

# **EFFECTS OF VARIOUS TURFGRASS MOISTURE LEVELS ON THE MEAN GREEN SPEED**

A Research Paper  
Presented to  
The Faculty of Philippine Science High School Western Visayas  
Bito-on Jaro, Iloilo

In Partial Fulfillment  
of the Requirements for  
SCIENCE RESEARCH 2

by

**Rafael Juan Alfredo M. Luz**

Fourth Year - Tau  
January 2011



## APPROVAL SHEET

This research paper herein entitled:

### **EFFECTS OF VARIOUS TURFGRASS MOISTURE LEVELS ON THE MEAN GREEN SPEED**

Prepared and submitted by Rafael Juan Alfredo M. Luz in partial fulfillment of the requirements in Science Research 2, has been examined and recommended for acceptance and approval.

EDWARD C. ALBARACIN  
Science Research Adviser

Approved by the members of the Science Research Committee on March 2011.

HAROLD P. MEDIODIA

MIALO C. LACADEN

ARIS LARRODER

FLORDELIZA T. REMONDE

ERIKA EUNICE P. SALVADOR

Accepted in partial fulfillment of the requirement in Science Research 2

JOSETTE T. BIYO, Ph. D.  
Director II - PSHSWC



## ACKNOWLEDGEMENT

First, I would like to thank my research adviser Sir Ed Albarracin for his assistance in this research study. With his knowledge and guidance, I was able to conduct this study properly and in an orderly manner.

To my beloved parents, without their support and constructive criticism of this paper, would not have been improve.

To the carpenters of West Visayas College of Science and Technology for the fabrication of the materials needed for my study.

Finally, to the Almighty God, my thanks for all that he has provided me with.

LUZ, RAFAEL JUAN ALFREDO M.



## **Effects of Various Turfgrass Moisture Levels on the Mean Green Speed**

Luz R.J.A.M.

Philippine Science High School Western Visayas, Bito-on, Jaro, Iloilo City  
[rjamluz@gmail.com](mailto:rjamluz@gmail.com)

### **ABSTRACT**

Golf putting greens are the most important area of a golf course. Much time is invested in the management of the turf grass. Such management methods are employed in order to maintain a green speed that meets the requirements set by the United States Golf Association and the expectations of golfers for fast green speeds. This study is conducted to determine the effects of the management method, particularly the irrigation on the mean green speed. This study focuses on the effects of surface moisture levels on the Ball Roll Distance of the putting green. A flat section practice green in Bacolod City Golf and Country Club served as the area to conduct the study. Five different moisture levels were applied to the green. A golf ball was then rolled onto the green with the use of a stimpmeter. Ball Roll Distance was recorded and the process was repeated for a total of five trials per moisture level before computing for the mean. A significant decrease in Ball Roll Distance was observed in higher levels of moisture levels as compared to dry conditions. Analysis of the data with One-Way ANOVA shows that majority of the results are insignificant. It is concluded that while there are decreases in Ball Roll Distance, the effects of moisture on the game play are not significant as compared to other management methods. The results imply that golfers can rely on their own judgment to adjust their putts accordingly.

Keywords: green speed, putting, grass moisture, ball roll distance



## TABLE OF CONTENTS

Acknowledgement	i
Abstract	ii
List of Tables	iii
List of Plates	iv
List of Appendices	v
<b>CHAPTER</b>	
<b>I. INTRODUCTION</b>	
A. Background	1
B. Statement of the Problem	2
C. Objectives	2
D. Hypothesis	2
E. Significance of the Study	3
F. Scope and Delimitation	3
G. Definition of Terms	3
<b>II. REVIEW OF RELATED LITERATURE</b>	
A. Putt	5
B. Green	5
C. Turfgrass	5
D. Stimpmeter	6
E. Putting Green Speed	7
F. Factors Affecting Green Speed	7
<b>III. METHODOLOGY</b>	
A. Work Area	11
B. Use of the Stimpmeter	11
C. Data Gathering	11
D. Levels of Moisture	12
<b>IV. RESULTS AND DISCUSSION</b>	
A. Results	13
B. Discussion	15
<b>V. CONCLUSION</b>	
A. Summary of Findings	17
B. Conclusions	17
C. Recommendations	17
<b>LITERATURE CITED</b>	
<b>APPENDICES</b>	



LIST OF TABLES  
**LIST OF TABLES**

TABLE	PAGE
Table 1. USGA Guidelines of Putting	7
Table 2. Mean Green Speeds of the Putting Green under Five Different Moisture Levels.	13
Table 3. One-way ANOVA Results on the Effects of Moisture on Green Speed.	14
Table 4. Result of Post-hoc Analysis of green speeds under different moisture levels.	14



