TABLE 1

Percentage of Silicon analysis of digested bermudagrass tissue (Tifway) non-inoculated and inoculated with *Bipolaris cynodontis*.

Treatment [a]	Control[b]	10[4] [c]	X [d]
- Si	.63 b	.68 b	.66 b
+ Si	1.13 a	1.2 a	1.17 a

[a] Treatment, + Si = silicon applied as calcium silicate slag (2,000 kilograms of Si per hectare) and – Si = nonamended control. Values represent combined bermudagrass tissue of five replications.

[b] Noninoculated bermudagrass tissue.

[c] 104 = inoculum concentrations of *B. cynodontis* at 1 X 104 conidia/ml.

[d] Mean value of –Si and +Si treatments. Values followed by different letters are significantly different based on Student's t-test (P is less than .05).

increase in percentage of Si in leaf tissue over the nonamended control (Table 1).

These results suggest that when soils low or limiting in plant available Si are amended with a soluble source of Si, the resistance of bermudagrass against leaf spotting caused by *B. cynodontis* can be enhanced. This also suggests that fungicides might be better managed if used in combination with silicon for controlling diseases in turf. This would fulfill two areas of interest by the USGA:

1) integrated turfgrass management — investigating practices that utilized IPM and reduce inputs; and

2) turfgrass germplasm enhancement — reducing the need for pesticides by increasing disease resistance.

Future research will focus on the interaction of silicon and fungicides for managing leaf spotting and melting out of bermudagrass.

Datnoff is professor of plant pathology at the University of Florida-IFAS, Department of Plant Pathology in Gainesville.

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Lower Mowing Heights Don't Influence Player Speed

By Kevin Trotta

Superintendents who feel they're alone in battling low mowing heights can take solace in a recent study of high-school field managers. Athletic field groundskeepers are being pressured by coaches who believe that their athletes can run faster on shorter cut grass to mow turf too low. This leads to scalped fields and damaged turf.

The athletic field is an unusual turfgrass situation. It is subjected to tremendous demands, undreamed of in a residential lawn setting. As explained by Goss and Cook (1993), the field must be able to "withstand intensive traffic under a range of climatic conditions." To support this activity, the field must first be designed and constructed properly (Indyk, 1986). Realistic scheduling of the use of the field is also critical since an irresponsible overuse of living turfgrass will cause it to fail (Goss & Cook, 1993).

Equal in importance to initial development and subsequent scheduling of use is the implementation of sound maintenance programs. A poorly maintained field will be less able to sustain and recuperate from the wear and tear of sports activities. To endure these pressures, turfgrass must be vigorous, dense, and deeply rooted. Proper mowing practices play an integral role in realizing these objectives. Cockerham (1989) noted this relationship: The first and most apparent result of mowing on grass is that some of the photosynthetically active tissue is removed, reducing the plant food-production capability. A direct result of that removal is a reduction in root growth. Indeed, the relationship between mowing and root development was established early on in pioneering turfgrass research.

A 1961 experiment by Deal clearly showed the influence of higher mowing on *Poa pratensis* (Kentucky bluegrass) root quantity. The study compared 2-inch and 1-inch clipping heights and the resulting increase in root mass associated with the higher cut. That investigation, and others like it, contributed to the basic understandings contained in modern textbooks that instruct today's turfgrass students. As explained by Hull (1996), a closely mowed turf will have a less-developed root system and will be less wear tolerant. For the cool-season species used for sports turf, a cutting height above 2 inches will produce more root mass than a height below 2 inches. This root/shoot relationship becomes a critical factor on football fields where stress is the norm, and each management decision requires a careful consideration of consequences. Nowhere is the attention to this detail more important than in the maintenance of school athletic facilities. A poorly developed root system is less able to access the water and nutrients needed for sustenance. This requires additional expenditures for the materials and labor needed to intensify fertilization and irrigation programs. Clearly then, on facilities with limited resources, mistakes made in basic procedures are magnified, becoming not only wasteful but also difficult to rectify and potentially devastating.

Despite its merits, the proposal to raise football field mowing heights is met with resistance from coaches and players. Joe Casarella, the athletic director of the North Rockland Central School District, believes that most coaches are convinced lower heights of cut will enhance the athletes running performance. He also feels that these coaches are unaware that low mowing practices can negatively affect the playing field.

