Relating Nutrient Imports to Exports and Losses during Sod Production


Graduate Student Researcher: Brandon McDonald, Soil & Crop Sciences Department, Texas A&M University, College Station, TX. cottonpicker9930@tamu.edu

Faculty Research Advisor: Dr. Don Vietor, Soil & Crop Sciences Department, Texas A&M University, College Station, TX. (979) 845-5357. dvietor@tamu.edu.

Problem Statement:
A system for using and exporting manure sources of phosphorus (P) and nitrogen (N) through turfgrass sod production is among best management practices (BMP) available for reducing nutrient loads on the Bosque River Watershed (BRW) in Texas. This system for exporting through sod provides an alternative to government-subsidized hauling and purchase of composted manure (Vietor et al., 2002). The large costs of transporting manure more than short distances and of more land for manure disposal have constrained efforts to reduce nutrient loading on land surrounding animal feeding operations (Daniel et al., 1998). The relatively large value of turfgrass, including sod products, helps defray costs of transporting manure sources of P and N off dairies and impaired watersheds (Sharpley and Tunney, 2000). Initial field studies demonstrated removal and export of 46 to 77% of P in manure applications through a single sod harvest for three turf species (Vietor et al., 2002). If 50% of the 400 kg of P applied ha⁻¹ in manure is removed in sod, a hectare of the sod could remove and redistribute the manure P excreted by 10 milk cows during an entire year!

Manure export through composted products and sod can reduce nutrient loads on impaired watersheds, but P loading on sod production fields and on landscapes of importing watersheds could contribute to nonpoint-source pollution. Compared to row crops, the established turf of a production field is expected to minimize runoff losses of sediment and nutrients after application of composted manure (Gross et al., 1990). Yet, composted manure applications at rates providing 200 kg total P ha⁻¹ on a relatively steep slope (8.5%) of bermudagrass turf contributed 7.1 kg dissolved P ha⁻¹ to runoff over 8 rain events (Gaudreau, 2002). Nonpoint-source losses of P and N need to be quantified to proactively establish limits for composted dairy manure applications on sod production fields, roadsides, and other land beyond CAFO boundaries.

The previous report for composted manure top-dressed on an 8.5% slope of turf represents an upper extreme for runoff losses of P during sod production (Gaudreau et al., 2002). Composted manure rates > 40 Mg ha⁻¹ could be applied on slight slopes (≤ 2%) more typical of sod production fields without causing large P losses previously reported (Gaudreau et al., 2002, Vietor et al., 2002). In addition, large rates of composted manure could be necessary to improve soil physical properties and water conservation during sod production (Giusquiani et al., 1995). Turf and soil responses, exports through sod, and runoff and leaching losses on near-level slopes of sod production fields need to be quantified and compared between manure and fertilizer sources of P on a field scale. Level to slight slopes are expected to minimize runoff losses of P and N for even large rates of composted manure, but leaching from the sod layer to groundwater or subsurface drainage could contribute to losses (McDowell and Sharpley, 2001).

The upper limits and optima for composted manure rates determined through this large-scale field experiment will complement future watershed-scale evaluations of sustainable systems for export of manure P and N through sod. For example, field data will contribute to GIS analyses of suitable locations for sod production the BRW, a watershed on which dairies and composting
facilities are concentrated and water quality impaired. In addition, the GIS data provides an opportunity for modeling of impacts of the sod production system on watershed processes and water quality in this impaired watershed. Through collaborations with Dr. Munster's group, the GIS package and database will interface with the EPA's BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) package, which incorporates the SWAT simulation model.

Nature, Scope, and Objectives of the Research:

Runoff and leaching losses of P and N will be quantified on a pair of 1.3-ha production fields of ‘Tifway’ Bermudagrass on a 1% slope. The large fields will accomplish four research objectives: 1.) quantify and compare turf and soil responses between sod production fields grown with composted manure P or inorganic P fertilizer only, 2.) Relate soil and turf data to collaborator observations of P and N losses, 3.) Establish collaborative research and partnerships with the turf industry, and 4.) Provide field data for GIS database development and soil and landscape inputs for the SWAT model. One of the paired production fields will receive a top-dressing of 100 kg P ha$^{-1}$ as composted dairy manure and the other inorganic P fertilizer sufficient to raise soil-test P to 50 mg kg$^{-1}$ for each sod crop produced. Samples of the composted manure will be analyzed for total N and P concentrations to determine application rates (Nelson and Sommers, 1980, Isaac and Jones, 1970). The manure and inorganic P sources will be applied prior to regrowth of a sod crop during 2003. Inorganic N fertilizer will be applied to both fields to optimize sod growth rates. Collaborators have instrumented the fields with surface runoff collection systems, including 30-cm H-flumes equipped with bubbler flow meters and automated water samplers. Flow meters will quantify flow rates throughout runoff events to produce runoff hydrographs. The automated samplers will obtain water samples throughout the runoff event that will be analyzed for N and P concentrations.

