PUTTING GREEN ROLLING CONCEPTS

by

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The golfer commonly refers to putting green surfaces in terms of being fast or slow , which refers to the speed or velocity of ball roll. By definition these terms would refer to the distance traveled per unit of time. In actuality, research techniques and practitioner assessments, such as the stimpmeter, measure the distance of ball roll. Thus terminology used in this paper will be the more correct **ball roll distance (BRD)**.

BALL ROLL RESISTANCE

The BRD as a result of a given impact force is affected by the sum total of the resistances (R_t) caused by the grass shoot/leaf characteristics (r_g), surface irregularities (r_s), and atmospheric (r_a) dimensions. The greater the total resistance, the shorter the BRD. The total ball roll resistance can be expressed by the following equation:

$$R_t = r_g + r_s + r_a$$

To fully understand and manage the putting green surface quality in terms of the desired ball roll distance, one must recognize the components contributing to the three resistances to ball roll, which are summarized in Table 1.

Atmospheric resistances (r_a) encompass the wind velocity and direction, and to a much lesser extent the density of the atmosphere as related to altitude. Individuals fail to recognize the major impact of wind velocity and direction on ball roll. Wind influence is much greater than the individual turfgrass cultural practices. Research involving ball roll distance assessments conducted without a wind barrier surrounding the measurement area are highly questionable.

There are interactions among the various components of **turfgrass shoot-leaf resistances** (r_g) which can either have positive or negative effects. A higher shoot density is being promoted as giving a greater ball roll distance. However, this is not necessarily the case. For example, the leaf density of a fine-leaf fescue putting green is quite high and the leaf is very narrow. However, the ball roll distance will be much shorter than for a creeping bentgrass green with a lower shoot density and wider leaf. The reason is the distinct leaf stiffness of the fine-leaf fescue caused by extensive sclerified tissue in comparison to a creeping bentgrass leaf. Leaf growth extension rate can strongly influence the resistance to ball roll, which in turn is controlled primarily by the cultural practices and microenvironment that cause either an increase or slowing of leaf growth.

Table 1. Components of the three resistances to ball roll.

Turfgrass Characteristics (r_g)	Surface Irregularities (r_s)	Atmospheric (r_a)
Leaf Stiffness: sclerified tissues lignin content potassium level species/cultivar Leaf Extension Rate: cutting height nitrogen level temperature water content species/cultivar Leaf Orientation: mowing pattern species/cultivar Leaf Density: cutting height nitrogen level species/cultivar Leaf/Stem Ratio: cutting height nitrogen level species/cultivar	Turfs Altered By: coring slicing spiking vertical cutting footprinting ball marks spike marks Impediments: dew exudate water topdressing weeds seed heads Contours	Wind: velocity direction Air Density: water vapor content atmospheric pressure (altitude)

The **surface resistances** (r_s) influencing ball roll distance are a much discussed concern that can be controlled to a great extent by cultural practices. When considering the range of components affecting the resistances to ball roll, there are two cultural practices that have the greatest overall effect in modifying the surface resistance. These components are (a) the mowing practices, including cutting height, mowing frequency, mowing pattern, and allied grooming operations and (b) turf rolling which effects not only the ball roll distance, but the smoothness of the surface. The remainder of this paper will address turf rolling practices that influence the surface resistances to BRD.

RENEWED INTEREST IN TURF ROLLING

The option of turf rolling reentered the cultural program with the frequent use of high-sand root zones in the construction of modern putting greens, and is being driven by the golfer's desire for fast putting greens. Use of high-sand root zones of the proper particle size distribution, such as the USGA perched hydration method, results in minimal susceptibility to soil compaction. Such root zones can be rolled without imparting serious compaction effects; thereby offering the potential for improved smoothness and uniformity of ball roll. It is particularly attractive in that ball roll distance can be enhanced via turf rolling, which reduces the need to use excessively close mowing heights that result in turf thinning and the subsequent development of moss and algae problems.

Two alternatives to turf rolling in terms of achieving an increased ball roll distance on putting greens are extraordinarily close mowing and frequent topdressing. However, the very close mowing required eventually introduces problems in terms of a weakened turf, with resultant thinning that provides openings for sunlight to reach the soil surface, thereby facilitating the invasion of moss and algae. Topdressing is more expensive and disruptive of play, although it is an essential cultural practice that offers other beneficial responses, such as enhanced biodegradation of potential thatch accumulations and filling of certain types of depressional areas that can not be accomplished via rolling.

