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# Evaluation of Various Slow-release Nitrogen Sources for Growth and Establishment of *Poa pratensis* on Sand-based Systems

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**ABSTRACT.** Nitrogen (N) is one of the most important nutrients among 17 essential nutrients for maintaining turfgrass color and quality. The slow release fertilizers were initially developed to provide a more consistent release of nitrogen over a longer period and are often used to decrease leaching potential from sandy soils. The goal of this study is to determine if various slow release N sources affect the rate at which turfgrass establishes. Six nitrogen sources were evaluated; Nitroform (38-0-0), Nutralene (40-0-0), Organiform (30-0-0), Sulfur coated urea (SCU, 37-0-0), urea (46-0-0), and Milorganite (6-0-0). The root zone media was seeded and sodded with 'Limousine' Kentucky bluegrass (*Poa pratensis* L.). Sodded pots produced 182 to 518 g more clipping dry weight than seeded pots. Among seeded pots, Milorganite produced greater amount of root dry weight than any other N sources. Because the period of turfgrass growth is different between sodded and seeded plots, there were differences on clipping yield and root growth. Overall, high N rate had turf color greater than acceptable color of 6 among seeded pots throughout the study. However, low N rate didn't produce acceptable turf color throughout the study. Based on the result of this study, Milorganite would be recommended for new establishment of Kentucky bluegrass than urea with less clipping yield which can lead to reduce labor.

***Key words*: Kentucky bluegrass, nitrogen, slow release fertilizers, leaching potential**

## Introduction

Nitrogen (N) is one of the most important nutrients among 17 essential nutrients for maintaining turfgrass color and quality. An intensive N fertilization program and high N fertilization rate are required for turfgrass optimal quality (Exner et al., 1991). However, frequent and excessive N application can lead to ground water contamination due to N leaching potential especially with soil of high infiltration rates. Golf greens, for instance, consist of sand mixture to prevent water flooding with high infiltration rates which may magnify leaching potential (Brown et al., 1982). Turfgrass $NO_3$ leaching potential is affected by various factors including irrigation practice, soil texture, solubility of N source, N application rate, and growth rate of turfgrass (Spalding and Exner, 1993). The previous researches have reported their results to reduce N leaching risk. Liu et al. (1997) reported that $NO_3$-N leaching risk can be decreased through proper water management because overwatering with fertilization may induce N leaching events. Hesketh et al. (1995) reported that well-established turfgrass have an increased ability to retain soil N compared to newly planted turfgrass. Miltner et al. (1996) and Nelson et al (1980) reported that thickness of thatch layer influenced N leaching potential.

Turfgrass fertilizers are classified into two categories based on their speed of N release. The fast release sources of N are consistently available and quickly untaken by N deficient turfgrass (Bowman and Paul, 1988). In contrast, the slow release fertilizers were initially developed to provide a more consistent release of nitrogen over a longer period (Wiedenfeld, 1986) and are often used to decrease leaching potential from sandy soils (Wang and Alva, 1996). Hummel and Waddington (1981) stated that use of slow release fertilizers may decrease of the possible contamination of drinking water sources due to high leaching potential, N volatilization, the number of N applications at higher rates, and burning potential of fertilizers. Slow N sources reduced the number of applications per year and allowed for higher rates of product to be applied in a single application. Because slow release fertilizers release smaller amounts of nutrient over longer periods of time, they have not been considered as a primary choice for rapid establishment of turfgrass. Establishing grass on sand based systems is problematic because nitrogen is easily leached from the system and soluble N sources often need application every 7 days to grow-in sand fields. It is also not clear if high rates of slow release N sources can be mixed into the sand mix to

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**Table 1.** Summary of the analysis of variance from the study on the evaluation of 6 nitrogen sources for establishment and growth of ‘Limousine’ *Poa pratensis* L. on sand-based systems.

