Slow Release Fertilizer Decreases Leaching Loss of Nitrogen in Sand-based Root Zone

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Effects of Chitosan on the Growth Responses of Kentucky Bluegrass (Poa pratensis L.)

완효성비료의 모래식재지반에 있어서 질소용탈의 감소

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ABSTRACT

When a football field is constructed using sand medium, the fertilizer management has to be adjusted because of the low nutrient holding capacity and higher leaching rate. The objective of this study was to test the effects of slow release fertilizers on Kentucky bluegrass (*Poa pratensis* L.) growth in simulated sport field rootzones with PVC pipe pots. Data of turfgrass color, uniformity, growth rate, biomass above ground, and the nitrate content in the leaching solution was collected at different growing stages and during four simulated rain fall periods. The result showed that the nutrient release rate of urea was the highest and that of controlled release nitrogen fertilizer was the lowest. Effects of the controlled release nitrogen fertilizer lasted 14 days more than other lawn fertilizers and 28 days longer than regular urea with acceptable quality levels of turf. The slow release fertilizer also restrained excessive growth of the grass, reduced the times of mowing. Slow release fertilizer used in this study reduced NO_3-N leaching by almost 50% at the beginning of turf establishment.

Key words: fertilizer, nitrate, pollution, sports fields

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INTRODUCTION

Fertilization is one of the most important means in turfgrass management(Wehner et al.1998). Sand-based rootzones using the United State Golf Association(USGA) specifications(USGA green section staff, 1973; Hummel N.1993; USGA Green Section staff, 1993) are widely adopted in China for sports fields. When a football field is constructed using sand medium, the fertilizer management has to be adjusted because of the small nutrient holding capacity and higher leaching rate. Slow release fertilizers are more and more popular in turfgrass management. The objective of this study was to test a slow release fertilizer in simulated root zones with PVC pipe pots.

MATERIALS AND METHODS

A 15 cm depth of mixture of native soil, organic matter, and fine sand (2:3:5 / volumetric basis) was packed into PVC tubes 40 cm in dia. and 50 cm deep on top 10 cm coarse sand and 15 cm of gravel, respectively. The bottom of the PVC tubes had a layer of gauze for water collection through the holes (Fig. 1).The general properties of the soil studied are shown in Table1.

This experiment was conducted in Shandong Agricultural University. The grass was established from a Kentucky bluegrass brand name 'Lawn Star', composed of 'Midnight' (30%), 'Nuglade'(25%), 'Total eclipse' (25%), and 'Award'(20%), in April 14, 2005 at a rate of 40g/m^2.

There were four fertilizers used in the study: Control(regular urea, 46-0-0), Treatment 1(T1) (Lawn fertilizer, 35-12-8); Treatment 2(T2) (Lawn fertilizer parcels, 33-11-7), and Treatment 3(T3) (Slow release urea,

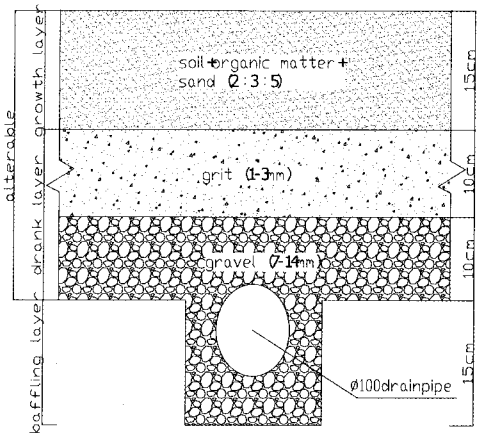

Fig.1. Vertical profile of simulated root zone for sport field

Table 1. General properties of the soil used in the study.

pH	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)	Nitrate N (mg/kg)	Inferior nitrate N (mg/kg)
6.1	78.07	85.62	11.95	6.22	8.02

43-0-0). The slow release fertilizer has a 3 month nutrient release period at 25℃ (Shandong Kingenta ecological engineering Co., Ltd). All fertilizers were applied at equal rate of 21g/m^2. Phosphate and potassium fertilizers were applied to every treatmentfrom KH_2PO_4 and K_2SO_4 at the rate of 12g/m^{2}of P_2O_5 and 8g/m^2 of K_2O, respectively. All the fertilizers were mixed into the top soil before seeding. This experiment was a randomized completeblock design with 3 replicates.

