The impact of putting green management on visible wear caused by golf cleat/sole designs
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The objectives of the research are to: 1) identify particular components of golf cleat sole designs that result in the least to greatest perceived differences in regard to green friendliness 2) identify putting green management practices that negate the visible damage caused by the most intrusive and/or destructive of the current golf cleat/sole designs and 3) search for correlations between Tru-Firm and TDR measurements when collecting data regarding turfgrass management practices including sand-topdressing, irrigation, vertical mowing, rolling and long-term thatch thickness.

To address Objective 1 golf cleat/sole traffic studies were performed at 11 locations in three states (Michigan, Arkansas, Florida) with over 20 cleat/sole designs and a non-trafficked check plot. The studies were conducted on various cultivars and ages of creeping bentgrass, annual bluegrass, ultradwarf bermudagrass, and seashore paspalum putting greens. At each location plots were trafficked with different cleat/sole designs and golfers rated the putting surface on a scale of 1-5 for putting green smoothness. Specifically, the rating scale was:

1 = Excellent; no visible traffic
2 = Very good; I think I see foot traffic
3 = Good; some visible foot traffic but I would not mind putting on the surface
4 = Fair; visible foot traffic that would most likely deflect my putt and
5 = Poor; terrible putting conditions recommend banning the cleat/sole from our golf course.

Researchers will avoid reporting manufacture golf shoe brand names because the objective of the study is to identify “components of golf cleat sole designs that result in the least to greatest perceived differences in regard to green friendliness”, not which current design is most damaging. One necessary exception to that rule comes from a study conducted at Field Day at The Hancock Turfgrass Research Center in 2016. The Field Day data are different because the research team made an evaluation comparing among the most aggressive golf cleat/sole designs from the 1990’s to the more recent Adizero golf cleat/sole that has been perceived as being among the most destructive on putting greens the past several years. A result of that study was raters perceived the poorest performing cleat/sole design of our current time period as being more green friendly than among the most aggressive products from the past (Fig. 1).

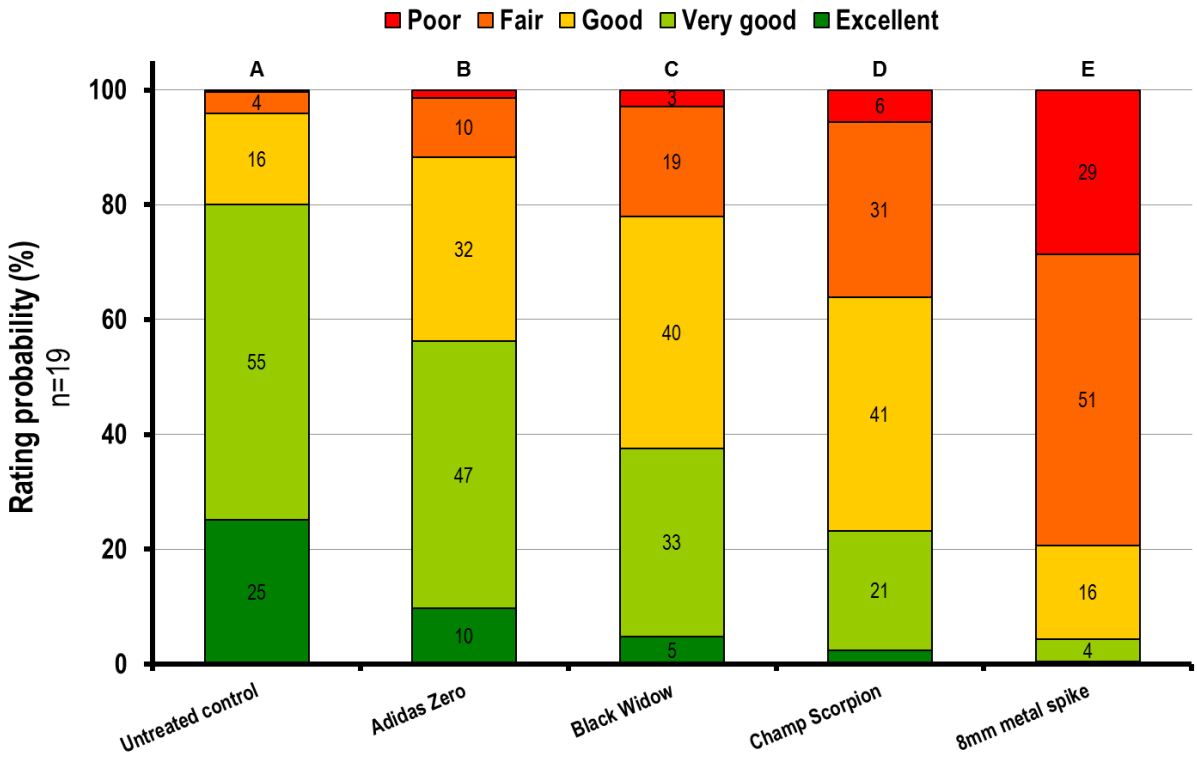

Figure 1. Predicted probabilities of spike treatments to be rated as either "Excellent", "Very Good", "Good", "Fair", or "Poor". Probabilities were estimated using logistic regression analysis of data collected from 3 replicate plots evaluated at the Hancock Turfgrass Research Center, East Lansing, MI on a 1-year old Pure Distinction creeping bentgrass putting green on August 17, 2016. Data is generated from 285 observations and bars that do not share a letter are significantly different ($\alpha = 0.05$).