| Source of variance | df | Total clipping yield | Root length at the end of the study | Turf color at the end of the study | Root dry weight |
|---|---|---|---|---|---|
| Nitrogen Sources (NSO) | 5 | ** | NS | ** | NS |
| Nitrogen Rate (NR) | 1 | * | NS | ** | NS |
| Establishment Type (TYPE) | 1 | ** | ** | ** | NS |
| NSO*NR | 5 | NS | NS | NS | NS |
| NSO*TYPE | 5 | ** | * | NS | * |
| NR*TYPE | 1 | * | NS | * | NS |
| NSO*NR*TYPE | 5 | NS | NS | NS | NS |

*, ** Significant at the $\alpha = 0.05$ and 0.01 probability level, respectively. NS = not significant.

improve turf establishment. The goal of this study is to determine if various slow release N sources affect the rate at which turfgrass establishes.

## Materials and Methods

Six nitrogen sources were evaluated; Nitroform (38-0-0), Nutralene (40-0-0), Organiform (30-0-0), Sulfur coated urea (SCU, 37-0-0), Urea (46-0-0), and Milorganite (6-0-0). Local mason sand that meets USGA specification was used as the growing media. The sand materials were packed into a 7.6 cm diameter PVC pipe lined with 6.9 cm diameter clear plastic tubing. The plastic liner was removed for viewing and replaced in the PVC tubes. The PVC pipe was capped at the bottom and the plastic tube tied off at the bottom with fine holes punched to facilitate drainage. The root zone depth was 36 cm and the holding tube was 38 cm. Each fertilizer, except urea, was mixed into the top 5 cm of the root zone media at rate of 10 and 20 g of N $m^{-2}$, respectively. Urea treatment was applied at the surface of the media at 0.8 and 1.6 g of N $m^{-2}$ $week^{-1}$ giving a total of 10 and 20 g of N $m^{-2}$ during a 12 weeks study period, respectively. The root zone media was seeded and sodded with ‘Limousine’ Kentucky bluegrass (*Poa pratensis* L.) and watered to field capacity on November 20, 2001. Water was applied daily thereafter according to the ET requirement. The study was conducted in the research greenhouse at the Iowa State University Horticulture Department, Ames, Iowa, US. Turfgrass color was measured by visual evaluation every week using a scale of 1 to 9 (1=straw brown, 6=acceptable, and 9=dark green). Turfgrass quality was measured by visual evaluation every week using a scale of 1 to 9 (1=worst, 6=acceptable, and 9=best). Turfgrass was mowed weekly with clippings collected. Turfgrass clippings were collected from 46 $cm^2$ area of each pot, dried at 67°C for 48 hours, and weighed. Root length was measured every 2 days for both seeded and sodded treatments and in the case of seeded treatment, germination dates, and days to three-leaf stage was also noted. At the termination of the study root dry weight was measured by washing sand from the roots and

**Table 2.** Mean root length and root dry weight of ‘Limousine’ *Poa pratensis* L. with factors of N sources and type of establishment averaged over replications and both levels of N rates at the end of the study.

| Nitrogen Sources | Total clipping dry weight ($g{\cdot}m^{-2}$) | | Root length (cm) | | Root dry weight ($g{\cdot}m^{-2}$) | |
|---|---|---|---|---|---|---|
| | Seeded | Sodded | Seeded | Sodded | Seeded | Sodded |
| Nitroform | 125.1[x] | 428.4 | 19.6 | 23.0 | 13.4 | 13.8 |
| Nutralene | 114.2 | 520.1 | 19.9 | 23.4 | 15.6 | 14.5 |
| Organiform | 105.2 | 485.7 | 18.8 | 22.9 | 14.2 | 16.5 |
| Sulfur coated urea (SCU) | 166.1 | 470.4 | 20.3 | 21.3 | 13.3 | 17.3 |
| Milorganite | 147.2 | 665.5 | 20.5 | 20.9 | 21.0 | 12.1 |
| Urea | 347.6 | 530.0 | 19.8 | 26.8 | 11.6 | 11.6 |
| SED[y] | 57.2 | | 1.5 | | 2.5 | |

[x] Each mean was calculated from 6 observations (three replications * two N rate levels).
[y] Standard error of difference.

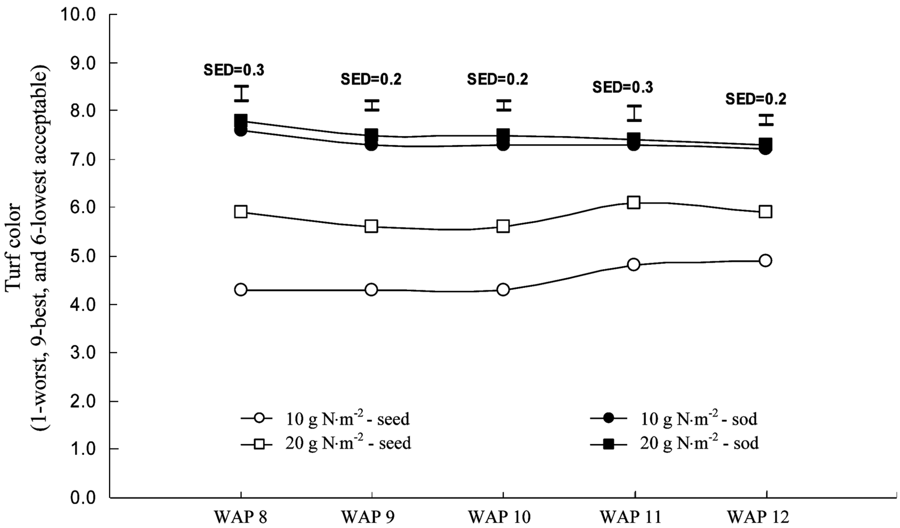


**Fig. 1.** Mean turf color per unit surface area of 'Limousine' *Poa pratensis* by N rate and type of establishment. Each mean was calculated from 18 observations (three replications * 6 N sources). The vertical bar represents the standard error of difference (SED). WAP means weeks after planting.

oven drying the roots.

The experimental design was a randomized complete block design with three replications. The data were analyzed using the t-test procedures and mean separation was performed by standard error of differences (SED) method of the Statistical Analysis System (SAS, 1987).

## Results and Discussion

There was an interaction between N source and establishment type and between N rate and establishment type for total clipping yield (Table 1). Sodded pots produced 182 to 518 g more clipping dry weight than seeded pots. The biggest difference was found from pots applied by Milorganite. Urea applied to the seeded pots produced 109 to 230% more clipping dry weight than other N sources applied to the seeded pots. However, Milorganite applied to the sodded pots created 26 to 55% more clipping dry weight than other N sources (Table 2). A significant interaction existed between N sources and establishment type for root length and root dry weight at the end of the study (Table 1). Milorganite applied to the seeded pots produced 9% more root length than organifrom applied to the seeded pots, although there was no difference between urea and Milorganite. Among seeded pots, significant difference on root length was found between Milorganite and Organiform. Sodded pot produced 1 to 7 cm more root length than seeded pots. The biggest difference was found from pots applied by Urea. Urea produced 13-22% more root length than other N sources. Among seeded pots, Milorganite produced greater amount of root dry weight than any other N sources. Sulfur coated urea had the greatest amount of root dry weight among sodded pots. Milorganite formed 25 to 45% more root dry weight than urea applied to the seeded pots. However, no difference for root dry weight was found between Milorganite and urea in the sodded pots. There were differences for turf color between treatments in both the seeded and sodded pots, even though no difference was found between rates in the sodded pots (Fig. 1). This was not changed until 12 week after planting (WAP). Overall, high N rate had turf color greater than acceptable color of 6 among seeded pots throughout the study. However, low N rate didn't produce acceptable turf color throughout the study.

