Comparisons of the "Bugle" golf tee to a standard wooden golf tee – impact the tee has on launch angle, spin rate and carry distance.

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Abstract

In golf, a player is first graded on the distance they drive the ball off the tee. It is the first shot each competitor will see other. This paper will evaluate the impact the golf tee has on the flight characteristics of a golf ball: launch angle, ball spin and carry distance; all critical aspects in the total distance a golf ball with travel off the tee. A "Bugle " tee will be evaluated against a wooden tee to determine if there is a difference in launch angle, ball spin and carry distance as related to the type of tee used.

Also varied as part of the evaluation was the golfer. Three golfers of different ages and abilities will be varied.

Introduction

The initial shot for every golf hole has the advantage of the use of a golf tee to elevate the ball off the teeing ground. In general, this allowed for more distance in golf ball carry do to less friction the club saw relative to other shots where the golf ball was in direct contact with the ground.

The "Bugle" tee by design allowed for greater ball speed by: reduced friction between the tee to the golf ball due to its low contact area. The "Bugle" tee also offered a material that was less resistive to bending as compared to a wooden tee.

Each golfer, no matter how close they are in physical characteristics and abilities; hits the golf ball in the exact way. These variations golfer-to-golfer due to swing differences impacts the dynamics of ball contact and effect's the outcome of each and every shot. Varying the golfer was also added to the mix to add the varying dynamics player-to-player has on golf ball flight.

A 2x2 full factorial with 25 replications where the input factors were: 1) the "Bugle" tee compared to the wooden tee 2) Golf Academy of America Students – 3 players of varying age, stature and handicap was designed.

Player	Age	Handicap
1	56	4.0
2	34	20
3	30	7

Table 1 – Player description

Each player hit in random order 52 golf shots of their own using their own driver; varying the golf tee used. A total of 156 drives were taken by the 3 players.

The "Trackman" golf launch monitor was used to measure the launch angle, spin rate and carry distance for each shot taken.

The 3 players hit the 156 drives within a period of 2 hours. Fatigue was considered to be a possible factor due to the short duration the 156 shorts was taken; however experimental blocking for time showed fatigue was not found to be a factor – see

tables 2-4. P-values A:Block, in this case time was well above 0.05 so was not significant.

Analysis of Variance for Launch Angle - Type III Sums of Squares

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
MAIN EFFECTS					
A:BLOCK	238.304	25	9.53216	1.18	0.3039
B:Tee	5.65442	1	5.65442	0.70	0.4071
C:Player	147.165	2	73.5826	9.10	0.0004
INTERACTIONS					
AB	169.244	25	6.76976	0.84	0.6796
AC	433.628	50	8.67256	1.07	0.4033
BC	5.53846	2	2.76923	0.34	0.7118
RESIDUAL	404.468	50	8.08936		
TOTAL (CORRECTED)	1404.0	155			

All F-ratios are based on the residual mean square error.

Table 2 – Launch Angle; Interaction Results for Golf Tee/Player Evaluation

Analysis of Variance for Spin Rate - Type III Sums of Squares

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
MAIN EFFECTS					
A:BLOCK	1.13566E7	25	454264.	1.14	0.3351
B:Tee	546819.	1	546819.	1.38	0.2463
C:Player	1.78494E7	2	8.92468E6	22.47	0.0000
INTERACTIONS					
AB	9.63267E6	25	385307.	0.97	0.5194
AC	2.52948E7	50	505896.	1.27	0.1978
BC	32763.7	2	16381.9	0.04	0.9596
RESIDUAL	1.98628E7	50	397256.		
TOTAL (CORRECTED)	8.45758E7	155			

All F-ratios are based on the residual mean square error.

Table 3 – Spin Rate; Interaction Results for Golf Tee/Player Evaluation

Analysis of Variance for Carry Distance - Type III Sums of Squares

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
MAIN EFFECTS					
A:BLOCK	18636.7	25	745.469	0.87	0.6433
B:Tee	475.652	1	475.652	0.55	0.4605
C:Player	61170.8	2	30585.4	35.57	0.0000
INTERACTIONS					
AB	18083.3	25	723.333	0.84	0.6744
AC	31371.2	50	627.424	0.73	0.8657
BC	156.824	2	78.4121	0.09	0.9130
RESIDUAL	42994.3	50	859.885		
TOTAL (CORRECTED)	172889.	155			

All F-ratios are based on the residual mean square error.

Table 4 – Carry Distance; Interaction Results for Golf Tee/Player Evaluation

Design and data analysis for the 2x2 full factorial was done using "Statgraphics" Centurion XVI – version 16.1.17. The analysis output from this experiment found that only player-to-player was statistically significant. This was to be expected as each player's golf swing characteristics were different.

It was observed that for all three players, the trend for spin rate and carry distance; while not statistically significant, was higher for the "Bugle" tee versus the wooden tee – see figures 1 and 2.