## LIST OF PLATES

### PLATE

Plate 1. Stimpmeter

Plate 2. Practice Green of Bacolod City Golf and Country Club

Plate 3. Measuring the Green Speed in Meters

Plate 4. Releasing the Golf Ball with the Stimpmeter

Plate 5. Releasing the Golf Ball with the Stimpmeter

Plate 6. Releasing the Golf Ball with the Stimpmeter



## LIST OF APPENDICES

### INTRODUCTION

#### APPENDIX

##### A. Raw Data

##### B. Plates

Golf is a precision sport in which an individual or golfer uses specially designed clubs to propel a small golf ball within a playing field known as a golf course prior to shooting the golf ball into the hole. The golf course is a series of 18 holes each composed of different areas. A typical hole is composed of a tee, fairway, green, and its own series of distinct roughs and hazards. During gameplay, the aim of the golfer is to advance the golf ball through the course. The game starts with a "drive" from the tee to the fairway, then an "approach" from the fairway to the green, and ending with a "put" on the green to place the golf ball into the hole.

The game is played in varying weather conditions. The only time a game is suspended is when rainwater is pooling in the playing field faster than it is draining and when there is a thunderstorm.

One of the strokes performed in the game is the putt. The putt is a stroke performed on the green in which the golf ball is struck with the putter and rolls towards the hole. The putt differs from the drive and the approach due to the location the stroke is performed with a flat backswing and the golf ball never leaves the ground.

The goal of this study is to measure the stress levels of the golfer while performing putts in various conditions.



## CHAPTER I

### INTRODUCTION

#### A. Background

Golf is a precision sport in which an individual or golfer uses specially designed clubs to propel a small golf ball within a playing field known as a golf course prior to shooting the golf ball into the hole. The golf course is a series of 18 holes each composed of different areas. A typical hole is comprised of a tee, fairway, green, and its own series of distinct roughs and hazards. During game play, the aim of the golfer is to advance the golf ball through the course. The game starts with a "drive" from the tee to the fairway, then an "approach" from the fairway to the green, and ending with a "putt" on the green to place the golf ball into the hole.

The game is played in varying weather conditions. The only time a game is suspended is when rainwater is pooling in the playing field faster than it is draining and when there is a thunderstorm.

One of the strokes performed in the game is the putt. The putt is a stroke performed on the green in which the golf ball is struck with the putter and rolls towards the hole. The putt differs from the drive and the approach due to the fact that the stroke is not performed with a full backswing and the golf ball never leaves the ground.

The goal of this research is to measure the mean green speed of the green under varying levels of moisture.



## B. Statement of the Problem

What is the green speed of a golf green with different moisture levels of the grass?

## C. Objectives

1. To measure the mean green speed (cm) of a green under the following water levels: 0ml/sq cm, 1.1ml/sq cm, 2.2 ml/sq cm, 3.4 ml/sq cm, and 4.5 ml/sq cm
2. To compare the mean green speed (cm) of a green under the following water levels: 0ml/sq cm, 1.1ml/sq cm, 2.2 ml/sq cm, 3.4 ml/sq cm, and 4.5 ml/sq cm

## D. Hypothesis

1. Null Hypothesis: There is no significant difference in the mean green speed (cm) of a green under the following water levels: 0ml/sq cm, 1.1ml/sq cm, 2.2 ml/sq cm, 3.4 ml/sq cm, and 4.5 ml/sq cm
2. Alternative Hypothesis: There is a significant difference in the mean green speed (cm) of a green under the following water levels: 0ml/sq cm, 1.1ml/sq cm, 2.2 ml/sq cm, 3.4 ml/sq cm, and 4.5 ml/sq cm



### **E. Significance of the Study**

The game of golf is played in all types of weather, including rain. This form of weather can have an effect on game play, hindering game play performance of golfer as compared to normal playing conditions.

The findings of the study will show the mean green speed of a golf ball on green under various moisture levels.

The study will help provide players data on which to calibrate and improve on putting performance under wet conditions.

### **F. Scope and Delimitation**

The study will be conducted on the practice green of Bacolod City Golf and Country Club. The stimpmeter to be used is provided by the groundskeeper of the golf course.

### **G. Definition of Terms**

**Golf** - It is sport played on a large outdoor field with a series of 9 or 18 holes. The goal of the sport is to propel the golf ball into the hole, using specially designed club, with the least amount of shots. (The American Heritage Dictionary)

In this study, it is the sport that makes use of a putt and a green



**Golf Ball** - A ball specially designed for the game of golf. It is decorated with dimples allowing it to travel large distances.

In this study, the golf ball will be used to measure the green speed.

**Putt** - A type of stroke intended to roll a golf ball into the hole on the green with a club called a putter. (The American Heritage Dictionary)

This study will replicate a putt with the use of a stimpmeter in order to produce a putt with a constant amount of force.

**Putter** - A golf club designed to putt a golf ball on a green into a hole. (The American Heritage Dictionary)

In this study, the putter isn't used to perform the putt. The stimpmeter will be used to perform the putt.