Because the period of turfgrass growth is different between sodded and seeded plots, there were differences on clipping yield and root growth. Based on the result of this study, Milorganite would be recommended for new establishment of Kentucky bluegrass than urea with less clipping yield which can lead to reduce labor.

## References

1. Bowman, D.C., J.L. Paul, and R.M. Carlson. 1988. A method to exclude nitrate from Kjeldahl digestion of plant tissues. Commun. Soil Sci. Plant Anal. 19:205-213.
2. Brown, K. W., J. C. Thomas, and R. L. Duble. 1982. Nitrogen source effect on nitrate and ammonium leaching and runoff from greens. Agron. J. 74:947-950.
3. Exner, M. E., M. E. Burbach, D. G. Watts, R. C. Sherman, and R.F. Spalding. 1991. Deep nitrate movement in the unsaturated zone of a simulated urban lawn. J. Environ. Qual. 20:658-662

4. Hesketh, E. S., R. J. Hull, and A. J. Gold. 1995. Estimating non-gaseous nitrogen losses from established turf. J. Turf. Manage. 1:17-30.
5. Liu, H., R.J. Hull, and D.T. Duff. 1997. Comparing cultivars of three cool-season turfgrasses for soil water $NO_3$ concentration and leaching potential. Crop Sci. 37:526-534.
6. Miltner, E. D., B. E. Branham, E. A. Paul, and P. E. Rieke. 1996. Leaching and mass balance of $^{15}N$-labeled urea applied to a Kentucky bluegrass turf. Crop Sci. 36:1427-1433.
7. Nelson, K. E., A. J. Turgeon, and J. R. Street. 1980. Thatch influence on mobility and transformation of nitrogen carriers applied to turf. Agron. J. 72:487-492.
8. SAS. 1987. SAS/STAT User's Guide. Version 6. Statistical Analysis System Institute, Inc., Cary, NC.
9. Spalding, R. F., and M. E. Exner. 1993.Occurrence of nitrate in ground-water - A review. J. Environ. Qual. 22:392-402.
10. Wang, F. L., and A. K. Alva. 1996. Leaching of nitrogen from slow-release urea sources in sandy soils. Soil Sci. Soc. Am. J. 60:1454-1458.
11. Wiedenfeld, R. P.1986. Rate, timing and slow-release nitrogen fertilizers on cabbage and onions. Hort Sci. 21:236-238.

# 모래지반에서 켄터키블루그래스의 성장과 조성에 미치는 질소의 유형별 효과

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**요 약**: 질소는 색감과 품질을 유지하기 위한 잔디의 성장에 필요한 17가지 필수 영양성분중에 하나이다. 완효성 비료는 일정한 양의 질소 영양성분을 오랜기간 동안 제공하기 위해서 개발이 되었고 모래지반에서 특히 더 잘 용탈되는 질소의 양을 줄이기 위해서 사용이 된다. 이 실험의 목적은 다양한 완효성 비료가 다른 비율로 시비 되었을때 잔디조성에 어떻게 영향을 미치는 지에 대해서 조사하였다. 총 6가지 질소비료가 실험되었으며 켄터키블루그래스가 파종과 뗏장을 위해 사용이 되었다. 뗏장으로 조성된 실험구가 파종으로 조성된 실험구 보다 182에서 518 g 예지물을 더 생산하였다. 파종으로 조성된 실험구중에서는 밀오거나이트가 가장 많은 뿌리의 건중량을 생산하였다. 파종과 뗏장은 잔디의 성장 기간이 다르기 때문에 예지물의 양과 뿌리의 건중량에서 차이가 난다. 본 실험의 결과에 따르면 밀오거나이트가 다른 5가지의 질소비료 보다 예지물의 생산이 적었으며 지하부의 성장이 다 좋았으므로 켄터키블루그래스가 처음 조성이 될때는 밀오거나이트가 권장이 된다.

**주요어**: 켄터키블루그래스, 질소, 완효성 질소, 용탈