Turfgrass Wear Tolerance Investigations

by DR. ROBERT C. SHEARMAN and DR. JAMES S. BEARD[1]

Turfgrass wear injury results when the crushing, tearing action of foot or vehicular traffic destroys the turfgrass leaf, stem, and crown tissues. The extent of this injury depends upon the (a) turfgrass species, (b) intensity of culture practiced, (c) environment, and (d) intensity and type of traffic. The most direct means of minimizing turfgrass wear injury is through manipulation of cultural practices such as cutting height, nitrogen and potassium fertilization, irrigation, and traffic control. These are short-term approaches that only partially alleviate the problem.

An equally important and more long-term approach involves breeding cultivars that have improved wear tolerance characteristics. In this regard, there is essentially no basic understanding of the plant characteristics that contribute to our turfgrass wear tolerance differentials.

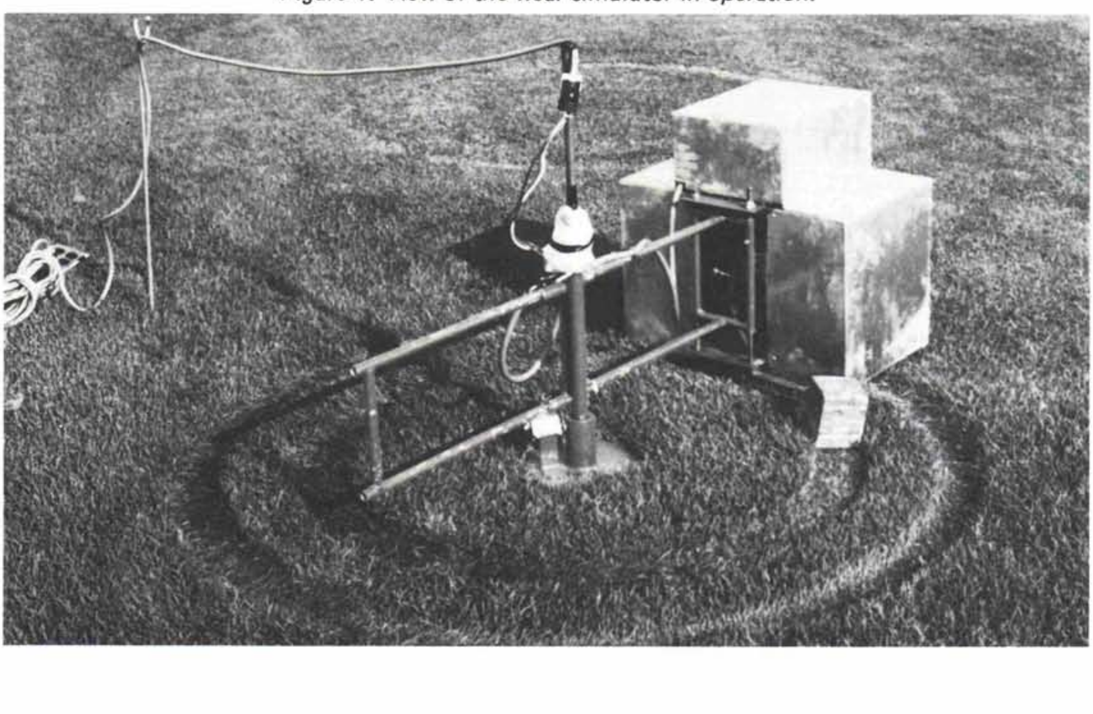
[1] Former Extension Associate, now Turfgrass Specialist, Dept. of Horticulture, University of Nebraska, Lincoln, Nebraska; and Professor, Dept. of Crop and Soil Sciences, Michigan State University, East Lansing, Michigan

If this information were available, it could be used in turfgrass breeding programs to develop cultivars with improved wear tolerance characteristics. A program of this nature would in turn result in turfgrasses better adapted for use on intensively trafficked areas, such as greens, tees, and fairways.

The objectives of this investigation were: (1) to evaluate the anatomical, morphological, and physiological characteristics of turfgrasses that contribute to wear tolerance; and (2) to develop criteria that could be used as selection tools in a turfgrass breeding program designed to select wear tolerant cultivars. In doing this, a portable wear simulator was developed and the wear tolerance of seven cool-season turfgrasses was determined.

Turfgrass Wear Simulator. Past investigations of traffic assessed the combined effects of turfgrass wear injury and soil compaction. In this investigation, a simulator was designed and constructed to evaluate turfgrass wear injury independent of soil compaction (Figure 1). The wear simulator was an electrically-powered, portable unit that could be used in a wide range of field conditions. It simulated both foot

Figure 1. View of the wear simulator in operation.



and vehicular wear. The unit proved to be a rapid, flexible, and reliable method of evaluating turfgrass wear tolerance differentials between turfgrass species and among management practices.