During the seedling stage, the top 1.5-cm soil layer was kept moist by watering twice a day. The mature grass was watered according to turf quality, local temperature, and the rainfall. We also included 4 simulations of heavy rainfallusing a rainfall simulator (American Norton Swing Type Artificial Rain Equipment). No herbicides were used during the study. The grass was clipped once a week. Clippings were collected for biomass measurement. We collected all leachates with a catch system. The NO_3-N was analyzed using spectrophotometer method. The color and uniformity of grass

Table 3. Growth rate of Kentucky bluegrass (*Poa pratensis* L.) affected by different fertilizers.

Evaluation dates	Growth Rate (cm/week)			
	CK	T1	T2	T3
12~18d	5.6a	5.1b	4.8b	3.4c
19~24d	4.4a	4.6a	4.8a	4.5a
25~31d	5.0ab	4.9b	5.1a	4.9ab
32~38d	4.7a	4.5a	4.2a	4.2a
39~45d	3.9ab	4.1a	4.3a	3.6b
46~52d	3.8a	1.9b	1.8b	3.5a
53~59d	2.0b	2.3a	2.2a	1.9b
60~66d	1.3b	2.2a	1.2b	2.4a
67~73d	1.4d	2.5b	3.4a	2.0c
74~80d	1.7c	1.7c	2.0b	5.6a
81~87d	2.0b	2.6a	2.8a	2.8a
88~94d	1.4c	2.7a	2.6ab	2.3b

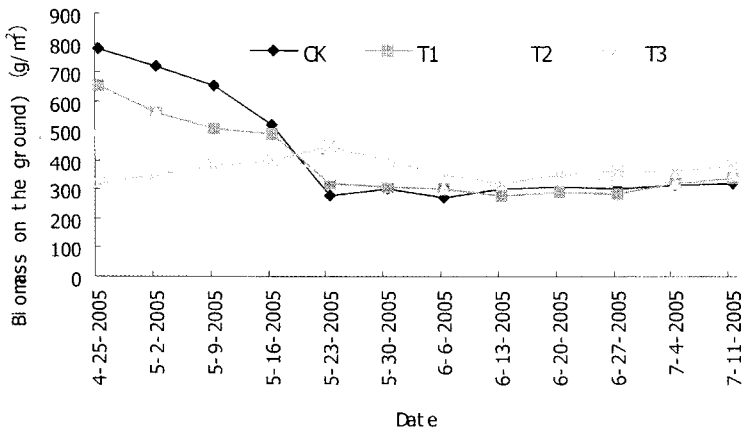

Figure 2. Clipping yield affected by various fertilizers.

were ranked in a 1 to 9 scale with 9 being the best and 6 is minimum acceptable.

RESULTS AND ANALYSIS

The color rating of the grass were in the order of Control(regular urea) > T1> T2 >

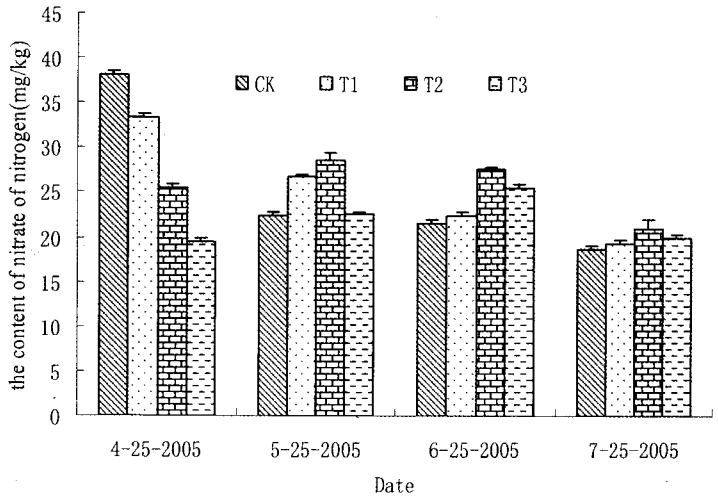

Figure 4. Changes in NO_3-N content in the collected leaching solution under simulated rainfall conditions.

Slow-release urea. Eleven days after fertilization, the number of days for a treatment with color rating above 7 was recorded with the results are: 14 days for the control, 35 days for T1, 28 days for T2, and 49 for T3(Table 2). The growth rates were in the order of Urea> T1>T2 > T3(Table 3). This is also reflected in the biomass collection as shown in Fig 2. During the entire experiment the uniformity in urea treatment was the worst whereas the slow release nitrogen treatment was the best(Fig. 3).