**Stimpmeter** - A device designed by Frank Thomas, It is used to provide a representative measurement of green speed. (Radko 1980)

In this study, the device will be used to produce a golf putt with the same amount of force

**Green Speed** - The condition of the putting surface as it relates to ball roll distance.

Green speed is the distance (m) that a golf ball can achieve on the green. The ball roll distance is based on the distance achieved with a certain speed. (Throssel 1981)

In this study, this will be the distance the ball rolled from the point where it left the stimpmeter to where it stopped.



## CHAPTER II

### REVIEW OF RELATED LITERATURE

#### A. Putt

##### A.1. Description

The putt is a golf stroke used to putt the golf ball into hole. This stroke is intended to make the golf ball roll on the ground rather than fly through the air. A specially designed club called a putter is used to perform this stroke.

#### B. Green

The green is a specially designed playing field of the golf course intended for putting. It is located at the end of each of the 18 holes. During maintenance, this portion of the golf course is given high priority since it is the most important part of the playing field. (Throssell 1981)

A good green possess a number of attributes in order to be fit for regular gameplay. A putting green should be uniform in all aspects and free of any disruptions and diseases. Resilience is what is needed in a green also, although a green that is too resilient will have its smoothness affected. It should be able to remain free from any irregularities caused by regular gameplay. (Throssell 1981)

#### C. Turfgrass

The choice of grass to be used for the surface of the putting green as well as the tees, fairways, and roughs is based on the grasses' climatic adaptability. It



is important that the grass is in its region of best adaptation. Deviation from its suitable region would otherwise result in difficulty establishing and maintaining the quality of the turf. Grasses such as Bluegrass, and bent are temperate grasses that grow best under moderate temperatures with good moisture. Other grasses, such as Bermuda and Zoysias can grow under even higher temperature with the same amount of moisture (Musser 1959).

Aside from climatic adaptation, soil adaptation of the grass is taken into consideration. Grasses also have a specific soil adaptation. Bermuda and Bluegrass need soil with higher alkalinity while Centipedegrass prefers soil with higher acidity. Fertility requirements are also taken into consideration (Musser 1959).

It is important that the grass to be used is capable of undergoing treatments required for specialized use, such as putting greens. Qualities such as texture, resistance to wear, and disease susceptibility are taken into consideration. Grasses have to be able to maintain all such qualities while maintained at conditions required for proper game play. It is known that certain grasses, such as Bermuda and bent, are selected due to their capability of thriving under required golf course conditions and management methods (Musser 1959).

## **D. Stimpmeter**

### **D.1. Description**

The stimpmeter is an aluminum or wooden bar with a V-shaped shoot down the length. It is 0.9m in length and has a ball release groove of 0.75m from



the lower end. The underside of the lower end is cut an angle to prevent the golf ball from bouncing when it makes contact with the putting green. The V-shaped shoot has an angle of  $145^\circ$  such that the ball rolls down the chute supported at two points 12.7mm apart. The ball release groove is set to release the ball when the stimpmeter is raised at angle of  $20^\circ$ . (Radko 1980)

## E. Putting Green Speed

### E.1. Definition

Putting green speed is the term to describe the ball roll distance (BRD). This relates to the firmness of a putt to move the golf ball across a certain distance. It is often described subjectively with terms like fast and slow. Fast refers to greens that require less force to putt. Slow for greens that require greater force (Bigelow 2008). Table 1 below, shows the subjective terms with corresponding quantitative measurements of BRD for regular play and tournament play (Throssell 1981)

**Table 1. USGA Guidelines of Putting**

Regular Play	Tournament Play	
8'6"	10'6"	Fast
7'6"	9'6"	Medium-Fast
6'6"	8'6"	Medium
5'6"	7'6"	Medium-Slow
4'6"	6'6"	Slow



## **F. Factors Affecting Green Speed**

There are a number of factors that affect the green speed, both physical and environmental. Management of these factors involves different practices in order to maintain the desired green speed while also maintaining a healthy green. While the level of maintenance is regulated to provide an even playing surface, the intensity of maintenance is increased during tournament play to provide fast green speeds for players. While maintaining tournament level green speeds are desired by most players, maintaining such speeds year round would result in poor turf quality (grounds-mag.com)

### **F.1. Types of Grass**

The grass planted on the green can have effect on how the golf ball travels on the surface of the green. Turfgrasses are divided into two groups: warm season and cold season. Warm season turfgrasses grow best in temperature ranging from 80 to 95 degrees F and can tolerate drought, heat and wear better than cold season turfgrasses. Natural grasses are used in appropriate locations and can withstand certain environmental conditions. Cultivars, which are specially designed varieties, are also developed and used specifically for putting greens but require intensive maintenance. (articlesbase.com)

### **F.2. Mowing**

The process of cutting the grass to a desired height, has greatest impact on the green speed, namely, the height in which the grass is cut, the frequencies of mowing and the direction of mowing. Most golf courses today, maintain a



mowing height of approximately 3.2mm. In some courses, advances in equipment allow an even lower mowing height of <2.5mm as a means to increase Ball Roll Distance. Turfgrass breeders respond to this trend with the cultivation of grasses capable of withstanding low mowing heights while maintaining high shoot density. (Bigelow & Walker 2007) Increasing the frequency of mowing is also shown to increase the green speed as well. Multiple mowing has shown to increase the speed of the golf ball as compared to a single mowing (Throssell 1981), though daily multiple mowing would result in poor turf health. It also showed that the speed of the golf ball increases when rolled in the direction of mowing compared to golf balls rolled in the opposite direction (Throssell 1981).