This author first observed a newly developed mobile, mechanically-powered turf roller for putting greens over ten years ago in Melbourne, Australia. This led to authorship of a turf rolling article in the January 1986 issue of Grounds Maintenance. Six years later, the interest in turf rolling of high-sand root zone putting greens started to increase. Turf equipment manufacturers accelerated the development of powered mechanical models of turf rollers specifically designed for putting greens.

TURF ROLLING INVESTIGATIONS

Reports from five turf rolling studies have been published. Each addresses specific dimensions of turf rolling on either a short-term or long-term basis. The BRD was assessed in all five studies by the stimpmeter method.

- ISTI - International Sports Turf Institute (1)
- OSU - Ohio State University (2)
- PSU - Pennsylvania State University (3)
- NCS - North Carolina State University (4)
- MSU - Michigan State University (5)

The findings from these five investigation sites are summarized as follows:

Basic Rolling Effect. Based on the studies conducted to date, the first morning response from turf rolling may typically be a ball roll distance increase in the order of 10%.

Rolling Effect Duration. These studies suggest that at least a 2-day effect on BRD can be achieved from a single turf rolling in many situations.

Turf Roller Weight. ISTI studies revealed no increase in ball roll distance when the single roller pressure as one event was increased from 4.8 to 11.9 pounds per lateral inch. Note that while roller weight may not significantly affect BRD, it may be an important factor affecting the smoothing benefits of turf rolling, with higher weights being more beneficial.

Diurnal Rolling Response. Following a single early morning rolling, the ball roll distance typically declined throughout the initial day after rolling. This was probably caused by increased ball roll resistance due to vertical leaf extension . There was a major reversal to a higher BRD after mowing on the 2nd day, even though there was no subsequent second-day turf rolling. A similar diurnal response of lower magnitude was observed in some cases on the 3rd day.

Single Versus Multiple Roller Effects. In two ISTI studies, a single event rolling in early morning involving 1, 2, 3, and 4 single roller passes were evaluated. The most significant response was achieved from 4 consecutive single rollings in one early morning event, with the BRD increased an impressive 20% and persisting more than 76 hours.

Rolling Interval Effects. The difference in ball roll distance between the rolled and unrolled turf plots increased throughout the 2- and 19-week duration of two studies. Also, there was an increase in BRD as the frequency of turf rolling was increased from 1 to 4 to 7 times per week.

Roller Operational Effects. ISTI studies assessed single roller operating speeds of 2.5, 4.0, 4.4, and 4.8 feet per second. There was no observed effect on the BRD. Similarly, there was no effect on ball roll distance when turf rolling following early morning mowing was in the same versus the opposite direction as the mowing operation. MSU studies of rolling before early morning mowing had a minimal effect on BRD, when compared to rolling immediately after mowing or rolling at midday to increase the afternoon BRD.

Turf Responses. The OSU study of 2-weeks duration revealed that turf rolling had negative effects on the visual turf quality, including a negative color response and some wear stress.

A 10-week turf rolling duration on a clayey soil in the NCS study resulted in a reduction in turf quality, but no effect on the root mass. Turf rolling at a once-per-week frequency in the NCS study resulted in no adverse affects on turfgrass quality, thatch accumulation, or root biomass.

Disease and Moss Responses. MSU studies showed a turf rolling schedule of 3 times per week significantly reduced the severity of dollar spot disease. In contrast, Microdochium patch (pink snow mold) was significantly increased as a result of rolling 3 times per week. There also was a substantial reduction in the extent of moss invasion on the rolled treatments compared to the adjacent untreated checks. The rolling effects also resulted in a decrease in localized dry spots.

Root Zone Effects. Both the soil bulk density in the surface 1-inch (25 mm) of root zone and the saturated infiltration rate were not affected by turf rolling on a USGA specification high-sand root zone. Rolling on the clayey root zone resulted in increased bulk density.

A high bulk density is associated with a more compacted soil, poorer aeration, and slower infiltration rate. Turf rolling had no significant effect on bulk density of two high-sand root zones of the proper particle size distribution. The increase in bulk density of the fine textured soil is expected and a concern in turf rolling on such soils. There also is the question of how much turf cultivation will be needed to correct the compaction effects of turf rolling on these soils.

Enhanced Surface Smoothness. All these studies resulted in visual improvements in surface smoothness that includes both reduced lateral deflection and reduced vertical bumpiness in ball roll action. Due to difficulties in quantitatively assessing these effects, no specific quantitative data are available at this time.

Note: The findings just summarized relate only to creeping bentgrass putting greens. To date there have been no turf rolling investigations conducted on hybrid bermudagrass putting greens.

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