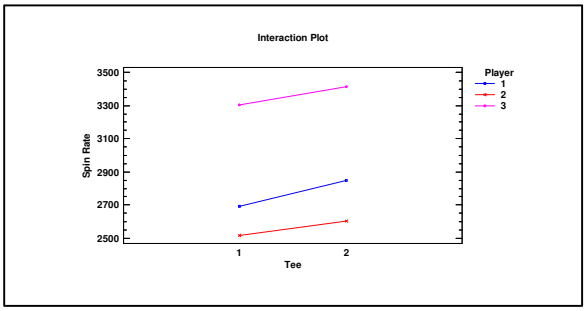

Figure 1 – Spin Rate versus Player

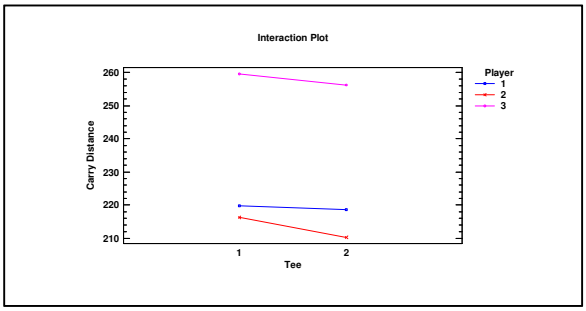

Figure 2 – Carry Distance versus Player

A one-way ANOVA for Spin Rate and Carry Distance to factor out player interaction showed the "Bugle" tee showed a trend down in spin rate by 118 rpm overall while carry distance trended up by 3.4 yards. It should be noted that neither was statistically significant - see Table 5.

Tee Type	Spin Rate	Carry Distance
Bugle	2837.6	231.9
Wooden	2955.9	228.4
Delta (Bugle to wooden)	(118.3)	3.5

Table 5 – Spin Rate and Carry Distance deltas

Corresponding means plots for spin rate and carry distance were shown in figures 3 and 4.

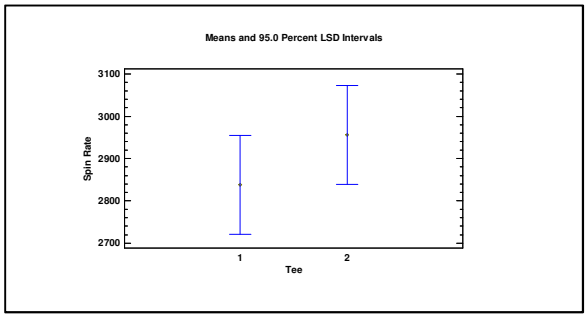

Figure 3: Mean Spin Rate versus Tee Type, Bugle Tee = "1"

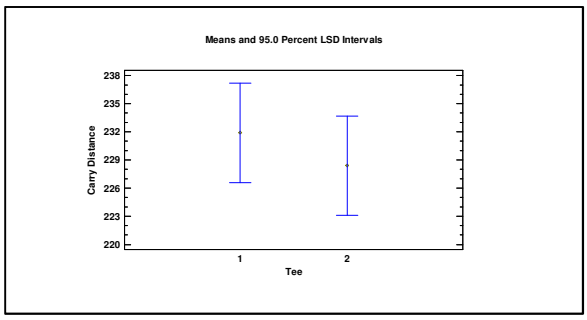

Figure 4: Mean Carry Distance versus Tee Type, Bugle Tee= "1"

While the carry distance and spin rate were not statistically significant, published literature[1] stated that lower spin rate correlates to higher carry distance so there may be merit in the results as measured by "Trackman" and the "Bugle" tee results in a distance gain of 3 yards.

[1] http://www.franklygolf.com/golf-driver-distance.aspx

Materials and Methods

The evaluation of the "Bugle" tee versus wooden tee was done using the "Trackman" hitting bay in the Golf Academy of America – Phoenix Campus. Tee 1 was the "Bugle" tee and Tee 2 was the wooden tee.

The ball/tee was teed up using an artificial grass supplied by the Golf Academy.

Three golfers with varying body size and handicaps were selected to allow for varying swing mechanics to see player-to-player variation. The players were designated players 1, 2, 3.

The experiment design was generated using "Statgraphics" Centurion XVI – version 16.1.17. A 2x2 full factorial with 25 replications was chosen. This resulted in 52 shots per player where the total was 156 shots. The order of both tee and player was randomized by the design of experiments (DOE) package to ensure no order/time dependency.

Each player teed their own shot with the appropriate tee in the order as prescribed.

The Trackman did not register the ball flight information for 7 of the 156 shots. The player was asked to re-tee with the correct tee and repeat the shot when this occurred.

Spin rate, carry distance and launch angle was recorded for each of the 156 shots. This data was manual entered into "Statgraphics" and the DOE evaluated.

Results

The results from the 2x2 full factorial with 25 replications showed that only player-to-player differences were significant. This was seen for all three measured parameters: overall spin rate, launch angle and carry difference.

Parameter	Player 1	Player 2	Player 3
Spin Rate	2771	2559	3359
Launch Angle	15.1	12.9	13.2
Carry Distance	219.2	213.3	257.9

Table 5 – Player Results for measure parameters

The interaction of tee type versus player was found not to be significant statistically. A trend was similar for all three players; the "Bugle" tee was greater for carry distance by 3.4 yards and lower for spin rate reduced by 118 rpm versus the wooden tee.

As a side note, during the experiment up to 20 wooden tees were broken while the "Bugle" tee remained intact showing the "Bugle" tee's potential durability relative to a wooden tee.

Discussion

The outcome from this experiment showed as expected that 3 different golfers resulted with varying abilities and mechanics was found to be the most significant to spin rate, launch angle and carry distance. A golfers swing mechanics, both static and dynamic had the most impact on the swing results.

With regards to the type of tee, it is not conclusive that the "Bugle" tee performed better than a wooden tee. The data suggested that the "Bugle" tee was trending in the favorable direction and that more analysis would be needed.

Acknowledgements

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