The content of NO_3-N in the collected leaching solution from the urea and lawn fertilizer(T1) treatments started high and decreased during the experiment, whereas that of parcel lawn fertilizer(T2) and controlled release fertilizer(T3) was less variable during the study. The total NO_3-N content in leaching solution was higher for urea and T1 than that of T2 and T3 at the first and second simulated rainfall.

CONCLUSIONS

Among all examined fertilizers tested, the nutrient release rate of urea was the highest

Table 2. Color ratings of Kentucky bluegrass(*Poa pratensis* L.) affected by different fertilizers.

Evaluation Date	Turf color ratings (1~9, 9 = best)			
	CK	T1	T2	T3
4-25-2005	7.0a*	4.8a	6.5b	6.9a
5-2-2005	7.8a	7.4b	7.5ab	7.8b
5-9-2005	6.2c	7.0b	7.4ab	7.7a
5-16-2005	6.4c	7.0b	7.3a	7.6a
5-23-2005	6.1b	6.1b	7.4a	7.8a
5-30-2005	5.7b	6.0b	7.3a	7.6a
6-6-2005	5.3c	6.4b	6.2b	7.4a
6-13-2005	5.3c	6.1ab	5.7b	6.2a
6-20-2005	5.3a	5.7a	5.3a	5.7a
6-27-2005	4.8b	4.8b	5.6b	6.5a
7-4-2005	4.9a	4.8a	5.1a	6.5a
7-11-2005	4.8a	4.8a	4.6a	4.8a

* Different superscript letters in the same row indicate significant differences at a 0.05 level

and that of controlled release nitrogen fertilizer was the slowest. Effect of controlled release nitrogen fertilizer lasted the longest period and that of urea lasted the shortest. The visual ratingsof uniformity and color of the grass treated with controlled release nitrogen fertilizer were higher than others for a longer period.

During the earlier stage of fertilization, the clipping yield for urea on lawn fertilizer treatments were higher than that of parcel type lawn fertilizer and controlled release fertilizer. But the fast growth was a waste of soil nutrient with out gain in turf quality under the condition without traffic. Controlled release fertilizer may prevent the nutrient loss and nitrate pollution of water body.

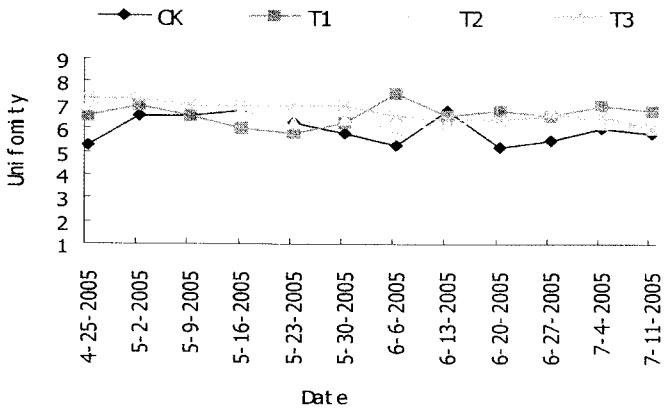

Figure 3. Turf uniformity affected by various fertilizers

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국문 요약

축구장의 식재지반이 모래로 조성될 경우 낮은 보비력과 높은 용탈율로 인해 시비관리의 조정이 필요하다. 본 실험의 목적은 PVC관을 이용한 경기장 유사모형 실험구에서 캔터키 블루그래스에 있어서 완효성비료의 생육 효과를 비교 실험하였다. 잔디의 색깔, 균일도, 생육, 지상부 생체량과배출수의 질산의 유출량을 몇가지 다른 생육상과 네번의 유사 강우 시험 시 행하였다. 실험 결과 요소의 성분 유출량이 가장 높았고 공시 완효성비료는 가장 낮았다. 이 완효성 비료는 다른 공시 잔디비료에 비해 14일간, 요소보다는 28일간 잔디의 품질 면에서 비효가 지속되었다. 또한 이 완효성비료는 잔디의 웃자람과 잔디깎기에 소요되는 시간을 줄일 수 있었다. 질산태 질소의 유출에 있어서도잔디의 조성 초반기에 50% 정도를 감소 시켰다.

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