### **F.3. Irrigation**

Irrigation is the artificial application of water on the soil. The amount of moisture can affect the green speed. Following irrigation and while wet, BRD was less when compared to dry conditions (Canaway & Baker n. d.).

### **F.4. Rolling**

There process wherein the grass is compacted through the use of a roller. Rolling grew prominence during early 1900's as a means of increasing green speed. This management practice is a debatable practice considering that while the process can increase BRD, it has been shown to increase the compaction of putting greens constructed on soils with high silt or clay content resulting in decreased turf quality. The compaction would reduce the infiltration rate hindering the availability of oxygen and water (Hartwiger 1996). However, it has been proven that it does not increase soil compaction on putting greens



constructed on soils with high sand content (DiPaola and Hartwiger 1994). The combination of rolling and mowing are usually integrated as a means to maintain the green speed. Rolling is also used as a substitute for mowing (Hartwiger et al 2001), though high frequencies of mowing may result in gradual decrease in turf quality (Hartwiger 1996).

#### **F.5. Topdressing**

Topdressing is the application of a soil mixture to the surface of the turf in order to smoothen that playing surface, control thatch, and nutrients for the growth of the grass. The process is performed in conjunction with aerification as a means of maintaining the health of the turf (Klingenburg 2009). Increases in speed occur after a set amount of days. Comparisons between topdressed and non-topdressed greens show that speed is lower than that of non-topdressed greens within eight days of application. After eight days, the speeds of topdressed greens are greater than speeds of non-topdressed green (Throssell 1981).

#### **F.6. Fertility**

Nitrogen rates have been shown to increase or decrease BRD depending on the amount applied per month. Nitrogen rate at 0.33 and 0.5 pounds per month, two and three times a week have shown a significant decrease in BRD. However, rates of 0.8 pounds per month increase the BRD (Rist & Gaussoin 1997).



**CHAPTER III**  
**METHODOLOGY**

**I. Work Area**

The work area was conducted in the practice green of Negros Occidental Golf and Country Club in Marapara, Bacolod City. The practice green was planted with Zoisya. The practice green is maintained by daily mowing with a walk-behind mower to a height of 4.5mm. Watering was done daily during dry season and no watering was done during the rainy season. A flat area of the green was used as the testing area.

**II. Use of the Stimpmeter**

The ball was placed on the ball release notch of the stimpmeter. The stimpmeter was slowly raised to an angle of 20 degrees from the horizon. The ball will roll down stimpmeter and onto the green.

**III. Data Gathering**

A tape measure was set up to be used to measure the green speed in centimeters. The ball will be rolled alongside the tape measure and recorded. The process was done in five trials for each of the five different moisture levels. Afterwards, the mean green speed was then recorded.



#### IV. Level of Grass Moisture

### RESULTS AND DISCUSSION

Moisture was applied in five different levels with a hose equipped with a spray nozzle. It will be measured in milliliters using measuring cups with a total area of 89.32 sq cm. The five levels of moisture were: 0mL/sq cm, 1.1mL/sq cm, 2.2mL/sq cm, 3.4mL/sq cm, and 4.5mL/sq cm.

The golf balls were rolled with the use of a stopwatch on the practice green of Buckle City Golf and Country Club. It was hypothesized that there would be a significant difference in the mean green speed (meters) of a green under the following water levels: 0ml/sq cm, 1.1ml/sq cm, 2.2ml/sq cm, 3.4ml/sq cm, and 4.5ml/sq cm.

#### A. Results

##### 1. Mean Green Speed of the Putting Green at Five Moisture Levels.

The mean green speed on the green applied with 3.4ml of water per square centimeter had the lowest PFD among the greens while the one applied with 1.1ml of water per square centimeter had the highest PFD. Table 2.1 Data shows that there is an increase followed by a decrease in PFD as the moisture level increases.

