MANAGEMENT FACTORS AFFECTING PUTTING GREEN SPEED

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Management Factors Affecting Putting Green Speed

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ABSTRACT

"Putting green speed" or "speed" is a term commonly used to describe the condition of the putting surface as it relates to ball roll. Since putting is so important to the game of golf, putting green speed receives much attention from the media, golfers and golf course superintendents. Putting green speed can be measured quantitatively using a Stimpmeter. The procedure involves measuring the distance a golf ball travels on the putting surface after rolling down an incline plane. Prior to the initiation of this research many of the effects of management on putting green speed were subject to speculation. To determine the effect of management on speed a survey of golf courses and field trials were undertaken.

The survey included 24 golf courses from central and southwestern Pennsylvania. The range in mean speed, as determined using a Stimpmeter, was from 5 feet to over 10 feet. Sixteen of the golf courses had a mean speed in the range of 6 feet 6 inches to 8 feet 5 inches. The difference in speed within a golf course ranged from 4 to 23 inches with a mean of 13 inches. The difference in speed within a green was less than or equal to 6 inches on 48 greens and greater than 6 inches on 31 greens. Results from this survey showed that mowing height was the management practice that had the most predictable effect on speed. As mowing height increased, speed decreased. Also as nitrogen fertilization rates increased, speed decreased.

Management practices were evaluated in field studies on creeping bentgrass (Agrostis palustris Huds.) turf at The Joseph Valentine Turfgrass Research Center. Over a range of 2/32 to 6/32 inch mowing heights, a change of one 32nd inch caused an inverse change in speed of 6 to

8 inches. As mowing frequency per week increased, speed increased logarithmically. The equation calculated was log $\hat{Y}$ = 0.77 + 0.12 (log of mowing frequency). Multiple mowings on a single day increased speed although not in a linear fashion. An 8-to-10 inch increase in speed was measured due to the first mowing. There was an increase in speed due to the second and third mowings. Compared to single mowing double mowing increased speed 8 inches after 3 days of double mowing. Nitrogen level and mowing height had no significant effect on the difference between single and double daily mowing. Putting green speed increased 6 to 9 inches when golf balls were rolled with the direction of mowing compared to balls rolled against the direction of mowing. There was no significant difference in speed measured at 2-hour intervals during the day regardless of nitrogen level or mowing height. It was calculated that for each change in nitrogen level of 1 pound per 1000 square feet there was an inverse change in speed of 3 to 5 inches. When compared to a non-topdressed check, speed was less on the topdressed plots for the first 8 days following topdressing. From the eighth day on speed was greater on the topdressed plots than on the non-topdressed check. Heavily topdressed plots had greater speeds than lightly topdressed plots. Aerification with 1/4 and 1/2 inch tines reduced putting green speed when compared to a non-aerified check. The greatest reduction in speed was on plots aerified with 1/2 inch tines. Verticutting, maintenance spiking and spike marks from golf shoes all reduced speed when compared to check plots. Moisture, from either irrigation or rain, decreased speed at 2/32 and 3/32 inch mowing heights and increased speed at 6/32 inch. Three varieties of creeping bentgrass were extensively evaluated. The average speed over the summer measured on Penneagle was 9 feet 2 inches, Penncross 9 feet

and Seaside 8 feet 11 inches, with the only significant difference between Penneagle and Seaside. Thirty-six entries in a creeping bentgrass evaluation test were measured for speed. The range in speed was from 7 feet 9 inches to 8 feet 6 inches with a mean of 8 feet 1 inch. It was found that variation in speed from season to season or day to day may be greater than variation due to management. Uniform speed among all greens on a golf course is a desirable feature. The management of a green or greens can be altered to obtain this uniformity. When attempting to alter the speed, changes may be made in several management practices rather than relying on any single practice.

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INTRODUCTION

Putting greens are the focal point of all golf courses. In a regulation round of golf three-quarters of the strokes taken involve the putting greens. One-half of all the strokes taken are on the putting greens with an additional one-quarter of the strokes played to the putting greens. Since greens are so important to the game of golf their condition receives top priority from golfers and golf course superintendents.

There are many attributes that a good golf green should possess. A putting green should be uniformly turfed, free of disruptions from weeds or damage due to disease or insects. The plant canopy should have a very high shoot density for the species grown and all the plants should preferably have approximately the same texture. The growth habit of the species grown on a putting green is extremely important. Ideally the growth habit should be upright with individual tillers and leaves oriented vertically to eliminate graininess. Grain develops on a putting green due to the procumbently oriented growth of grass leaves, shoots and stolons which adversely affect the trueness of a green. A green that is true will hold the line of the putt that the golfer reads and executes. Also a putting green should offer some resiliency to shots played to it. A green should not be too resilient or it would adversely affect the smoothness of the green. The green should be free of depressions left from shots played to the green and lasting imprints from soles of golf shoes are also undesirable. These attributes all contribute to how the putting green influences the speed that the ball rolls after it is putted.

"Putting green speed" or "speed" is a term commonly used to describe the condition of the putting surface as it relates to ball roll. The

speed of a green is of importance to the golfer because it affects the force of a putting stroke required to putt the ball a given distance. Qualitative terms such as "fast" or "slow" are commonly used to describe speed.

To provide a fair challenge to the golfer all greens within a golf course should have approximately the same speed. On most golf courses there is a large amount of variability in speed among the greens. It is the golf course superintendent's responsibility to provide greens with a uniform speed. To aid golf course superintendents in achieving a uniform putting green speed among all greens on a golf course the United States Golf Association introduced the Stimpmeter. Putting green speed can be measured quantitatively with a Stimpmeter. Since a Stimpmeter is easy to use and available to golf courses all across the country, putting green speed has become the subject of much attention from the media, golfers, and golf course superintendents.

The intended use of the Stimpmeter and the actual use are often quite different. Instead of using this instrument to help achieve uniformity in speed among greens, the Stimpmeter data are often used to force an increase in speed. The speed measured on a golf course is often compared to the guidelines established by the U.S.G.A. and to speed measured at other local golf courses. The Stimpmeter and associated guidelines for putting green speed are rapidly becoming standards. The prevailing opinion is that faster greens provide more of a challenge to the golfer and are better greens. Hence golf course superintendents are under increasing pressure to provide faster greens for play.

Despite the attention on putting green speed there has only been a limited amount of research on factors affecting putting green speed.

This research was undertaken to determine and document the effect of certain management practices on speed. The results of this research will help golf course superintendents better meet the demands for faster greens.

The objectives of this research were:

1. To survey management practices and the variations in speed on a selected group of golf courses.

2. To study the effect individual management variables including; mowing height, mowing frequency, multiple mowings, mowing direction, nitrogen fertility level, water management, aerifying, topdressing, verticutting and maintenance spiking have on putting green speed in field trials at The Joseph Valentine Turfgrass Research Center.

LITERATURE REVIEW

Historical Background

The first reported attempt to measure putting green speed using a mechanical device rather than relying on human judgment was in 1929. Monteith (1929) described the Arnott mechanical putter and its possible uses. The Arnott putter had a spring loaded pendulum head mounted on an adjustable tripod. Monteith suggested that the Arnott mechanical putter be used to assess the putting qualities of various turfgrass species. In addition the mechanical putter could be used to determine if differences existed in putting quality due to establishment from stolons or seed (Monteith, 1929).

Evaluation of velvet, colonial, and creeping bentgrass established from either stolons or seed was done in 1933 using the Arnott mechanical putter at the Arlington Turf Garden. All plots were maintained the same and mowed at 3/16 inch. Five balls were putted, all in the same direction, on each plot and the average was taken. The range for the eight plots was 13 feet 10 inches to 16 feet 6 inches with a mean of 14 feet 9 inches. In another experiment the plots went unmowed for 2 days and golf balls were then putted on all eight plots immediately before and after mowing. An average increase of 21 inches were measured following mowing (Grau, 1933).

The forerunner of today's Stimpmeter was introduced in 1937 by Edward Stimpson (Stimpson, 1937). The early models were made of wood but the basic features and principles of design and use were incorporated into the Stimpmeters used today.

Putting green speed was measured on several golf courses when local and U.S.G.A. tournaments were held using the Stimpmeter developed in

1937. A large amount of variation was
(Stimpson, 1974).

The Stimpme

Putting green speed, hereafter re
using a Stimpmeter, researched and di
Golf Association. The Stimpmeter is
long, 1.75 inches wide and .75 inches
top serves as a track which a golf ball rolls down. The V-shaped trough has an included angle of 145 degrees supporting a golf ball at two points 1/2 inch apart. The bottom end is tapered and rests on the putting surface. Six inches from the top end is a notch to hold a golf ball (Figure 1). The notch is present to insure that the golf ball is repeatedly released from the same height. With a ball cradled in the notch, the notched end of the Stimpmeter is slowly raised until the ball just begins to roll out of the notch. The Stimpmeter is then held motionless until the ball rolls completely off of it.