Soil of each field will be sampled to a 5-cm depth before and after manure or fertilizer applications and after rain events that cause runoff to quantify P, N, and C concentrations near the surface. In addition, soil will be sampled to a 90-cm depth and divided into depth increments of 0-5 cm, 5-15 cm, 15-30 cm, 30-60 cm, and 60-90 cm prior to P applications and shortly before and after the sod harvest. The soil cores are collected from each field on a 2 x 6 grid according to U.S. EPA guidelines. In addition to P, N, and C, bulk density and gravimetric soil water content will be quantified for each depth increment. Holes from the soil cores will be backfilled with bentonite clay and sand (40% clay) to prevent preferential flow paths. In addition, a tension infiltrometer (Soil Measurement Systems, Tuscon, AZ) will be used to measure and compare water infiltration rates before and after composted manure application and between the two fields.

Plant and soil fractions of sod will be sampled and analyzed during each sod harvest for each field (Vietor et al., 2002). Dry weight and total N, P, and C concentrations of the two fractions will be measured to quantify nutrient removal in sod during each harvest (Bremner et al., 1972, Hons et al., 1990, Sheldrick, 1986, Tabatabai and Bremner, 1970). In addition to nutrient removal in sod, sod weight per unit area, stand density, turf quality and color will be evaluated at sod harvest.

Partial logistical support for the project is being provided by Turfgrass America. As one of the nation’s largest sod producers, they agreed to handle the planting and harvesting operations associated with the project. Obtaining equipment for planting and harvesting necessary for such a large project would be cost prohibitive without the Industry support. In addition, assistance provided by Turfgrass America establishes a close linkage with the Industry, which not only contributes to sharing of resources, but dissemination of research findings to those who will implement the system and practices being studied.
Results Expected from this Project:
This study will contribute to development of optima and limits for use of composted dairy manure in turf production systems. The optima and limits can be related to improvements in soil properties, turf quality, and water use and conservation. In addition, field-scale estimates of export of manure P and N through sod will be developed for commercial-scale sod production. Moreover, the collaboration with Turfgrass Industry partners will not only foster sharing of resources, but enhance the rate of adoption of the systems for manure export through sod. The collaborative monitoring of runoff and leaching on the paired fields presents a unique opportunity to relate production practices and soil and turf properties to water, sediment, P, and N losses for turf production systems using manure or fertilizer sources of P.

References
Objective Statement:
   To earn a Master of Science Degree in Agronomy from Texas A&M University

Education:
   Texas A&M University
   Bachelor of Science in Agricultural Development
      Minor: Agronomy-Turfgrass Management

Important Related Class Work:
   AGRO 301  Soil Science                        AGRO 429  Turfgrass Management
   AGRO 302  Recreational Turf                    AGRO 430  Turfgrass Maintenance
   AGRO 422  Soil Fertility and Fertilizers       AGRO 445  Soil Physics
   AGRO 428  Turfgrass Culture

Undergraduate GPR:  3.923  GRE Score (Quantitative + Verbal):  1100

Awards and Honors:  Professional Memberships:
   Summa Cum Laude graduate                     Texas Turfgrass Association
   Gamma Sigma Delta Agricultural Honor Society
   Phi Eta Sigma National Collegiate Honor Society

Work Experience:
   • Texas A&M Agricultural Engineering Research Laboratory ................ January 1999-present
      This job includes a wide variety of responsibilities such as metal fabrication, carpentry, mechanical repairs, remodeling, property maintenance, and equipment transportation.

   • Texas A&M Turfgrass Field Laboratory staff (internship) ..................... May 2001-August 2001
      I gained experience in turfgrass cultural practices, research methods, and the use of turfgrass machinery.

   • Pebble Creek Country Club Golf Course Maintenance staff (internship)  May 2001-August 2001
      I performed general golf course maintenance practices. I gained valuable experience in golf course operations and large scale turf maintenance.

      I served as a crew foreman. I gained experience in residential and commercial lawn maintenance, landscape installation, irrigation system repair, and team leadership.

Language Skills:
   Communicational abilities and experience with Spanish

Extracurricular Activities:
   Grace Bible Church:
      Men's Bible Study group member   Fellowship Team member   Fall Festival Organizer
CURRICULUM VITA

Donald Melvin Vietor
Professor
Soil and Crop Sciences
Texas A&M University
College Station, TX 77843-2474

RESEARCH INVOLVEMENT:


HONORS AND AWARDS:

Fellow, American Society of Agronomy, 1997
Fellow, Crop Sciences Society of Agronomy, 2001
American Society of Agronomy Resident Education award, 2001

SERVICE:

Board of Directors, American Society of Agronomy and Crop Science Society of America, 1999-2002
Associate Editor, Crop Science Journal, Crop Science Society of America, 1991-1997
Chair, Crop Physiology and Metabolism Division (Div. C-2), Crop Science Society of America, 1996

PUBLICATIONS & PROCEEDINGS:


