Lessons Learned from a Bold Experiment

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BACKGROUND

In 1993 the UW turfgrass research team consisting of Drs. Koval, Kussow, Meyer and Rossi designed a long term study entitled "Turfgrass Management Systems". This was a bold venture because the design of the study was unconventional. Rather than take the classical approach of varying only one or two cultural practices while attempting to keep all other practices constant, in this study the suite of cultural practices making up the production system was constantly varied to achieve the ultimate goal of maintaining different putting green speeds on a sustained basis. In other words, the cultural practices employed were not fixed, but were those required to achieve a particular type of performance, that being putting green speed.

In the interest of making the outcomes of the experiment broadly applicable, the study included three different green speeds that served as the performance standards being sought, and was conducted on sand-based and pushup greens, each populated with three creeping bentgrass cultivars of different vintages and physical attributes. The target speeds were: (1) consistently > 10 feet; (2) around 9 feet; and (3) between 7 and 8 feet. The intent was to cover the full gambit from private clubs with very demanding members to daily fee public golf courses. The creeping bentgrass cultivars were 'Penncross', 'Providence' and the recently released 'Crenshaw'.

Another bold feature of the experiment is that it was designed to extend over several years. Very few agencies are willing to commit to funding a research project for more than two or three years. This study had an intended lifetime of 10 years broken into several phases. The phases were: (1) grow-in year; (2) 3 years of maturation; (3) 2 years of transition to *Poa annua* infested greens; and (4) a 4-year conversion back to bentgrass.

The final bold feature of this team effort was the assumption that the team would remain intact or replacement faculty would be hired on a timely basis. This didn't happen. Dr. Rossi departed for Cornell University, Dr. Koval retired, and Dr. Meyer left the university to start a family. It took up to two years to replace each of them and in some instances the replacements chose to pursue other avenues of research. Thus, Dr. Kussow reluctantly assumed responsibility for the project in 1996. Efforts to populate the greens with *Poa annua* in 1998 and 1999 were not successful and, with funding rapidly being depleted, the experiment was terminated in 2001 without the final two phases being implemented.

LESSONS LEARNED

There were positives and negatives with regard to the lessons learned in this bold study. As already noted, continuity in staffing and funding became serious issues. The project proved to be overly ambitious. Its execution required far more time, supplies and materials, equipment and manpower than anticipated. These are the negative lessons learned.

What follows are the main and presumably useful lessons learned in the study or, as the case maybe, lessons relearned. The format is a series of graphs based on what were literally hundreds of observations.

Lesson # 1: Putting green speed is determined primarily by mowing height. Over seven years the height of cut accounted for nearly 81 % of the differences measured in green speed (Fig. 1). Choice of creeping bentgrass cultivar and type of green construction rarely had a significant influence. The thought that the more upright growth habit of 'Crenshaw' would result in greater speeds than those of the more prostrate 'Penncross' proved not to be true.

Figure 1 is a useful guide when attempting to change putting greens speed through change in mowing height. But speed will vary significantly around the average value at any particular height of cut. Differences of 6 inches or more (those detectable by low handicap golfers) can occur on a day-today basis depending on time of day and weather. The typical situation is peaking of green speeds at about 1:00 (1300 hours) in the afternoon (Fig. 2). This presumably reflects morning drying and then the effect of turfgrass re-growth as the day progresses. But many times putting green speed just kept increasing through out the day, often gaining up to 8 inches between 9:00 am and 5:00 pm. The other factor affecting green speed is time of year. In every year of the study green speeds increased as the season progressed (Fig. 3) and the lower the height of cut the greater the shift in speed. What caused this was not apparent in the study.

Lesson #2: The most effective way to temporarily increase speed is double cutting, but only if the speed is already at 9 feet or more (Fig. 4). Rolling the greens or mowing when the surface was dry rather than wet did increase speed, but the increases were quite variable and often not significant (> 0.5 foot) from the golfer's perspective.

Lesson # 3: Application of Primo may or may not significantly increase putting green speed. In this study, where Primo was applied monthly at 0.24 oz/M, the season-long effect on green speed was nearly always insignificant regardless of bentgrass cultivar or type of green construction (Fig.5). Rather, the effect of Primo on green speed depended on time of season (Fig. 6). In this example, speed increases when Primo was applied in August were consistently significant (above 0.5-foot) while none of the speed increases in June were significant. Note that in both months the increases in green speed achieved with Primo application were greatest at the lowest mowing height.