To use the Stimpmeter on a putting green a level area should be selected. Using the procedure described above three golf balls are rolled in any direction. The tapered end of the Stimpmeter should not be moved between any of the three rolls. The three balls should stop within 8 inches of each other, if not, the three rolls should be repeated. The balls are then rolled back in the opposite direction following the same procedure (Figure 2). The mean of the distance of the six balls rolled, three each in opposite directions, is the putting green speed for that location. If the difference of the averages for the three balls rolled in the opposite directions is greater than 18 inches the area selected for use may not accurately measure the speed for that

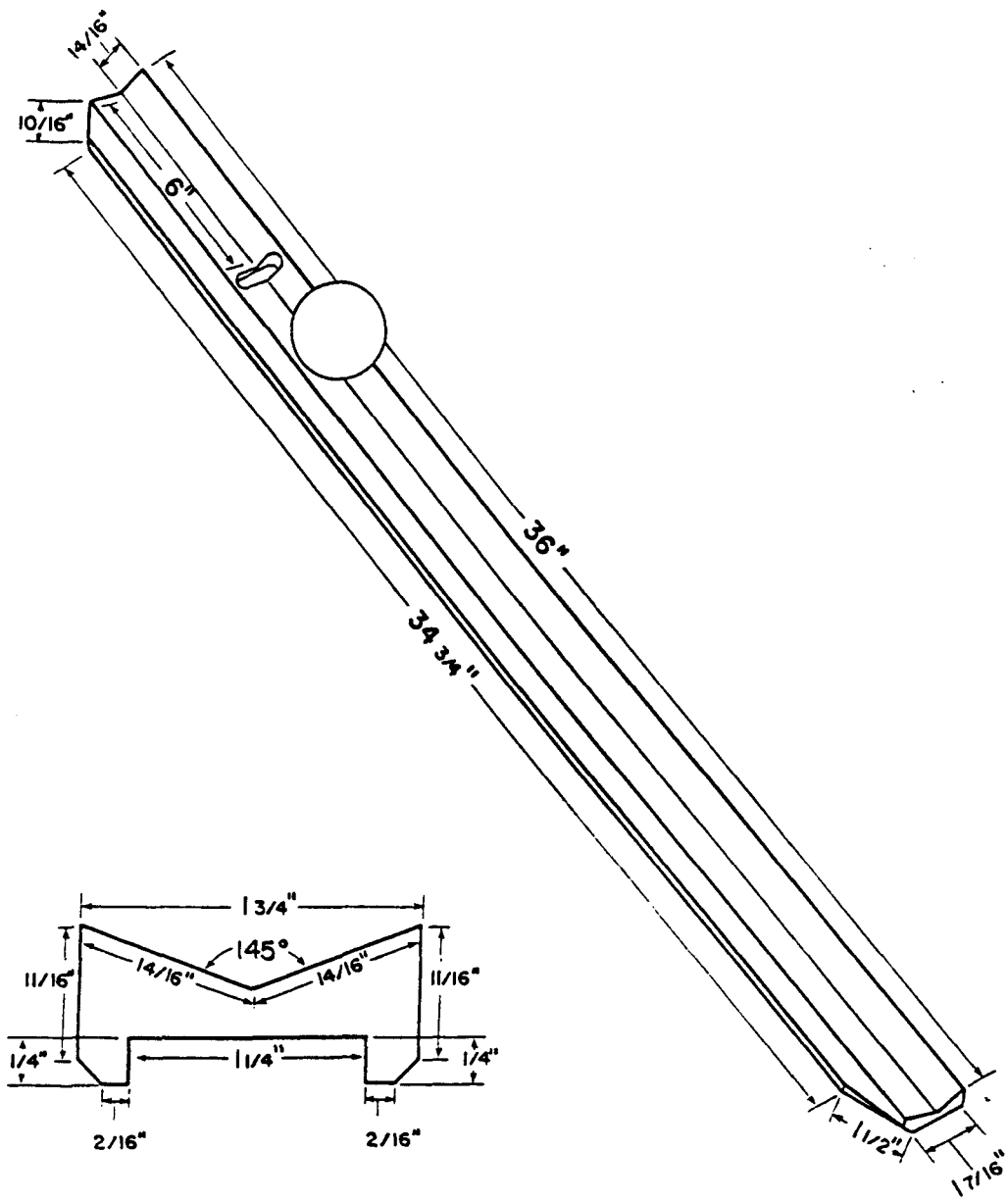

Figure 1. Face view, cross section and dimensions of a Stimpmeter.