Comparative Wear Tolerance Evaluations of Seven Cool Season Turfgrasses. The seven cool-season turfgrass species evaluated were Cascade chewings fescue (*Festuca follax var. Cascade*), Italian ryegrass (*Lolium multiflorum*), Kentucky 31 tall fescue (*Festuca arundinacea var. Kentucky 31*), Manhattan perennial ryegrass (*Lolium perenne var. Manhattan*), Merion Kentucky bluegrass (*Poa pratensis var. Merion*), Pennlawn red fescue (*Festuca rubra var. Pennlawn*), and rough bluegrass (*Poa trivialis*). All seven species were established from seed one year prior to superimposing the wear treatments. All were maintained at a cutting height of 1.5 inches, and were mowed twice weekly with the clippings returned. Irrigation was applied as needed to prevent visual wilt symptoms.

Three quantitative measurements of wear injury were compared to a visual rating system. The three quantitative methods proved to be quite satisfactory for separating wear differentials, even on very closely related species. All three methods were preferred to the visual rating system. The assessment of the per cent verdure (turf remaining under a specific mowing height) remaining after wear treatment relative to that quantity present before treatment proved to be the simplest and most reliable method tested.

The comparative ranking of the seven cool-season turfgrasses in terms of vehicular and foot simulated wear are summarized in Table 1. The superior ranking of Manhattan perennial ryegrass compared to previous reports of the classical unimproved ryegrasses is particularly striking. Also of interest was Merion Kentucky bluegrass. It ranked comparably with Kentucky 31 tall fescue. These data suggest that a mixture of improved perennial ryegrass and Kentucky bluegrass might be effective in minimizing wear injury of intensively trafficked areas around the golf course. More work needs to be done to evaluate wear tolerance differentials between cultivars of improved perennial reygrass and Kentucky bluegrass, as well as among mixtures of these species.

Anatomical, Morphological, and Physiological Factors Contributing to Wear Tolerance. The comparative wear tolerance data was correlated with 15 turfgrass characteristics that were subsequently evaluated to assess their association with wear tolerance. The specific characteristics evaluated included: (a) cellulose, hemicellulose, lignocellulose, lignin, and total cell wall content; (b) verdure, shoot density, leaf width, load bearing capacity, and leaf tensile strength; and (c) the per cent moisture content, relative turgidity, and sclerenchyma tissue distribution in leaf sheaths and blades.

The results of this investigation indicated that the cell wall constituents (i.e. cellulose, hemicellulose, lignocellulose, and lignin) expressed on a weight per unit area basis could be effectively used to express wear tolerance characteristics of turfgrass species. Total cell wall content alone, expressed on a weight per unit area basis accounted for 78 per cent of the observed variation in wear tolerance. While, the combined effects of all the cell wall constituents accounted for over 90 per cent of the observed variation.

Of the 15 turfgrass characteristics studied, five primary characteristics were best suited for selection purposes: (1) total cell wall content

Table 1. Relative ranking of seven cool season turfgrasses according to wear tolerance and such predictive characters as total cell wall content, load bearing capacity, leaf tensile strength, and leaf width.

Relative ranking with 1 best and 6 poorest

Turfgrass Species	Wear tolerance		Total cell wall content	Load bearing capacity	Leaf tensile strength	Leaf width
	Vehicular type	Foot type				
Manhattan perennial ryegrass	1	2	2	2	2	2
Merion Kentucky bluegrass	2	1	2	4	2	2
Kentucky 31 tall fescue	2	3	1	1	1	1
Italian ryegrass	3	4	3	3	1	1
Pennlawn red fescue	4	4	3	5	4	3
Cascade chewings fescue	5	4	4	5	5	3
Rough bluegrass	6	6	5	5	3	2

Firgure 2. View of two plots after wear treatment. (Right) Pennlawn red fescue, (Left) Manhattan perennial ryegrass.

expressed on a weight per unit area basis, (2) leaf width, (3) leaf tensile strength, (4) lignin content and distribution, and (5) per cent sclerenchyma fibers and their distribution in the leaf sheath and blade. Of these characteristics, total cell wall content was the best individual indicator of turfgrass wear tolerance. The determination of total cell wall content is a simple and direct method that could be effectively incorporated into a breeding program designed to select wear tolerant cultivars.

Investigations in Progress. Continuing research on turfgrass wear tolerance aspects is being supported by the United States Golf Association Green Section. Among these studies are (a) the assessment of wear tolerance differentials of 24 Kentucky bluegrass and eight creeping bentgrass cultivars that are available for use on golf courses; (b) the effects of cultural practices such as mowing height, nitrogen and potassium fertilization, and irrigation on wear tolerance; and (c) anatomical, morphological, and physiological turfgrass characteristics associated with intraspecies wear tolerance differentials. Results of these investigations will be reported in the GREEN SECTION RECORD when available.

ABOUT THE AUTHOR

Dr. Robert C. Shearman was appointed turfgrass specialist and assistant professor of horticulture January 1, 1975.

Prior to coming to the University of Nebraska-Lincoln, he was a research agronomist for O.M. Scott & Sons Co. in Oregon. Shearman received his Ph.D. (1973) and M.S. (1971) degrees in turfgrass physiology and management from Michigan State University. He did undergraduate work at Oregon State University, where he received a bachelors degree in agronomy in 1967.

Shearman wrote a classic thesis on wear mechanisms in turf while at Michigan State. He is a member of Sigma Xi, American Society of Agronomy, Crop Science Society and associate member of the Nebraska Golf Course Superintendents Association.