TITLE: Quantification and Fate of Nitrogen from Amended and Trafficked Sand Putting Green/Tee Profiles

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Quantification and Fate of Nitrogen from Amended and Trafficked Sand Putting Green/Tee Profiles

1991 Research Grant: $20,000
(First year of support)

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The concern in the coastal Pacific Northwest is whether NO_3-N in the leachate from putting green profiles constructed of sand or peat/soil amended sand can be significantly improved through efficient irrigation practices, efficient N fertilizer application, reduction in total N fertilization rate or use of deeper sand profiles while retaining maximum play. The Northwest has a history of constructing sand greens from pure sand, some with coarse particle sizes, without amendment in order to reduce cost of construction. The current research needs to identify the susceptibility of these systems to NO_3-N leaching and provide guidance for its correction, reduction or elimination. Lighter, more frequent applications of fertilizers from slow-release sources may be helpful. In addition, frequent, light, liquid application of ammonium sulfate, from a portion of the N supplied, may improve N uptake efficiency and improve turf quality and playability without promoting excessive thatch development.

Lysimeters were constructed during 1991 from local funds and labor. Thirty six of the lysimeters were seeded in early October to 'Putter' creeping bentgrass (Agrostis palustris ***Huds.***) and is to be overseeded to local ecotypes of annual bluegrass (Poa annua ***L.***) in the spring of 1992. The turf is managed as a putting green and will be trafficked with a Brinkman (BTS) traffic simulator equipped with golf cleats.

With these lysimeters an amended sand/N rate/N application timing study was established. The field lysimeters built similar to USGA green specifications are 1.2 m x 2.48 m and were constructed with chlorosulfonated polyethylene reinforced liner, and each fitted with 3.75 mm ABS perforated drain tube. The drain tubes are overlaid by 8 cm of pea gravel and 8 cm of coarse sand. Lysimeters are fitted with PVC suction water samplers placed at 22 to 28 cm in the profile. Irrigation timing and quantity is computer logged in each group of 12 lysimeters and is controlled by computer monitoring of moisture sensors located at 8 to 11 and 27 to 30 cm below the putting surface to provide for the control of optimum water management and control of excessive irrigation.

The growing medium consists of 30 cm depth USGA specification sand alone or sand amended with 10% spaghnum peat and 2% fine sandy loam soil. Nitrogen application consist of three N rates (38.72, 58.1 and 77.4 g N $m^{2\ -1}$ annually), two application methods (granular slow release/soluble N fertilizer in four-week applications and biweekly granular slow release N with liquid ammonium sulfate).

Leachate data collection was begun the last week of October with the beginning of fall rains on the weekend of October 20, 1991. Soil-water percolate from each

lysimeter during excessive precipitation periods or from excess irrigation is monitored and quantified on 24-h intervals during leachate production periods. Leachate samples are analyzed by NO_{3-} and NH_{4+} ion sensitive electrodes and ion analyzer. Graduate student support is provided by the USGA and the Northwest Turfgrass Association.

Quantification and Fate of Nitrogen from Amended and Trafficked Sand Putting Green/Tee Profiles

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In a previous study nitrate-N levels in the percolate from the lysimeters often exceeded 10 mg/l, particularly in the fall with the beginning of the rainy season and with excessive irrigation, but the N application levels in that study were high, representing the very highest N maintenance levels used by a few superintendents in the past but perhaps no golf superintendent today. There were significant NO_3-N loss differences between N sources. Movement of NH_4-N was mostly absent. Generally, NO_3-N in the percolate was lower from ammonium sulfate in the spring than from other N sources while urea and ammonium nitrate were significantly higher than ammonium sulfate and slow release N sources, such as isobutylidine diurea (IBDU), sulfur coated urea (SCU) and oximide (OX). Turf quality was superior from ammonium sulfate.

The concern is whether NO_3-N in the leachate from putting green profiles constructed of sand or peat amended sand can be significantly improved through efficient irrigation practices, efficient N fertilizer application or deeper profiles while retaining maximum play. The Northwest has a history of constructing sand greens from pure sand, some with coarse particle sizes, without amendment in order to reduce cost of construction. The current research needs to identify the susceptibility of these construction practices to NO_3-N leaching and provide guidance for its correction, reduction or elimination. Lighter, more frequent applications of fertilizers from slow-release sources may be helpful. In addition, frequent, light liquid application of ammonium sulfate, from a portion of the N supplied, should improve N uptake efficiency and improve turf quality and playability without promoting excessive thatch development.

