ENHANCING PARTICIPANT SAFETY ON NATURAL TURFGRASS SURFACES - PART I

by

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Injuries on football fields and other sports surfaces can be grouped into different categories as related to the type of athlete movement and to the relative softness of the turf-soil surface. Many impact-type injuries are related to varying degrees of surface hardness, with the safety of the participant increasing inversely with a lessening of surface hardness. There are other surface playability characteristics of concern, such as traction, wear tolerance, divot opening/turf recovery, and smoothness. This paper will address primarily the aspects of hardness of surfaces.

Surface Hardness Assessment

The hardness and resultant safety of a surface can be measured using a light-weight, portable, peak deaccelerometer apparatus, the Clegg Impact Soil Tester. Several models of this device, with differing hammer weights of 0.5, 2.25, and 4.5 kg (1, 5, and 10 lb), are used in turf research. Each provides a relative scale of impact resistance of the surface measured in gravities (g), with a decreasing number indicating a lessening of hardness.

Comparisons of surface hardness for nine surfaces, ranging from concrete to turfed soil, as assessed by the Clegg device with a hammer weight of 2.25 kg (5 lb), are shown in Table 1. Results indicate a decrease in surface hardness as the composition of the material becomes less dense. Major differences in hardness occur among (a) solids, materials such as cement, composition, or wood floor surfaces, (b) other types of artificial playing surfaces, and (c) the natural turf-soil surfaces.

Turfgrasses offer the least hard surface in comparison to other alternatives available for sports activities. This is due to the biomass of the turf and the associated root zone that provide a uniquely resilient characteristic and cushion. Differences occur within the natural turf-soil surfaces with changes in (a) soil texture, (b) moisture content, and (c) whether the surface is bare soil or turfed.

Table 1. Comparisons of hardness for representative surfaces in the College Station, Texas area, expressed as means of multiple observations of Clegg Impact Values (CIV).

Representative Surface Types	Clegg Impact Value (g)
cement floor	1426
asphalt road	1442
tennis court - outdoor composition	1422
composition running track	1432
basketball court - permanent wood	640
football stadium - outdoor, 4-year-old artificial surface	175
football stadium - indoor, 1-year-old artificial surface	141
baseball - bare clay infield	504
baseball - natural turfed field of bermudagrass	100

Sports participant safety on natural turfgrass is maximized through providing a dense biomass of above-ground turfgrass leaves, shoots, and stems grown on a stable, low-density root zone. It, therefore, is important to select the (a) correct turfgrass species/cultivar, (b) root zone, and (c) cultural practices that have the capability of sustaining the highest possible biomass over the entire use period. Results of several of our cultural studies as described in the following paragraphs illustrate these effects.

Other considerations should include the turfgrass species/cultivar adaptation, turfgrass wear tolerance, pest resistance, environmental stress tolerance, and the ability to recover rapidly from turf injury during the time of year when intense use occurs.

Cutting Height Effects

Surface hardness of turfed sport venues can be modified by changing the height of cut. This was shown in our study with Tifway hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) grown on a modified high-sand root zone at seven heights of cut from 12 to 250 mm (0.5 to 10 inches). Total shoot biomass density was determined by counting the shoots per decimeter, harvesting, and obtaining dry weight of shoots per square decimeter.

As the height of cut increased the number of shoots per square decimeter decreased at each of the seven heights, and the shoot biomass per dm^2 decreased at each height up to 100 mm (4 inches) then increased at 250 mm (10 inches). This was accompanied by a decrease in surface hardness from 12 to 25 mm (0.5-1.0 inch), then a stable reading to 50 mm (2 inches) and another plateau to 100 mm (4 inches), followed by a further decrease to 250 mm (10 inches) (Table 2).

Table 2. Effects of seven heights of cut on the surface hardness, expressed as five-year means of the Clegg Impact Values (CIV), of Tifway bermudagrass turfs grown on a modified high-sand root zone. 1989-1994.

Height of Cut in mm (inch) Treatment	Shoot Density per dm^2	Clegg Impact Value - g (2.25 kg Hammer)
12 (0.5)	501	62 a*
25 (1.0)	304	58 bc
37 (1.5)	297	57 c
50 (2.0)	241	54 cd
75 (3.0)	207	51 d
100 (4.0)	131	51 d
250 (10.0)	40	47 e

*Means followed by the same letter within the same column are not significantly different at the 5% level, LSD t-Test.

All results were within the acceptable range specified in the standard for surface playability of football (soccer) fields (10-100g) proposed by the Sports Turf Research Institute, Bingley, U.K. and the acceptable running range in the proposed standard for turfed horse racing surfaces (30-110 g) by the authors (Beard and Sifers, 1990).