Table 2.1 Mean Green Speed of the Putting Green under Five Different Moisture Levels

Moisture Level (mL/sq cm)	Mean Green Speed (meters)
0	1.80
1.1	2.10
2.2	1.90
3.4	1.70
4.5	1.85



## CHAPTER IV

### RESULTS AND DISCUSSION

The purpose of the study is to determine the effects of moisture of the grass on the green speed. The project utilized five different water levels: 0mL/sq cm, 1.1mL/sq cm, 2.2mL/sq cm, 3.4mL/sq cm, and 4.5mL/sq cm respectively. The golf balls were rolled with the use of a stimpmeter on the practice green of Bacolod City Golf and Country Club. It was hypothesized that there would be a significant difference in the mean green speed (meters) of a green under the following water levels: 0ml/sq cm, 1.1ml/sq cm, 2.2 ml/sq cm, 3.4 ml/sq cm, and 4.5 ml/sq cm

#### A. Results

##### 1. Mean Green Speeds of the Putting Green at Five Moisture Levels.

The mean green speed of the green applied with 3.4mL of water per square centimeter had the lowest BRD among the group while the set applied with 1.1mL of water per square centimeter had the highest BRD (Table 2). Data shows that there is an increase followed by a decrease in BRD before increasing again.

**Table 2. Mean Green Speeds of the Putting Green under Five Different Moisture Levels**

Levels of Moisture	0ml/sq cm	1.1mL/sq cm	2.2mL/sq cm	3.4mL/sq cm	4.5mL/sq cm
Average	2.0602m	2.1276m	1.9648m	1.8292m	2.0038m



Statistical analysis using One-way ANOVA showed that there is a significant difference in the mean green speed under different moisture levels (Table 3).

**Table 3. One-way ANOVA Results on the Effects of Moisture on Green Speed.**

Source of Variation	Sum of Squares	df	Mean Square	f	Significance
Between	0.251	4	0.063	4.169	0.0129
Within	0.302	20	0.015		
Total	0.553	24			

Post-Hoc analysis using Tukey's pair wise comparison shows that the green speed of the golf ball under different moisture levels have no significant difference except between 1.1mL/sq cm and 3.4mL/sq cm (Table 4).

**Table 4. Result of Post-hoc Analysis of green speeds under different moisture levels.**

Moisture Levels (mL/sq cm)		Mean Difference	Significance Level	Interpretation
0	1.1	-0.0674	0.9503	Not Significant
0	2.2	0.0954	0.7355	Not Significant
0	3.4	0.231	0.05193	Not Significant
0	4.5	0.0564	0.9479	Not Significant
1.1	2.2	0.1628	0.2601	Not Significant
1.1	3.4	0.2984	0.008121	Significant
1.1	4.5	0.1238	0.5178	Not Significant
2.2	3.4	0.1356	0.4303	Not Significant
2.2	4.5	0.1356	0.9863	Not Significant
3.4	4.5	-0.1746	0.2031	Not Significant



## B. Discussion

Mean green speeds of the golf ball under the moisture level of 1.1 mL/sq cm have been shown to produce the greatest overall green speed among the different moisture levels. Moisture level at 3.4 mL/sq cm has been shown to produce the lowest overall green speed. However, statistical analysis shows that there is a significant difference in green speed only between the moisture levels of 1.1 mL/sq cm and 3.4 mL/sq cm.

In putting greens, environmental effects are factors that cannot be controlled by the greens keeper in order to maintain ball roll distance. A relative increase in relative humidity can result in a decrease in ball roll distance. The decrease in ball roll distance is largely imperceptible to the golfer.

The results of this study show similarity to the findings of the study conducted by Canaway & Baker (n. d.). There is a significant difference in ball roll distance. Following irrigation of the five different grass species, there was a reduction in ball roll distance by 6%.



## CHAPTER V

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study aims to measure the mean green speeds of a putting green or Ball Roll Distance under five different moisture levels.

#### Summary of Findings

1. The mean green speed in meters under five moisture levels (0mL/sq cm, 1.1mL/sq cm, 2.2mL/sq cm, 3.4mL/sq cm, and 4.5mL/sq cm) are 2.0602m, 2.1276m, 1.9648m, 1.8292m, and 2.0038m respectively.

#### Conclusion

1. The mean green speed of the green under 3.4mL/sq cm has the shortest Ball Roll Distance and has the highest under 1.1mL/sq cm.

#### Recommendation

1. The measurement of other factors that affect green speed to ensure consistency of the green.
2. The use of a more effective method of measuring moisture levels on the turfgrass surface.



