/a)	Floret number			1000 seed weight		
	Sherman Farm	Taylor Farm	2-site average	Sherman Farm	Taylor Farm	2-site average
	(avg. no. per spikelet)			(g/1000 seed)		
0	4.5	5.3	4.9	1.12	1.16	1.14
30	5.3	5.6	5.5	1.08	1.16	1.12
50	5.5	5.9	5.7	1.05	1.19	1.12
70	5.6	5.4	5.5	1.08	1.21	1.15
90	5.5	5.4	5.5	1.07	1.16	1.12
110	5.3	5.5	5.4	1.11	1.22	1.16
140	6.5	5.9	3.2	1.11	1.20	1.16
LSD 0.05 (0.10)	(0.9)	(0.4)	---	0.04	NS	---
P value	0.106	0.090		0.022		

Table 7. Plant height and inflorescence length at maturity in fine fescue following varied rates of spring applied N, 1999.

Spring applied N (lb/a)	Plant height			Inflorescence length		
	Sherman Farm	Taylor Farm	2-site average	Sherman Farm	Taylor Farm	2-site average
		(cm)			(cm)	
0	63.9	74.6	69.3	10.9	13.0	12.0
30	70.1	78.9	74.5	11.1	13.6	12.4
50	77.5	77.8	77.7	11.2	14.5	12.9
70	77.8	77.8	77.8	12.0	14.4	13.2
90	75.3	75.8	75.6	11.3	14.4	12.9
110	76.2	71.4	73.8	13.1	14.0	13.6
140	79.1	75.4	77.3	13.2	15.8	14.5
LSD 0.05 (0.10)	8.7	NS	---	1.5	NS	---
P value	0.027			0.020		

Table 8. Soil NO_3-N post harvest concentrations (taken 11/99) at three soil depths of fine fescue following varied rates of spring applied N, 1999.

Spring fertilizer applied (lb N/a)	Post harvest samples (early fall 1999.)		
	0-12 in.	13-24 in.	25-36 in.
Sherman Farm.		(ppm)	
0	2.8	1.0	1.3
70	5.1	1.5	1.9
140	10.2	3.9	2.9
LSD 0.05 (0.10)	3.4	1.5	NS
P-value	0.009	0.011	
Taylor Farm.			
0	3.8	1.4	3.3
70	6.0	2.7	3.4
140	10.8	4.6	5.6
LSD 0.05 (0.10)	5.4	2.2	(1.6)
P-value	0.050	0.035	0.060
2 site average			
0	3.3	1.2	2.3
70	5.6	2.1	2.7
140	10.6	4.3	4.6

Table 9. Soil NO_3-N post harvest concentrations (taken 11/99) from spring N fertilizer rate and depth of sampling on fine fescue, 1999.

Treatment	Sherman Farm	Taylor Farm	2-site average
Spring fertilizer (lb N/a)		(ppm)	
0	1.7	2.8	2.3
70	2.8	4.0	3.4
140	5.7	7.0	6.4
LSD 0.05 (0.10)	*1	1.6	---
P-value		0.000	---
Soil sample depth			
0-1 ft	6.0	6.9	6.5
1-2 ft	2.1	2.9	2.5
2-3 ft	2.0	4.1	3.1
LSD 0.05 (0.10)	*1	1.6	---
P-value		0.000	---

*1 Interaction of rate x depth significant at P(0.05 (see table 8)