Lesson # 4: Mowing height definitely influences putting green quality visually rated by observing turfgrass density, stand uniformity, erectness, and amount of grain. Quality did not vary significantly among the

Figure 1

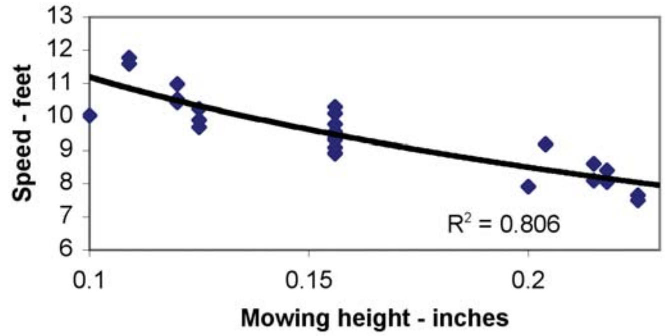
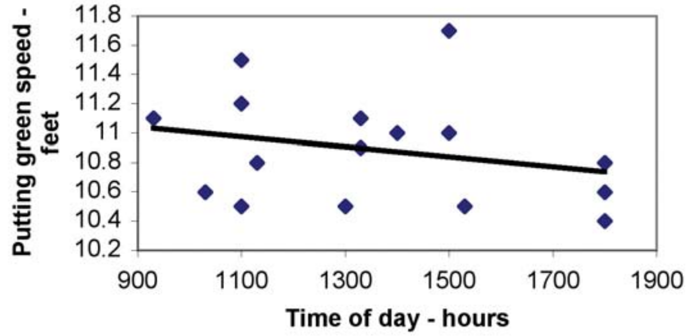


Figure 2



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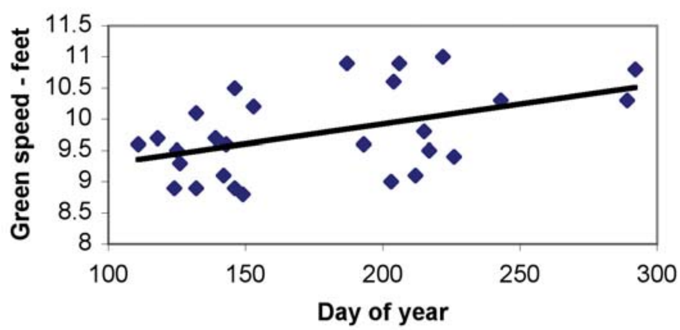

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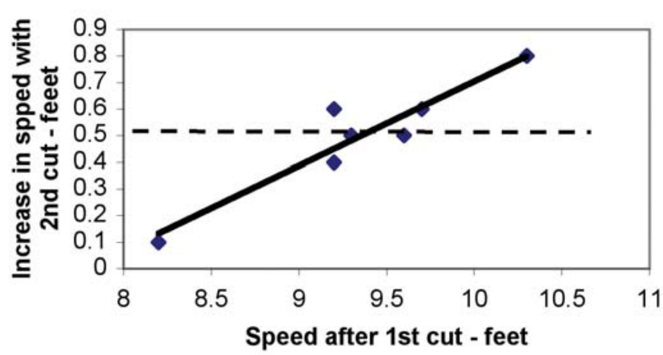

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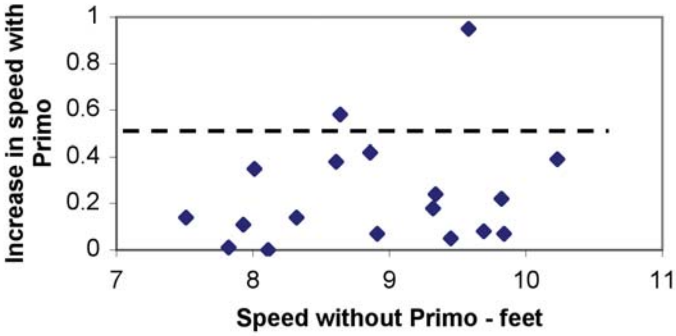