## REFERENCES

- Canaway, P., & Baker, S. (n. d.) Ball Roll Characteristics of Five Turfgrasses Used For Golf and Bowling Greens. *J. Sports Turf Res. Inst.* Vol. 68, 88-94
- DiPaola, J., & Hartwiger, C. (1994). Green Speed Rolling and Soil Compaction [Electronic Version]. *Golf Course Management*. 49-51, 78
- Foy, J. (2006) Selecting the Right Grass. *USGA Green Section Record*. 44(6), 1-8
- Hartwiger C. (2001). The The Ups and Downs of Rolling Putting Greens. [Electronic Version]. *USGA Green Section Record*, 1-4
- Hartwiger, C., Peacock, C., DiPaola, J. & Cassel, D. (2001) Impact of Light-Weight Rolling on Putting Green Performance. *Crop Sci.* 41: 1179-1184
- Klingenburg, T. (2009) Topdressing and Aerification Programs on Creeping Bentgrass Fairways. [Electronic Version].
- Musser, H. (1959) Grasses. *USGA Journal and Turf Management*. 31-32
- Nikolai, T. (2004) Rollin', Rollin', Rollin. *GCM*. 121-124
- Richards, J., D. Karcher, T. Nikolai, M. Richardson, A. Patton and J. Summerford. 2009. Mowing height, mowing frequency, and rolling frequency affect putting green speed. *Arkansas Turfgrass Report* 2008, *Ark. Ag. Exp. Stn. Res. Ser.* 568:86-92.
- Rist, A., & Gaussoin, R. (1997). Mowing Isn't the Sole Factor Affecting Green Speed. [Electronic Version] *Golf Course Manage.* 49-54
- Soto, D. (2010) How Grass Affects Your Game. Retrieved January 18, 2011, from <http://www.articlesbase.com/sports-and-fitness-articles/how-grass-affects-your-game-2414506.html>
- Sweeney, P., Hamilton, G., & Danneberger, K. (2000) Factors Affecting Green Speed. Retrieved January 2, 2011, from [cropsoil.psu.edu/turf/extension/factsheets/green\\_speed.pdf](http://cropsoil.psu.edu/turf/extension/factsheets/green_speed.pdf)
- Throssell, C. (1981) Management Factors Affecting Putting Green Speed. The Pennsylvania State University.
- Wienecke, D. (2003) Putting Green: Speed Kills. Retrieved January 18, 2011, from [http://grounds-mag.com/golf\\_courses/grounds\\_maintenance\\_putting\\_greens\\_speed/index.html](http://grounds-mag.com/golf_courses/grounds_maintenance_putting_greens_speed/index.html)



## APPENDIX A

### RAW DATA

Ball Roll Distance of Green in Meters

Levels of Moisture	0ml/sq cm	1.1mL/sq cm	2.2mL/sq cm	3.4mL/sq cm	4.5mL/sq cm
1	2.069	1.951	1.801	1.778	1.994
2	1.958	2.158	1.853	1.982	1.79
3	1.934	2.222	2.056	1.737	2.129
4	2.24	2.102	2.037	1.871	1.946
5	2.10	2.205	2.077	1.778	2.16
<b>Average</b>	<b>2.0602m</b>	<b>2.1276m</b>	<b>1.9648m</b>	<b>1.8292m</b>	<b>2.0038m</b>



