A NEW APPARATUS TO SIMULATE ATHLETIC FIELD TRAFFIC AND AN EVALUATION AND COMPARISON OF NATURALLY AND ARTIFICIALLY ENHANCED SAND TEXTURED ATHLETIC FIELD ROOT ZONES

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ABSTRACT

A NEW APPARATUS TO SIMULATE ATHLETIC FIELD TRAFFIC AND AN EVALUATION AND COMPARISON OF NATURALLY AND ARTIFICIALLY ENHANCED SAND TEXTURED ATHLETIC FIELD ROOT ZONES

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This work was comprised of two studies. The Cady Traffic Simulator (CTS) (a modified walk behind core cultivation unit) was developed to more aggressively simulate athletic field traffic and was utilized to evaluate fifteen athletic field systems. The objective of the first study was to compare the magnitude and direction of the forces produced by two traffic simulators; the Brinkman Traffic Simulator (BTS), the simulator currently most widely used in research, and the CTS. Both simulators were operated over an in-ground force plate which measured the forces in three directions; front to back, side to side, and vertical. The CTS produced higher compressive stress and higher net shear stress when operated in either the forward or reverse direction.

The objective of the second study was to compare artificially enhanced, sand root zones to well-graded sand and to sand-soil mixes under simulated traffic over a three-year period. Sand-soil mixes containing 9% and 15% silt+clay increased soil bearing capacity more consistently than artificial inclusions, but also showed the greatest decrease in infiltration rates over two traffic seasons. The sand-soil mix containing 15% silt+clay had the poorest wear tolerance, while

artificial inclusions had minimal effects on wear tolerance during both traffic seasons.

Dedicated to Wayne W. Henderson and Harvey E. Reeser, my grandfathers, in loving memory.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BTS - Brinkman Traffic Simulator

CTS - Cady Traffic Simulator

CBR - California Bearing Ratio

INTRODUCTION

Subjecting research areas to simulated traffic is imperative when the objective is to contribute to information on the effects of traffic stress on turfgrasses and/or playing surfaces. Turfgrass traffic stresses can be separated into two major components; turfgrass wear and soil surface disruption (Beard 1973). Turfgrass wear can include tissue tearing, tissue bruising and tissue removal (ie. divoting), primarily horizontal forces. Soil surface disruption can include soil compaction (ie. increased soil bulk density) and rutting (ie. soil displacement), primarily vertical forces. Once traffic stresses are imposed on a turfgrass area the factors mentioned above have the ability to combine to yield a deterioration of playing surface quality.

Traffic simulation began in turfgrass research by applying traffic using automobiles and trucks to simulate aircraft traffic on research plots designed to test seed mixture suitability for airfields (Morrish and Harrison 1948). Perry (1958) described the first machine designed specifically to create traffic stress on turfgrass. Many traffic simulators have since been developed and used to create traffic stress on turfgrass areas for research purposes (Shearman et al. 1974, Canaway 1976, Cockerham and Brinkman 1989, Bonos et al. 2001, Carrow et al. 2001, Shearman et al. 2001). Successful simulated traffic should encompass the following; 1) Traffic should be uniform and reproducible. 2) Traffic should be similar to natural wear. 3) The rate of wear must be accelerated greatly over the natural rate of wear in order to keep the relative number of simulated passes to a minimum (Youngner 1961).

Previously developed traffic simulators have proven to induce uniform and reproducible traffic, but the traffic they produce is not similar to the natural wear that takes place on an athletic field (ie rolling drum compaction vs impact compaction) (primarily two dimensional). The Brinkman Traffic Simulator (BTS) is a drawn type traffic simulator that is used widely in the U.S. as an athletic field traffic simulator (Cockerham and Brinkman 1989). This machine utilizes differentially connected studded drums to create traffic stress over large plot areas very quickly, but it must be pulled over the plots.

A new traffic simulator (a modified self-propelled core cultivation unit) has been developed with the goal of producing a realistic pattern of wear typically generated between the hashmarks of a football field (Cockerham 1989). The Cady Traffic Simulator (CTS) has a “foot” attached to each of the four core heads. The feet alternately strike the ground as the machine moves over the turf surface producing dynamic forces in three directions. The CTS has shown to create approximately five times the wear that the BTS produces (Vanini et al. 2003).

Aggressive traffic simulation was necessary to evaluate and compare fifteen athletic field systems currently available on the market. Presently, many athletic fields are constructed with high sand content root zones. Sand root zones maintain macropores once compacted and drain rapidly. Sand has many advantages, but can become unstable under normal playing conditions. The vigorous wear produced on an athletic field often deforms the playing surface making it unsafe.

The stability concern of sand has sparked the development of several products to aid in sand and surface stabilization. These products are in the form of soil amendments, soil inclusions, and reinforced sod materials. Unfortunately, some products have been marketed very aggressively to team owners, universities and high schools without quality research to support their claims. Many newly constructed fields are not performing as promised. After installation, some of these systems have been removed due to rapid deterioration of playing surface quality.

In response to these concerns, a three-year study was initiated at Michigan State University to evaluate and compare fifteen athletic field systems under simulated athletic field traffic. The experiment had a single factor (amendments/Inclusions) with fifteen treatments. Traffic was applied as a strip treatment at two levels: daily, (5 traffic events per week) to simulate a practice field situation and weekly, (1 traffic event per week) to simulate a stadium situation. Treatments were evaluated in two major categories; root zone properties and playing surface characteristics. The root zone properties included: particle-size analysis, bearing capacity, infiltration, saturated hydraulic conductivity, and root mass by depth. Playing surface characteristics included: turfgrass cover, surface hardness, traction, and resistance to divoting. These data will enable team owners, universities, and high schools to make informed decisions when faced with the task of choosing the best field for their situation.

The objectives of this research were 1) to describe the Cady Traffic Simulator, 2) to compare the magnitude and directions of the forces produced by the Brinkman traffic simulator and the Cady traffic simulator, and 3) to use the Cady Traffic Simulator to study the effects of amendments, randomly oriented inclusions, specifically oriented inclusions, and reinforced sods on the playing surface characteristics of Kentucky bluegrass athletic fields.