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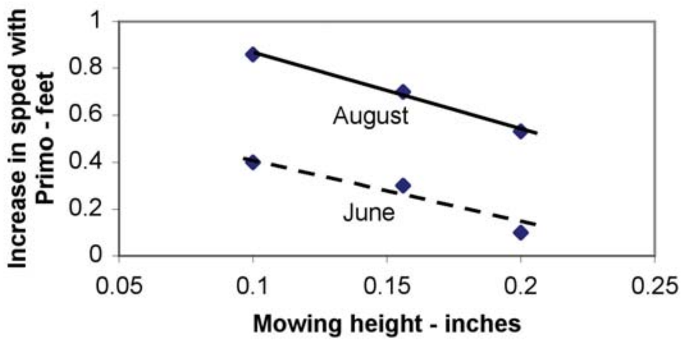
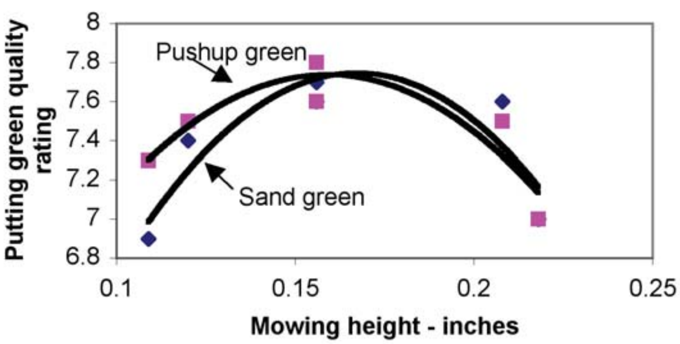


Figure 7



three bentgrass cultivars. At the lowest height of cut the pushup green averaged higher quality ratings than did the sand green (Fig. 7). This difference arose primarily because the pushup green maintained consistently higher turf density. Putting green quality attained a maximum at the 0.156-inch height of cut and there was no longer a difference between the pushup and sand greens. Declines in quality at greater mowing heights were due more prostate growth and extensive grain development.

Lesson # 5: Putting green traffic tolerance increases with increasing mowing height and decreases with the amount of traffic (Fig. 8). These are not surprising results. Studies with various grass species maintained under different cultural practices have almost invariably shown that traffic tolerance relates primarily to verdure, the amount of live plant material remaining after mowing. As seen in figure 8, whether or not mowing height significantly alters traffic tolerance depends on the amount of traffic imposed. When traffic was equivalent to only 12,000 rounds of golf, both increases in mowing height (0.125 to 0.156-inch and 0.156 to 0.2-inch) significantly increased traffic tolerance.

With 23,000 rounds, traffic tolerance increased significantly only when the change in height of cut was from 0.125 to 0.2-inch. Applying the equivalent of 30,000 rounds of golf reduced traffic tolerance to very low levels and the effect of mowing height was no longer significant. Rather, traffic tolerance was extremely low at all mowing heights.

Lesson # 6: Creeping bentgrass growth is influenced much more by mowing height than cultivar or type of green construction. Several counts of tiller numbers showed that on the sand green those numbers consistently increased with increases in mowing height (Fig. 9). On the pushup green tiller numbers increased when mowing height was increased from around 0.1 to 0.156-inch, but not when further increased to around 0.2-inch.

Mowing height affected root density (Fig. 10), but

Figure 8

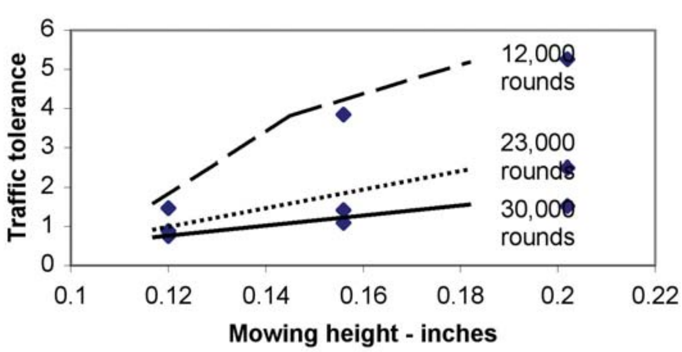
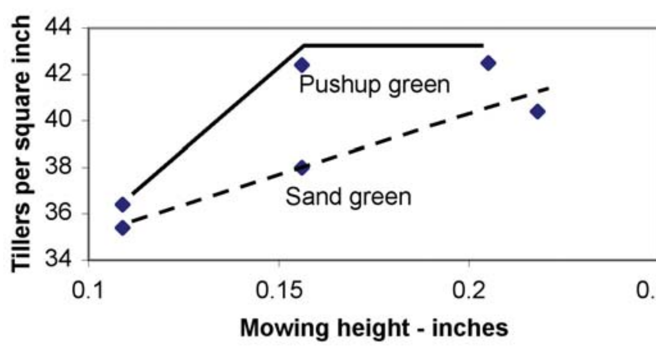


Figure 9



not rooting depth (Fig. 11). Both were consistently greater in the pushup than the sand green. In fact, rooting depth in the pushup green averaged twice that of the 4-inch depth in the sand green. Root density, the weight of roots per unit soil volume to a 6-inch soil depth, linearly increased with increased height of cut. When going from a mowing height of around 0.1 to 0.2-inch, root density increased 54% in the sand green and 38% in the pushup green. Differences among the bentgrass cultivars in root density and depth were not significant.