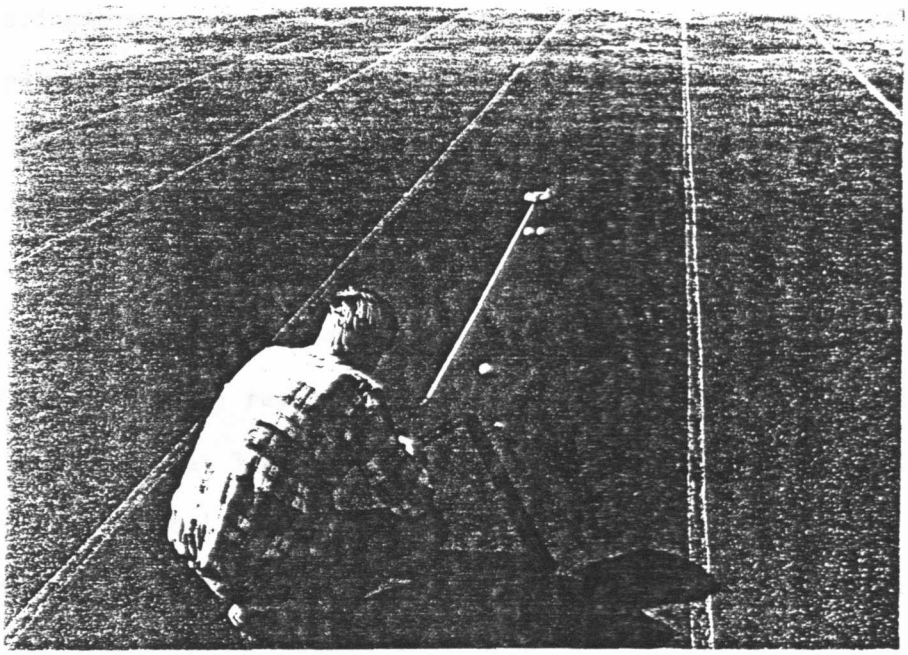

Figure 2. Measuring putting green speed using a Stimpmeter.

location (U.S.G.A., 1979). Guidelines for speed have been established by the U.S.G.A., one for regular membership play and one for tournament play (Table 1).

Current Uses

The Stimpmeter currently used was first made available to golf course superintendents in 1978 (Radko, 1978). The 1978 U.S. Open marked the first time Stimpmeter measurements were used in preparing greens for a tournament. During the tournament one of the tests made was to measure putting green speed prior to and immediately after play and there was relatively little change in speed during the day (Thomas, 1978).

Engel et al. (1980) reported a range in putting green speeds of 6 feet 3 inches to 9 feet 3 inches on golf courses located primarily in the northeastern United States. The range of differences among greens on individual golf courses was from 5 to 25 inches. In a study on golf courses located across the country a range of putting green speeds of 5 to 9 feet was measured (Radko et al., 1981). The range of differences among greens on the same golf course was from 0 to 30 inches.

Putting green speed readings were taken weekly on several golf courses and the speed varied substantially on some golf courses throughout the 1980 golfing season. The variation on three golf courses was from 3 to 4 feet while on the other golf courses the seasonal variation was less than 2 feet (Radko et al., 1981). Excess moisture from rainfall accompanied by a lack of regular mowing accounted for some of the variation (Radko et al., 1981).

The putting green speed, on the average, was 25 inches greater on putting greens mowed at 6/32 inch than 8/32 inch (Engel et al., 1980). Comparisons were also made between golf balls rolled with and against

Table 1. Guidelines for putting green speed established by the United States Golf Association (1979).

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

the direction of mowing. At 6/32 and 8/32 inch mowing heights golf balls rolled with the direction of mowing averaged 14 and 6 inches longer roll, respectively, compared to balls rolled against the direction of mowing.

GOLF COURSE SURVEY ON PUTTING GREEN SPEED

A survey of 24 golf courses, five in the State College, PA. area and 19 in the Pittsburgh, PA. area, was conducted in August of 1979. The importance of this survey was to determine the range of speeds found on golf courses and the possible relationship between putting green speed and agronomic management practices of these greens.

The golf courses in the State College area were chosen because of their proximity to The Pennsylvania State University. The Pittsburgh area was chosen as the other area to conduct this survey because of the concentration of golf courses with a known range of management practices. A few specific golf courses included in the survey in the Pittsburgh area were chosen because they were known to be intensively managed, particularly Oakmont Country Club with its national reputation for fast greens.