Research Methodology

An amended sand/N rate/N application timing study was established in late summer of 1991 and is being conducted on 36 newly constructed pure sand or peat-amended sand lysimeters built similar to USGA green specifications. Lysimeters, 1.2 m x 2.48 m, were constructed with chlorosulfonated polyethylene reinforced liner, and fitted with 3.75 mm ABS perforated drain tubes. The drain tubes are overlaid by 8 cm of pea gravel and 8 cm of coarse sand. Lysimeters are fitted with PVC suction water samplers placed at 22 to 28 cm in the profile. Irrigation timing and quantity is computer logged in each group of 12 lysimeters and is controlled by computer monitoring of moisture sensors located at 8 to 11 and 27 to 30 cm below the putting

surface to provide for the control of optimum water management and control of excessive irrigation.

Soil-water percolate from each lysimeter during excessive precipitation periods and from excess irrigation is monitored and quantified on 24-h intervals during leachate production periods. In addition, two cells will be monitored after 1991 with an Omnidata data logger for leachate flow during excess precipitation periods. Leachate samples and suction water samplers are monitored on a regular basis to follow NO_3-N and NH_4-N losses. Leachate samples are analyzed by NO_{3-} and NH_{4+} ion sensitive electrodes (15) and ion analyzer and periodically checked for accuracy by Kjeldahl steam distillation and then reduced with DeVarda's alloy and analyzed for NO_2-N and NO_3-N (6). Standards of NH_4-N and NO_3-N are analyzed daily. Percolate samples, that are not immediately analyzed following collection, are stabilized with boric acid or potassium chloride prior to NO_3-N determination or acidified with sulfuric acid prior to NH_4-N determination and stored at 33° C.

The growing medium consists of 30 cm depth USGA specification sand alone or sand amended with 10% spaghnum peat and 2% fine sandy loam soil where amended sand is a treatment component. The experimental area is established to 'Putter' creeping bentgrass (Agrostis palustris ***Huds.***) and is to be overseeded to a mixture of local ecotypes of annual bluegrass (Poa annua ***L.***) in the spring of 1992. Depending on season, cutting management is three to five times weekly, core aerified three times annually, regularly and lightly topdressed with sand at 50 l are $^{-1}$. Traffic will be simulated with a Brinkman (BTS) traffic simulator equipped with golf cleats.

The experimental treatments consist of three factors in a randomized complete block design with three replicates. Three N rates (38.72, 58.1 and 77.4 g N $m^{2\ -1}$ annually), two application methods (granular slow release/soluble N fertilizer in four-week applications and biweekly granular slow release N with liquid ammonium sulfate) and two sand growth mediums (pure sand and amended sand) are used. Nitrogen is applied from late February to early December. Nitrogen source consits of a blend of IBDU, SCU, MU plus ammonium sulfate. The method of application consists of 11 granular applications at four-week intervals of 3.52, 5.28, and 7.04 g N $m^{2\ -1}$ and 22 bi weekly applications of 1.72, 2.58 and 3.52 g N $m^{2\ -1}$. In the biweekly applications the ammonium sulfate is applied as liquid at 1.29 g N $m^{2\ -1}$. Plots will be maintained with 5.4 g P, 32.3 g K, 16.1 g Ca and 9.1 g S $m^{2\ -1}$ applied as a component of each slow release N application.

Clippings will be collected twice weekly, usually on Tuesday and Friday but always following one or two days of growth, depending on growth pressure (one day growth during peak growth periods, and two day growth periods during low growth periods). Growth rate will be determined from oven dried clippings and N recovery values from dried clippings and total tissue N data. Total N in the clipping tissue will be determined on a 0.1 g subsample by micro-Kjehdahl procedure (3).

The second study, using 12 lysimeters, will be irrigated with excessive water and consists of four treatments: unamended USGA specification sand at 30 or 45 cm depth or peat/soil amended USGA specification sand at 30 or 45 cm depth. Nutrition will be applied at 77.4 g N (supplied in 11 applications as the above granular blend), 2.93 g P, 14.8 g K, 9.7 g Ca, and 9.1 g S $m^{2\ -1}$. These lysimeters were completed by late October 1991 but were not seeded due the lateness of the season.

Expected Research Results

The data generated in these studies will assist in quantifying the fate of N applied as slow release and ammonium sulfate to putting green turf. This data will assist in the understanding of nutrient leaching in putting greens and provide a background for the development of Best Management Practices (BMP) for golf course and athletic field management in order to protect the environment. The data will provide a quantitative assessment of effect of deeper rooting profiles to help in buffering nutrient leaching and provide a close approximation on N efficiency under several sand base systems at varying levels of N fertilization. The data on N loss through the profile will identify the critical periods during the calendar year when N is most subject to movement and provide management guidelines for alternative N management.

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