Lesson # 7: Mowing height has secondary effects on putting green quality. The two secondary effects observed were the extent of infection by dollar spot and of invasion of the greens by algae. Dollar spot infection rates were always higher in the pushup green and in both greens increased with height of cut (Fig 12). Algae began to invade the greens in 1997, the second year during which the target green speeds were being consistently achieved. Mowing at 0.109 to 0.125-inch resulted in algae invasion of 25% area of the sand greens and 50% of the pushup green areas (Fig.13). Merely increasing the mowing height to 0.156-inch reduced the area of algae invasion to 2% or less. At no time during the course of the study did algae invade greens mowed at 0.2-inch or higher.

Extents of dollar spot infection and algae invasion were strongly related to tiller numbers, a measure of turfgrass stand density. Across all mowing heights tiller numbers accounted for 94% of the differences in numbers of dollar spot infections per plot (Fig. 14). The most likely explanation for this relationship is the dual effects of mowing height and tiller numbers on the amount of leaf surface area available for infection. With tiller numbers increasing with mowing height (Fig.9), the relationship between tiller numbers and algae invasion (Fig. 15) was almost identical to the relationship between algae invasion and mowing height (Fig. 13). The implication here is that in going the lowest to the highest height of cut, the increases in turf density eventually led to shading of the soil surface to the extent where algae could no longer survive.

The secondary effects of mowing height, bentgrass cultivar and type of green construction on soil analyses were also observed. Changes in soil pH and soil test P and K were tracked over a 47 month period. The changes observed bore no relationship to mowing height or bentgrass cultivar grown, but understandably differed with type of putting green construction.

Soil pH slowly declined in the calcareous sand green and rose in the acid pushup green (Fig. 16). Both greens appear to have been approaching a common pH of around 7.3. This suggests achievement of a chemical equilibrium that reflects the 8.3 pH and ion content of the irrigation water, the types and quantities of fertil-