Materials and Methods

The general procedure followed when measuring putting green speed was to measure speed twice on each of four greens. All measurements were made on areas that were relatively level. Acushnet Titleist Pro Trajectory 90 compression golf balls were used in this study. One set of measurements was taken within 10 feet of the cup and the other at a distance of at least 30 feet from the cup. This was done to determine the effect of golfer traffic on speed and also to determine variation found within a green. The greens selected to measure were usually recommended by the superintendent because they were level. In some instances the greens selected were dictated by play or their location in relation to other greens.

In addition to measuring speed, information pertaining to mowing, fertilization, topdressing, aerification, and type of grass was obtained from the golf course superintendent.

In some cases wet conditions prevented the greens from being mowed on the day putting green speed was measured. The data gathered from these golf courses are included in the overall presentation of data, and are indicated as having come from golf courses where the greens had not been mowed. Speed measurements on the rest of the golf courses were taken under a variety of temperatures, wind speeds, relative humidities and soil moisture conditions. It is possible that the prevailing weather and soil moisture conditions influenced the speed in some cases.

Results and Discussion

The speeds measured on the 24 golf courses ranged from 5'0" to 10'1" (Table 2). This range is similar to that reported by Engel et at. (1980) and Radko et al. (1981). Two-thirds of the golf courses had speeds from 6'6" to 8'5". The distribution of the putting green speeds measured is shown in Table 3.

The variation in green speed measured within a golf course ranged from 4 to 23 inches. (Table 4). The difference reported was determined by subtracting the minimum speed measured on any green from the maximum speed measured. On most golf courses the minimum and maximum speeds measured were on different greens. These results show the variation in speed within a golf course. Engel et al. (1980) and Radko et al. (1981) reported similar variation among greens on the same golf course.

Since putting green speed was measured on two locations on each green the difference between these two readings provides information on the variation that is found within a green (Table 5). In many cases

Table 2. Range of putting green speeds measured on 24 golf courses.

Golf Course	Course Mean	No. of Greens Measured	No. of Readings Taken
Oakmont	10' 1"	4	8
Pittsburgh Field Club	8'10"	4	8
Fox Chapel†	8' 7"	4	8
South Hills	8' 7"	4	8
Toftrees	8' 7"	4	8
Saint Clair	8' 5"	4	8
Highland	8' 4"	4	8
Centre Hills	8' 2"	6	11
Longue Vue	8' 1"	4	8
Sewickley Heights	8' 0"	4	8
Shannopin	8' 0"	4	8
Allegheny	7' 6"	4	7
Elks	7' 6"	3	6
Oakmont East†	7' 5"	4	8
Wildwood	7' 4"	4	8
Valley Brook	7' 2"	6	12
Ligonier†	7' 1"	4	7
Westmoreland†	7' 1"	4	8
Hidden Valley	7' 0"	4	8
Latrobe	7' 0"	4	8
Churchill Valley†	6' 9"	4	8
P.S.U. Blue	5'11"	2	2
P.S.U. White	5' 4"	5	10
Appledale†	5' 0"	4	7

†Greens were not mowed on the day Stimpmeter readings were taken.

Table 3. Distribution of putting green speeds measured on 24 golf courses.

Putting Green Speed	Number of Golf Courses
9'6" - 10'5"	1
8'6" - 9'5"	4
7'6" - 8'5"	8
6'6" - 7'5"	8
5'6" - 6'5"	2
4'6" - 5'5"	1

Table 4. Differences in putting green speed within a golf course.

Golf Course	Course Mean	Minimum Speed	Maximum Speed	Difference
Highland	8' 4"	8' 1"	8' 5"	4"
P.S.U. Blue	5'11"	5' 7"	6' 2"	7"
P.S.U. White	5' 4"	5' 0"	5' 7"	7"
South Hills	8' 7"	8' 5"	9' 2"	9"
Ligonier†	7' 1"	6' 7"	7' 4"	9"
Hidden Valley	7' 0"	6' 6"	7' 3"	9"
Shannopin	8' 0"	7' 6"	8' 4"	10"
Allegheny	7' 6"	7' 0"	7'10"	10"
Sewickley Heights	8' 0"	7' 7"	8' 6"	11"
Oakmont East†	7' 5"	7' 1"	8' 0"	11"
Latrobe	7' 0"	6' 5"	7' 4"	11"
Elks	7' 6"	6'11"	8' 0"	13"
Centre Hills	8' 2"	7' 6"	8' 8"	14"
Westmoreland†	7' 1"	6' 7"	7' 9"	14"
Appledale†	5' 0"	4' 6"	5' 8"	14"
Longue Vue	8' 1"	7' 4"	8' 7"	15"
Wildwood	7' 4"	6' 9"	8' 0"	15"
Valley Brook	7' 2"	6' 6"	7' 9"	15"
Churchill Valley†	6' 9"	6' 1"	7' 4"	15"
Fox Chapel†	8' 7"	7'10"	9' 2"	16"
Saint Clair	8' 5"	7' 8"	9' 0"	16"
Pittsburgh Field Club	8'10"	8' 2"	9' 8"	18"
Toftrees	8' 7"	7'11"	9' 7"	20"
Oakmont	10' 1"	9' 6"	11' 5"	23"