**APPENDIX B**

**PLATES**



**Figure 1. Practice Green of Bacolod City Golf and Country Club (12/26/10)**



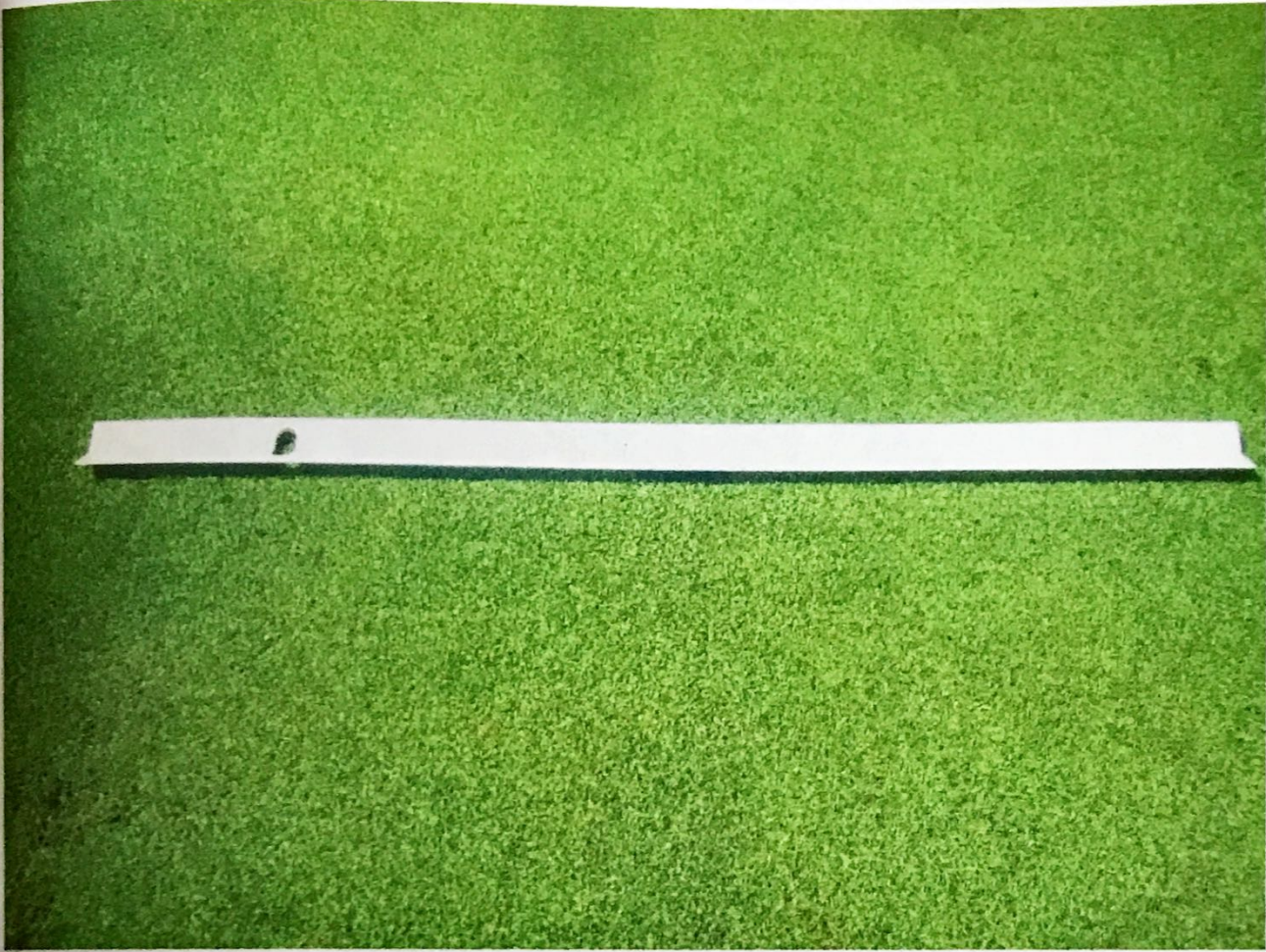
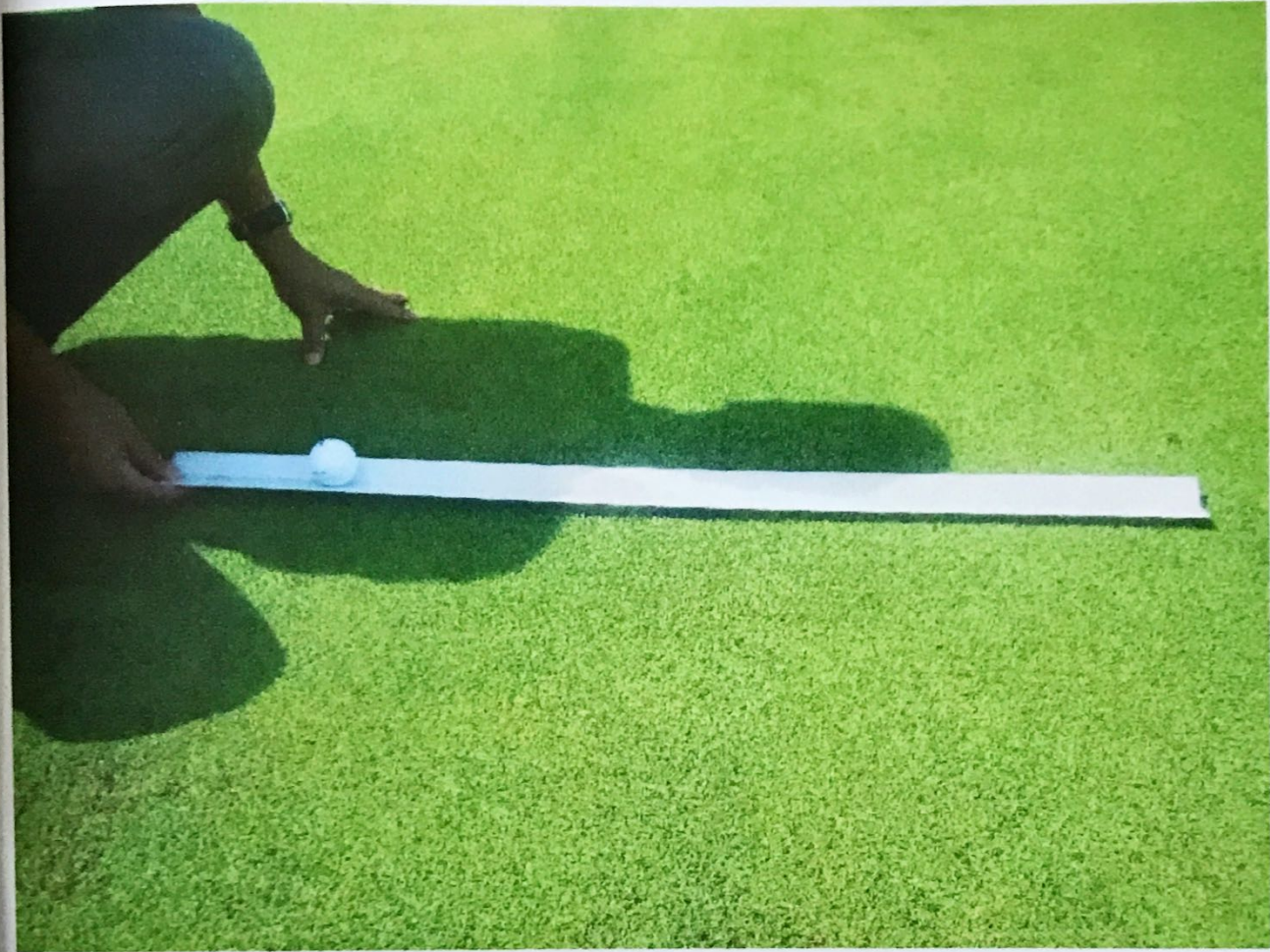