Figure 10

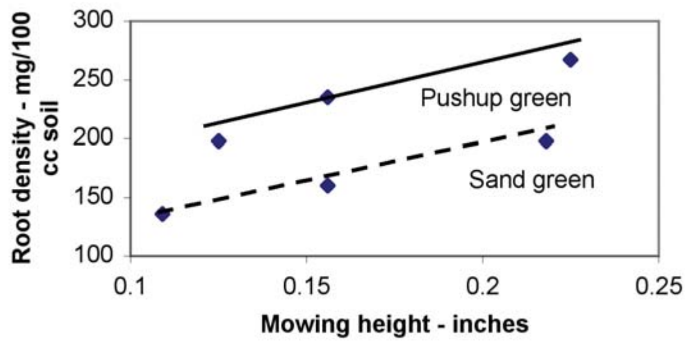


Figure 11

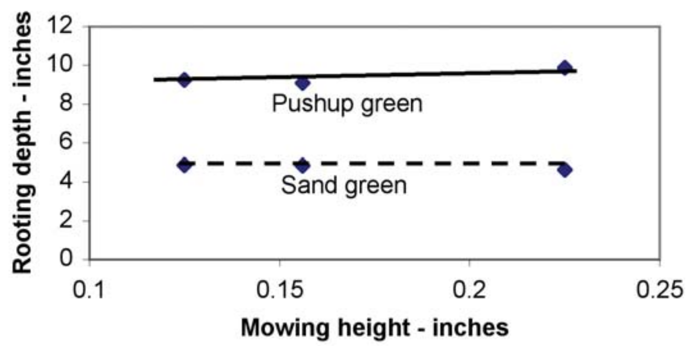


Figure 12

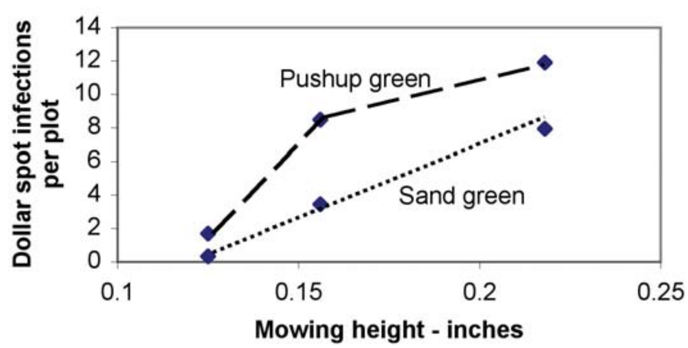
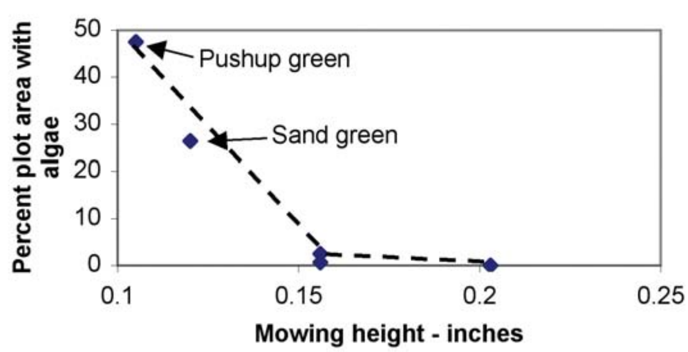


Figure 13



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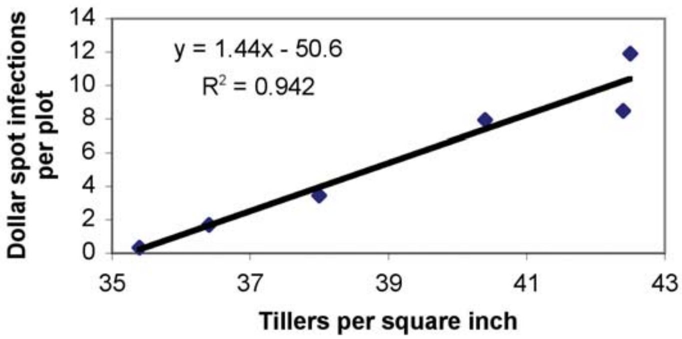


Figure 15

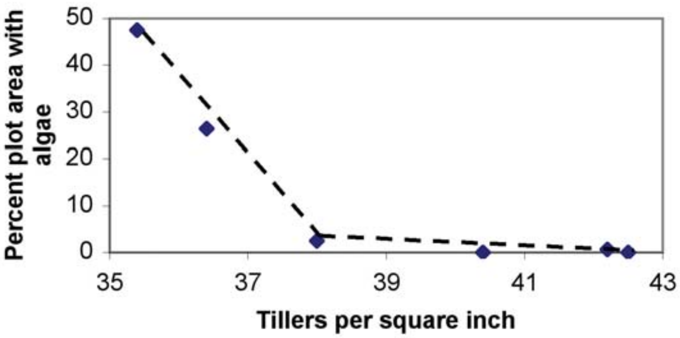
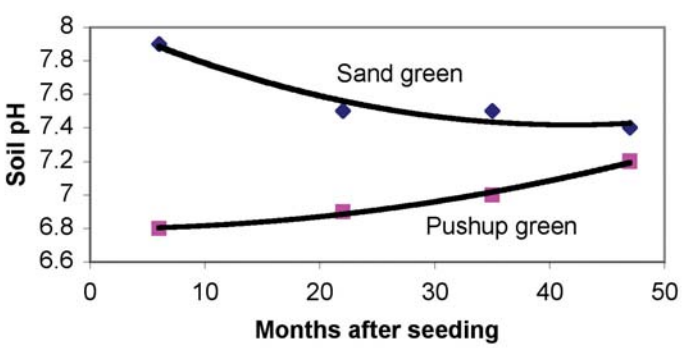


Figure 16



izers applied, and nutrient leaching and clipping removal rates.

Tabulation of all fertilizer applied between 1994 and 2001 showed an annual N rate that averaged 3.2 lb/M on the sand green and 3.1 lb/M on the pushup green. Of particular interest are the ratios of N, P_2O_5 and K_2O applied because it is turfgrass growth response to N that drives plant uptake of P and K. The ratios of P_2O_5 to N applied were nearly identical at 0.25 to 0.26 lb P_2O_5 per pound of N for the two putting greens. At this ratio, soil test P in the sand green rose from a minimally adequate 4 ppm initially to 12 ppm at 20 months and then stabilized at about 15 ppm (Fig. 17). This signifies that in the sand green the maintenance application rate of P was 0.25 lb P_2O_5 per pound of N.