†Greens were not mowed on the day Stimpmeter readings were taken.

Table 5. Differences in speed between a location on the green within 10 feet of the cup and a location at least 30 feet from the cup.

Speed Differences (inches)	Number of Greens	
	Speed Greater Near Cup	Speed Greater Away From Cup
0 - 3	18	10
4 - 6	15	5
7 - 9	16	2
10 - 12	9	0
> 12	3	1

these differences can be attributed to differences in golfer traffic because one of the locations measured for putting green speed was within a radius of 10 feet of the cup and the other location was at least 30 feet away. On 62 of 79 greens the speed measured within 10 feet of the cup was the greater of the two locations. The increased golfer traffic near the cup caused the increase in speed measured near the cup because of compaction of the thatch and verdure. These comparisons were made regardless of the pin location and traffic patterns on the green. This procedure may account for the differences found on the greens where the putting speed is greater at the location away from the cup rather than at the location near the cup.

A summary of the answers the superintendents gave in response to questions pertaining to the agronomic management of their greens is given in Tables 6, 7, and 8.

The mowing heights listed in the second column of Table 6 were measured to the nearest 32nd of an inch using calipers. In cases where the mowing equipment was in use on the golf course the mowing height listed is the superintendent's measurement. The relationship between mowing height and putting green speed is shown in Figure 3. The speed listed is the mean speed of the greens measured on the golf course. Results show a general relationship of greater speed at lower mowing heights. The regression equation calculated for this data was $\hat{Y} = 12.30 + -.95\ H$, with H being the mowing height in 32nds of an inch. This equation was highly significant, with an r^2 value of .66 which was highly significant. The data had C.V. of 8.9%.

The other questions regarding mowing practices were mowing frequency per week and the type of mowing equipment used. From the results of

Table 6. Mowing practices used on the putting greens included in the survey.

Golf Course	Putting Green Speed	Mowing Height	Mowings per Week	Mowing Equipment §
Oakmont	10' 1"	3/32‡ grind bedknives	7	Th, Tt-w
Pittsburgh Field Club	8'10"	4/32‡ grind bedknives	7	Tt
Fox Chapel†	8' 7"	4/32‡ brushes grind bedknives	7	Jt
South Hills	8' 7"	5/32‡ combs grind bedknives	7	Tt
Toftrees	8' 7"	5/32	6	Jh, Jt-w
Saint Clair	8' 5"	4/32 grind bedknives	9	Tt
Highland	8' 4"	4/32	7	Jt
Centre Hills	8' 2"	4/32	7	Jt
Longue Vue	8' 1"	4/32 grind bedknives	7	Th, Tt-w
Sewickley Heights	8' 0"	5/32 combs	7	Tt
Shannopin	8' 0"	5/32 grind bedknives	7	Jh
Allegheny	7' 6"	4/32‡	6	Tt
Elks	7' 6"	6/32 brushes	7	Tt
Oakmont East†	7' 5"	6/32	6	Tt
Wildwood	7' 4"	5/32 grind bedknives	6	Tt
Valley Brook	7' 2"	5/32‡ brushes	6	Th, Tt-w
Ligonier†	7' 1"	5/32	6	Tt

Table 6 (Continued).

Golf Course	Putting Green Speed	Mowing Height	Mowings per Week	Mowing Equipment
Westmoreland†	7' 1"	5/32	6	Tt
Hidden Valley	7' 0"	6/32	10	Tt
Latrobe	7' 0"	6/32	7	Tt
Churchill Valley†	6' 9"	6/32‡ combs	7	Tt
P.S.U. Blue	5'11"	6/32	7	Tt
P.S.U. White	5' 4"	7/32	7	Tt
Appledale†	5' 0"	6/32	4	Jh

†Greens not mowed on the day Stimpmeter readings were taken.