Figure 2. Stimpmeter (12/07/10)





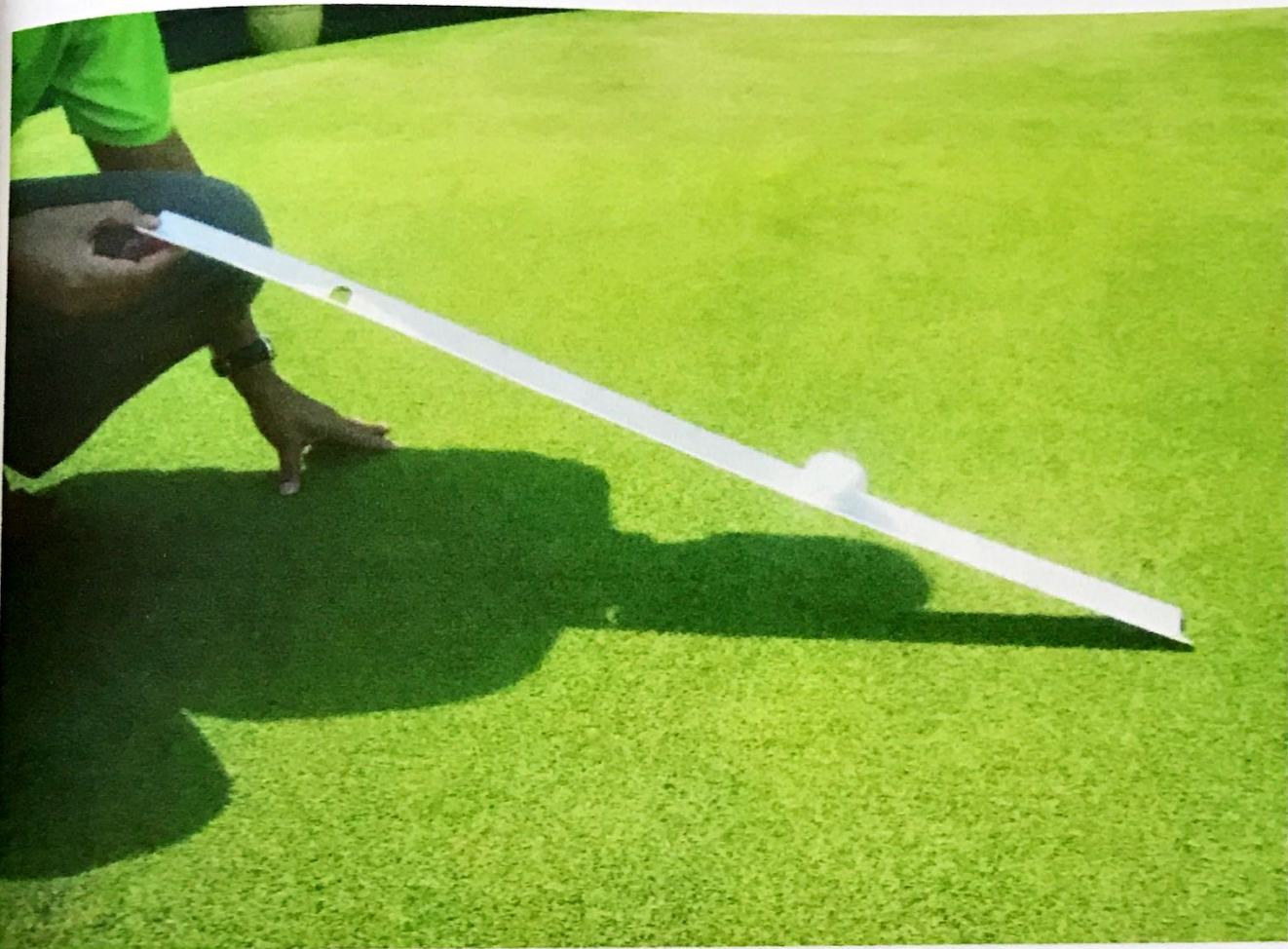
**Figure 3 Releasing the Golf Ball with the Stimpmeter**





**Figure 4. Releasing the Golf Ball with the Stimpmeter**





**Figure 5. Releasing the Golf Ball with the Stimpmeter**





Figure 6. Measuring the Green Speed in cm (12/27/10)