Soccer Field Turf-Soil Status	CIV Value (g)
Too hard	> 100
Acceptable	10 to 100
Preferred	20 - 80
Too soft	< 10

Although seven heights of cut were assessed in our study, the most appropriate turfgrass cutting height for football and other field sports from the playability and turfgrass health viewpoints ranges from 12 to 50 mm (0.5 to 2.0 inches), depending on the turfgrass species. Turfed horse racing surfaces generally have cutting heights of 50 to 100 mm (2 to 4 inches), depending on the turfgrass species.

Nitrogen Fertility Effects

Smaller changes in surface hardness can be made by increasing the nitrogen fertility rate within the same height of cut (Table 3). The increased nitrogen fertility resulted in increased shoot biomass at each of the three heights. However, in this study on Tifway hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*), the height of cut effects on surface hardness was more dominate than the effects from an increased nitrogen nutritional level.

Proper turfgrass P and K fertilization, irrigation, and cultivation practices also aid in maximizing the biomass cushion, thus lessening surface hardness.

Table 3. Effects of three heights of cut and three nitrogen (N) fertilization levels on the surface hardness, expressed as five-year means of the Clegg Impact Values, of turfs grown on a modified high-sand root zone. 1989-1994.

Height of Cut in mm (inch) Treatment	Nitrogen Rate Per Growing Month as N kg/100 m^2 (lb/1,000 ft^2)	Clegg Impact Value (g) (2.25 kg Hammer)
12 (0.5)	0.25 (0.5)	62 a*
12 (0.5)	0.50 (1.0)	58 ab
12 (0.5)	0.75 (1.5)	53 b
25 (1.0)	0.25 (0.5)	58 ab
25 (1.0)	0.50 (1.0)	53 b
25 (1.0)	0.75 (1.5)	60 ab
37 (1.5)	0.25 (0.5)	60 ab
37 (1.5)	0.50 (1.0)	59 ab
37 (1.5)	0.75 (1.5)	55 b

*Means followed by the same letter within the same column are not significantly different at the 5% level, LSD t-Test.

Turfgrass Cultivar Effects

The effects of six *Zoysia* cultivars and two heights of cut, assessed with the 0.5 kg Clegg hammer and the fourth drop, indicate that surface hardness can be modified by cultivar selection and by height of cut. The softness benefits exceeded 50% among the six cultivars (Table 4). The increasing softness among cultivars was associated with an increase in shoot density and a higher leaf-to-stem ratio. The effects of an increased cutting height on enhanced softness of the surface were substantial as reported earlier.

ROOF GREENING

Roof greening involves the development of a root zone and the establishment of turf and/or landscape plantings on the flat roofs of buildings. This is an issue that is gaining favor in Germany. Cities have actually enacted roof greening regulations for specific buildings and in some cases provide financial support for this effort. Some German states provide recommendations relative to roof greening, with the objective of improving the ecological and aesthetic environment of urban areas.

Table 4. Effects of six mature *Zoysia* cultivar turfs and two heights of cut on the surface hardness expressed as the Clegg Impact Values (CIV), when grown on a modified high-sand root zone.

Zoysiagrass Cultivar Treatment	Height of Cut - mm (inch)		Percent Change from 12 to 25 mm Cutting Heights
	12 mm (0.5 in.)	25 mm (1.0 inch)	
Belair	69 a*	41 a	-41
El Toro	54 b	39 a	-28
Korean Common	55 b	35 a	-36
Meyer	48 bc	33 a	-31
FC 13251	44 c	31 ab	-30
Emerald	32 d	22 b	-31

*Means followed by the same letter within the same column are not significantly different at the 5% level, LSD t-Test.

References:

- Beard, J.B and S.I. Sifers. 1990. Feasibility assessment of randomly oriented interlocking mesh element matrices for turfed root zones. American Society of Testing Materials, Standard Technical Publication 1073. pp 154-165.
- Beard, J.B and S.I. Sifers. 1993. Stabilization and enhancement of sand-modified root zones for high traffic sports turfs with mesh elements. Texas Agricultural Experiment Station, Texas A&M University System. B-1710, 40 pages.
- Beard, J.B and S.I. Sifers. 1989. A randomly oriented, interlocking mesh element matrices system for sport turf root zone construction. Proc. Int. Turfgrass Res. Conf. 6:253-257.

UPCOMING JB VISITATIONS:

Provided for Institute Affiliates who might wish to request a visitation when I'm nearby:

- March 1 to 5 - Montreal Canada.
- March 11 to 14 - Columbus, Ohio.
- April 14 to 17 - Washington, D.C.
- April 21 to 22 - Phoenix, Arizona.
- May 21 to June 6 - UK, Netherlands, Belgium, & Germany.
- May 7 to 14 - Italy.