‡Superintendent's measurement of mowing height.

§Mowing equipment: T = Toro, J = Jacobsen, t = triplex, h = hand, w = weekends.

Table 7. Nitrogen rate and type of grass on the putting greens included in the survey.

Golf Course	lbs Nitrogen 1000 ft^2/year	Type of Grass
Oakmont	1.5	South German, Penncross, Poa annua
Pittsburgh Field Club	3	Penncross, Poa annua
Fox Chapel	2.5-3	South German, Penncross, Poa annua
South Hills	5	Seaside, Poa annua
Toftrees	3	Penncross, Poa annua
Saint Clair	4	Seaside, Penncross, Poa annua
Highland	--	South German, Penncross, Seaside, Poa annua
Centre Hills	5-6	South German, Penncross, Poa annua
Longue Vue	5-6	South German, Poa annua
Sewickley Heights	4	Penncross, Poa annua
Shannopin	5	South German, Poa annua
Allegheny	5	South German, Congressional, Poa annua
Elks	4	Penncross, Poa annua
Oakmont East	--	Penncross, Poa annua
Wildwood	6	Penncross, Poa annua
Valley Brook	8	Seaside, Poa annua
Ligonier	--	Penncross, Poa annua
Westmoreland	4	Penncross, Poa annua

Table 7 (Continued).

Golf Course	lbs Nitrogen 1000 ft^2/year	Type of Grass
Hidden Valley	4	Penncross, Poa annua
Latrobe	--	Penncross, Poa annua
Churchill Valley	--	Washington, Seaside, Poa annua
P.S.U. Blue	6	Penncross, Poa annua
P.S.U. White	6	South German, Penncross, Poa annua
Appledale	6	Penncross, Poa annua

Table 8. Topdressing and aerification used on putting greens included in the survey.

Golf Course	Most Recent Topdressing/ Aerification	Frequency of Topdressing and Aerification/Year	Composition of Topdressing Sand:Soil:Peat	Rate of Topdressing
Oakmont	May 79/October 78	2/1	6:2:2	very light
Pittsburgh Field Club	Spring 79/Spring 79	1/1	mostly sand	heavy
Fox Chapel	Spring 79/Spring/79	2/2	2:1:1	mod-heavy
South Hills	July 79/May 79	4/2	6:2:2	very light
Toftrees	July 79/Spring 79	5/2	6:2:2	very light
Saint Clair	August 79/Spring 79	4/3	7:2:1	heavy
Highland	July 79/Spring 79	5/2	8:0:2	heavy
Centre Hills	April 79/September 78	2/1	6:3:1	mod-heavy
Longue Vue	August 79/Fall 78	5/1	7:1:2	very light
Sewickley Heights	November 78/November 78	1/1	8:1:1	light
Shannopin	August 79/August 79	2/1	8:0:2	light
Allegheny	June 79/Fall 78	3/1	5:5:0	light
Elks	May 79/May 79	2/2	2:2:1	heavy
Oakmont East	Spring 79/Spring 79	1/1	6:2:2	moderate
Wildwood	July 79/October 78	5/1	6:2:2	moderate
Valley Brook	78/77	--	--	--
Ligonier	April 79/Fall 78	2/1	6:2:2	light

Table 8 (Continued).

Golf Course	Most Recent Topdressing/ Aerification	Frequency of Topdressing and Aerification/Year	Composition of Topdressing Sand:Soil:Peat	Rate of Topdressing
Westmoreland	July 79/July 79	3/2	8:1:1	heavy
Hidden Valley	June 79/April 79	4/2	8:1:1	very light
Latrobe	Fall 78/Fall 78	1/1	6:2:2	heavy
Churchill Valley	June 79/Fall 78	2/1	7:3:1	heavy
P.S.U. Blue	Spring 79/Spring 79	2/2	6:2:2	moderate
P.S.U. White	Spring 79/Fall 78	2/2	6:2:2	moderate
Appledale	July 79/Fall 77	3/1	- -	light