While soil test P on the pushup green was never inadequate for a putting green, the 0.26 lb P_2O_5 applied per lb N was not sufficient to maintain soil P at a reasonably constant level. This might be expected in view of the fact that native soil P buffering capacities are far less those of sand-based greens.

The ratios of K_2O to N applied averaged 0.74 lb K_2O/lb N on the sand green and 0.66 on pushup green. Neither prevented declines in soil test K (Fig. 18). Other research conducted at the Noer Facility has indicated that for sand greens the maintenance rate of K is more like 1.0 lb K_2O/lb N.

SUMMARY

This 8 year study confirmed that first and foremost, mowing height determines putting green speed. For the bentgrass cultivars 'Pencross', 'Providence' and 'Crenshaw', the cultivar grown had little to no influence on speed. In fact, 'Pencross' provided slightly higher speeds than did the more upright growing 'Crenshaw". With a frequent sand topdressing program in place, putting green speeds generally did not differ with type of construction (sand-based or pushup). Mowing at 0.109 to 0.125-inch maintained putting green speeds at > 10 feet and they occasionally approached 12 feet. Mowing at 0.156-inch resulted in speeds quite consis-

Figure 17

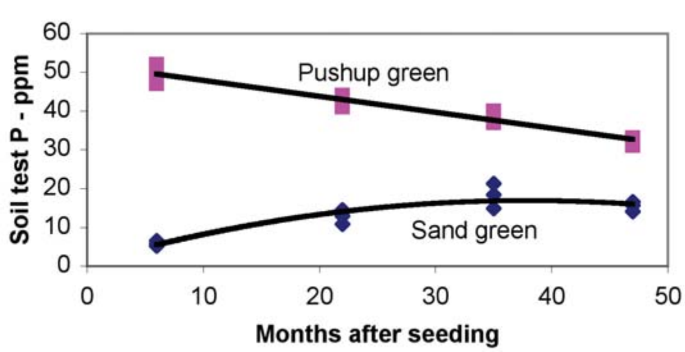
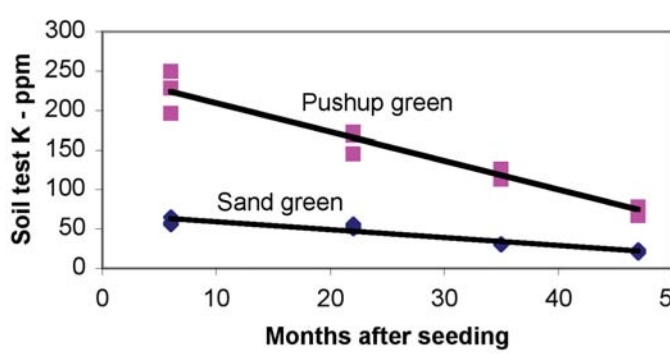


Figure 18



tently in the range of 9 to 10 feet. A target speed range of 7 to 8 feet was easily achieved by mowing at 0.2 to 0.218-inch.

Maintenance of putting green speed within a very narrow range is an exercise in futility. Speed can vary significantly and unpredictably with time of day and weather. There is a pronounced trend for speeds to increase as the season progresses. As an example, over a 3-year period speeds averaged 9.4 feet in May and increased to10.5 feet in October even though the greens were consistently mowed at 0.156-inch.

Significant (> 0.5 foot) temporary increases in putting green speeds for member-guest days and tournaments are best achieved with double cutting of the greens. Other practices such as rolling are less reliable when it comes to significantly increasing green speed. The impact of all these practices on putting green speed decreases with increasing heights of cut. Even at a mowing height of 0.156-inch and green speeds of around 9 feet the increases in green speed may be more illusionary than real.

There are numerous costs that arise with the maintenance of fast greens. Mowing at 0.125-inch or less curtails tiller production and root growth. Thin grass cover enhances speed, but fast greens are much more prone to damage from traffic, favoring invasion by *Poa annua*, quite possibly leading to the need for a *Poa* control program and frequent overseeding or even regrassing. With reduced root growth, irrigation practices may have to be modified and hand watering instituted. Frequent, light sand topdressing is required to prevent scalping. Algae invasion is almost assured, triggering control measures.

Given these added costs arising from maintenance of fast greens and seemingly ever declining golf course maintenance budgets, perhaps the time has come for at least some superintendents to sit down with club members or customers and have a frank discussion about what costs of meeting their expectations for fast putting greens does to maintenance budgets and the cost of a round of golf.