With respect to observations regarding components of golf cleat/sole design and green friendliness made at the other 10 sites in 2016, results include:

1. Metal spikes (both 8 and 6 mm) were perceived to be the most destructive at 10 of 11 sites. The single anomaly was that the 6mm metal spike was the second poorest treatment.
2. Spikeless/rubber outsole golf shoes result in the least amount of apparent foot traffic on all putting surfaces (bentgrass, annual bluegrass, bermudagrass, and paspalum).
3. In general cleated/rubber outsole shoes result in the most perceived foot traffic, however, the range is wide and to date researchers have not quantified variables that result in some designs having more visible wear than others.
4. The spikeless/TPU (thermoplastic polyurethane) outsole is often perceived as creating more damage than most of the cleated/rubber outsole golf shoes. Again, to date researchers have not quantified why but have collected or are collecting manufacturer data regarding type of plastic, number of cleats and protrusions, etc. regarding each golf cleat/ sole design.

To address Objectives 2 and 3 Pure Distinction creeping bentgrass and an annual bluegrass putting greens at Michigan State University (MSU) and Pure Distinction creeping bentgrass and Tifeagle ultradwarf bermudagrass putting greens at the University of Arkansas were treated with different levels of grooming (none vs. 3x weekly), lightweight rolling (none vs. 3x weekly), sand-topdressing (none vs. every other

week), and fertility (low vs. high N). Treatments were evaluated for foot traffic tolerance on three occasions during the season. Other data collection included green speed measurements, total biomass to the surface to a one inch depth, surface firmness as measured with the Tru-Firm, and volumetric water content from the surface to a 1.5 inch depth.

Results from Objective 2 indicate:

1. Creeping bentgrass had more visible damage following 20 simulated rounds of golf at both sites compared to annual bluegrass (MSU) and ultradwarf bermudagrass (UA).
2. At UA and MSU, fertility had the biggest impact of visible damage on creeping bentgrass (Fig. 2) and at UA the impact was similar on the ultradwarf bermudagrass areas. Higher nitrogen rates resulted in greater visible damage from foot traffic, which was more pronounced on the creeping bentgrass relative to the ultradwarf bermudagrass but was not significant on the annual bluegrass.

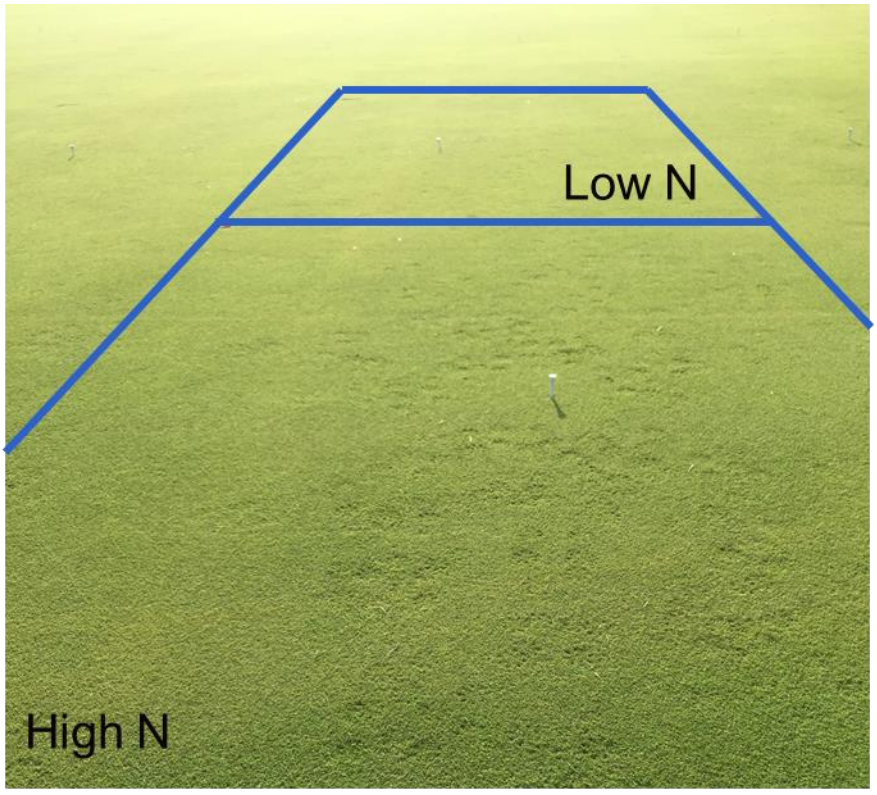

Figure 2. Fertility effects on visible damage on a 'Pure Distinction' creeping bentgrass putting green following 20 simulated rounds of golf (photo taken July 28, 2016; Fayetteville, AR). The "High N" plot (foreground) received 0.5 lb. N / M monthly whereas the "Low N" plot (background) received half that amount.

To date, data have not yet been fully analyzed for Objective 3. These studies will be repeated in 2017 at MSU and UA.