Effect of Nitrogen Fertilization on Tiller Population of Cool-Season Grasses

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Abstract

On April 8, 1966 an experiment was iniated on the Purdue University Agronomy Farm at Lafayette to determine the response of cool-season grasses to nitrogen fertilization. The soil type on the experimental area was Chalmers silty clay loam.

The four cool-season grasses included in the experiment were Potomac orchardgrass (*Dactylis glomerata* L.), Kentucky 31 tall fescue (*Festuca arundinacea* Schreb.), Lincoln smooth bromegrass (*Bromus inermis* Leyss.), and reed canarygrass (*Phalaris arundinacea* L.). Nitrogen, as ammonium nitrate, was broadcast at rates of 0, 14, 28, 56, 112, 224 and 448 kg/ha per harvest beginning in the spring of 1967. Three replications were included in the experiment. The initial application of nitrogen was in early April and the following applications immediately after each hay harvest. Nitrogen was not applied after the last cutting of each year.

Morphological characteristics were used as a guide to cutting frequency. Orchardgrass and tall fescue head in early May and the regrowth does not joint thus permitting five cuttings annually on a cutting schedule of every five weeks. Reed canarygrass and smooth bromegrass head in mid-May and the regrowth joints. Six to seven weeks are required for stem elongation. Therefore, only four cuttings of these two grasses were obtained annually.

Yield data indicate that approximately 250 kg/ha of nitrogen are required annually to obtain high yields (16 tons per ha or more under good growing conditions) of these grasses and that possibly even higher rates are needed for maximum yield and quality. After this experiment had been underway for six years, tiller counts were taken following the first cutting in 1973 to determine the effect of nitrogen fertilization on tiller population. Excellent stands of tall fescue, orchardgrass, and reed canarygrass were still present at all levels of nitrogen after six years of nitrogen treatments. However, smooth bromegrass was completely eliminated in all three replications of the two highest nitrogen rates. The stands of smooth bromegrass were satisfactory at the lower four rates of nitrogen after six years.

The results of this study indicate that tall fescue, orchardgrass, and reed canarygrass meadows can tolerate nitrogen applications in excess of 1,792 kg/ha annually when applied in four or five split applications. Smooth bromegrass appears sensitive to rates of nitrogen in excess of 448 kg/ha annually applied in four split applications.

Introduction

About 10 years ago Purdue University scientists demonstrated that alfalfa-grass mixtures were capable of yielding more than 16 tons/ha of hay containing nearly 3,000 kg of protein (4). However, at about that same time alfalfa weevil appeared in southern Indiana and it soon became apparent that unless effective insecticides and/or resistant germplasm were found it would not be possible to continue to produce alfalfa in Indiana. Therefore, agronomists began looking for alternative forage crops. Because of the availability of low cost commercial nitrogen interest developed relative to the yield potential of cool-season grasses when liberally fertilized with nitrogen. Consequently, the following experiment was initiated at the Purdue University Agronomy Farm to study the effect of nitrogen on yield and persistence of stands of four cool-season perennial grasses.

Materials and Methods

On April 8, 1966 an experiment was initiated on the Purdue University Agronomy Farm at Lafayette to determine the response of cool-season grasses to nitrogen fertilization. Potomac orchardgrass (*Dactylis glomerata* L.), Kentucky 31 tall fescue (*Festuca arundinacea* Schreb.), Lincoln smooth bromegrass (*Bromus inermis* Leyss.), and reed canarygrass (*Phalaris arundinacea* L.) were seeded individually with oats (*Avena sativa* L.) as a companion crop. The soil type was Chalmers silty clay loam. At time of seeding 342 kg/ha of 25-25-0 were applied. On July 22 the oat crop was harvested and the straw removed.

Plots in triplicate were established in April, 1967 on the four grasses. Nitrogen, as ammonium nitrate, was broadcast at rates of 0, 14, 28, 56, 112, 224, and 448 kg/ha of actual nitrogen per harvest. The initial application of nitrogen was made in early April and the following applications immediately after each harvest. Nitrogen was not applied after the last cutting of each year.

The growth habit of each grass determined the cutting frequency. Five cuttings were obtained annually from orchardgrass and tall fescue since these grasses head in early May and the regrowth does not joint. Consequently, orchardgrass and tall fescue could be harvested at approximately five-week intervals. Smooth bromegrass and reed canarygrass head about the middle to the latter part of May and the stems of the regrowth joint. Six to seven weeks are required for stem elongation to ensure rapid regrowth and persistence of stands of these two grasses. Thus, only four cuttings of smooth bromegrass and reed canarygrass were obtained annually.

Lime was applied prior to seeding to raise the soil pH to 6.8. Phosphorus and potassium were added annually. In 1967, phosphorus and potassium were applied at rates of 112 and 336 kg/ha, respectively. In 1968, and each succeeding year, potassium was applied at a rate of 336 kg/ha in spring and again in late summer while phosphorus was applied each spring at the rate of 112 kg/ha.

The experiment was terminated immediately following the first cutting in 1973. Stand counts were taken at that time employing a 0.1 m^2 quadrat.

Results and Discussion

The effect of nitrogen fertilization on forage yields and crude protein concentrations has been published (1, 5, 6). It was demonstrated that these grasses are capable of hay yields of 16 tons/ha or more when properly managed which is comparable to that of high producing alfalfa-grass mixtures. When stands are pure grass, it appears that approximately 250 kg/ha of nitrogen must be applied annually to produce hay yields of 14 tons/ha under favorable growing conditions and that possibly even higher applications are required for maximum hay and crude protein yield. Crude protein concentration ranged from approximately 10 percent to as high as 30 percent depending on the level of nitrogen applied.

The effect of nitrogen fertilization on tiller population is shown in Tables 1 and 2. The stand of smooth bromegrass was completely eliminated at the two highest rates of nitrogen. However, it is apparent that nitrogen rates producing the highest yields in this study did not have a detrimental effect on tiller density when applied in 4 to 5 split applications. These data are similar to those reported in the literature although previous studies did not include nitrogen fertilizer rates this high (2, 3).

TABLE 1. *Effect of nitrogen fertilization on tiller population of smooth bromegrass and reed canarygrass after a period of six years (1967-1973).*

Species	Nitrogen-kg/ha						
	0	56	112	224	448	896	1796
	Tillers/m^2						
Smooth bromegrass	506	377	441	527	327	0	0
Reed canarygrass	603	463	635	463	667	635*	388

*Avg. of 2 rather than 3 replications.

TABLE 2. *Effect of nitrogen fertilization on tiller population of orchardgrass and tall fescue after a period of six years (1967-1973).*

Species	Nitrogen-kg/ha						
	0	70	140	280	560	1120	2240
	Tillers/m^2						
Orchardgrass	366	474	366	463	517	366	280
Tall fescue	1023	1087	1184	818*	861	990	829

* Only 1 replication.

Tall fescue and reed canarygrass were found to be most tolerant to very high rates of nitrogen. This was especially true of tall fescue as can be seen from Table 2 since the number of the tillers per square meter declined very little at the highest nitrogen level of 2240 kg/ha.

Summary

The results of this study indicate that tall fescue, orchardgrass, and reed canarygrass meadows can tolerate nitrogen rates in excess of 1,792 kg/ha annually when applied in four or five split applications. Smooth bromegrass appears sensitive to annual rates in excess of 448 kg/ha annually when applied in four split applications.

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