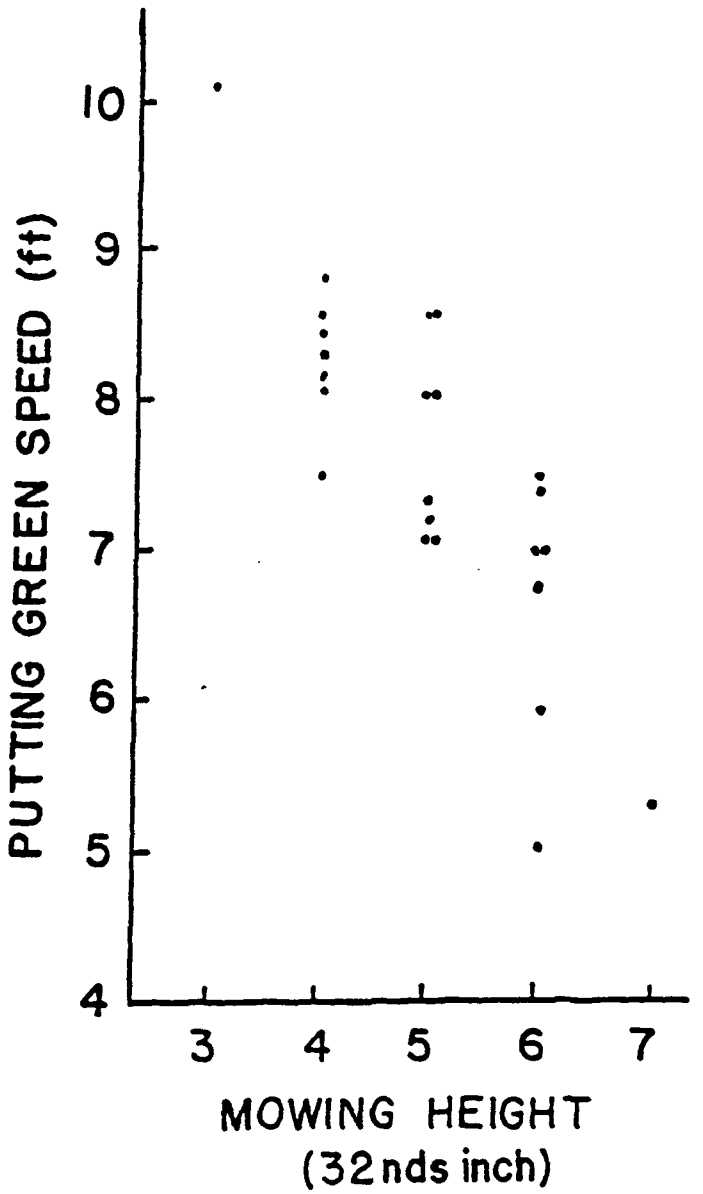

Figure 3. Comparison of mowing height and putting green speed measured on 24 golf courses.

this survey it was difficult to determine what effect they had on putting green speed.

Nitrogen use as recorded in Table 9 shows the relationship of nitrogen fertility rate and putting green speed. The relationship between nitrogen rate and speed may not fully portray the effect of nitrogen rate because of the wide variety of nitrogen sources used and the schedule of their applications. A recent application of nitrogen may cause a temporary reduction in putting speed which was recorded by this survey but does not accurately reflect the putting speed throughout the golfing season.

Topdressing and aerifying are important to the management of every green. For this reason questions concerning topdressing and aerifying were included in this survey. The responses to these questions were varied and reflected a wide range of practices (Table 8). From these results it is difficult to determine the relationship between these two management practices and putting green speed in a single date reading on each course.

The species of grass grown on the greens were found to be various combinations of creeping bentgrass (Agrostis palustris Huds.) and annual bluegrass (Poa annua L.). South German bent was present on many of the older greens that were later overseeded with Penncross or Seaside creeping bentgrass. Penncross or Seaside creeping bentgrass were predominant on the newer greens along with varying amounts of Poa annua.

Summary and Conclusions

The results of this survey indicate a wide range of putting speeds among the 24 golf courses. Variation in speed was also found within a golf course and often within a single green. Golfer traffic patterns may account for some of the within green variation. As anticipated,

Table 9. Comparison of nitrogen applied on putting greens and putting green speed.

	No. of Golf Courses in Each Speed Range lb. N/1000^{2}ft /season	
Speed Range	≤4 lbs	>4 lbs
≥9'6"	1	
8'6" - 9'5"	3	1
7'6" - 8'5"	3	4
6'6" - 7'5"	2	2
5'6" - 6'5"		1
4'6" - 5'5"		2

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ment of speed the results were discussed

superintendents were mostly interested in how the spe

their greens compared with the U.S.G.A. speed guidelines, with sp

measured at other local courses and in Pittsburgh with the speed measured at Oakmont C. C. Few expressed concern with the variability between greens.

ITTING GREEN SPEED

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