According to a survey of football coaches, "the overwhelming attitude of the coaches was that a higher cut turf would somehow impede the speed of the athletes (especially fast running backs) and thus somehow affect the outcome of the contest" (Caton, 1993). This belief persists despite the lack of data to support it. In their athletic field cooperative extension publication, Goss and Cook (1993) wrote: "Shorter mowing will provide a denser turf and a faster playing surface. Higher mowing will provide a slower surface but increased rooting depth." It is unclear if the authors are referring to running speed or perhaps to ball roll. Canaway and Baker (1993) linked ball roll and mowing height.

It is accepted in the golf world that low-cut heights are vital to playability, and superintendents

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manage turf for low heights. At a different (mowing) level, that holds true in other sports like soccer. Cockerham, Weston, and Kiesling (1995) constructed an apparatus for ball roll measurement in preparation for World Cup Soccer USA. Their device showed an increase in ball roll distance with a decrease in mowing height. However, there is nothing in the literature which links mowing height and foot speed.

Mowing cool-season high school football fields at 2 inches should be a standard, justifiable procedure.

The purpose of this study is to investigate the influence of clipping height on player speed and turfgrass quality on high-school football fields.

In reviewing the literature, two key issues emerge which argue for the enhanced vigor associated with higher mowing on tight-budgeted school football fields. In light of the fact that there is no evidence that lower mowing increases foot speed, these fields should be mowed at 2 inches to promote safer fields of better playing quality and produce more pest-resistant turfgrass stands.

Harper, Morehouse, Waddington, & Buckley (1984) determined that a relationship exists between maintenance factors, surface and vegetative characteristics and field-related injuries in high-school football. A follow-up study demonstrated that greater shear resistance [traction] and lower impact values [more resilient field surface] were related to maintenance practices (Rogers, Waddington, & Harper, 1988). While traction and hardness will influence sport participant perceptions of playing quality (Canaway & Baker, 1993), their greater importance clearly lies in field safety. Those practices, like proper mowing that contributes to improved turf cover, must be encouraged. Sifers and Beard (1996) acknowledged that "many impact-type injuries are related to varying degrees of surface hardness." They also demonstrated that surface hardness is decreased with increasing heights of cut.

With limited budgets, the margin for error narrows, making it all the more important to adhere to sound mowing practices. A 1994 industry profile survey conducted by the Sports Turf Managers Association reported that the average cost per acre for the maintenance of professional sports facilities was $4,333. The figure for school fields was $658 per acre. Player safety, as well as enjoyment, needs to be considered in the efficient, effective and responsible management of school facilities.

An unpublished study by Gramckow (1966) showed no correlation between height of cut and foot speed. Conducted at Cal-Turf Nurseries in Camarillo, Calif., the study investigated characteristics of turfed areas such as impact energy absorption, shear strength and wear tolerance in addition to the clipping height/running speed relationship. Running tests were performed on 100-yard tracks with eight tracks laid out on bermudagrass, six on fescue and six on bluegrass for a total of 20 separate lanes. These lanes were cut at heights ranging from 1 inch to 3 inches in half-inch increments, with two additional lanes on the bermudagrass at one-half inch each.

Ten high school football players were timed in a 100-yard sprint, running once on each track. Randomly selected, the track order was different for each runner. The 10 running times for each track were then averaged. The results showed no significant difference in sprint times. The conclusion was that cutting height had no appreciable affect on running speed.

Considering the location and time elapsed since the California study, it is apparent that further research is needed to verify the important inference that mowing below 2 inches does not enhance athletic performance.

Results and discussion

To test the hypothesis that there would be no difference in running speed on turfgrass mowed at the three different heights, a recent study in New York recorded sprint times of 2,000 high school students and evaluated them to determine whether they were statistically significant.

The stability of individual sprint times is consistent with the hypothesis. There was no statistically significant difference in the comparison. When the subsample of only the 14 football players is examined, the data are equally supportive. The average time (rounded to the nearest tenth) for the 40-yard sprint of 14 high school football players was 5.7 seconds at each clipping height.

The study clearly showed their nearly identical performances in running the 40 yards regardless of mowing height. When the data were examined in this subgroup manner, the cross-country results seemed at first glance to indicate an association between height of cut and foot speed.

The study also showed what appeared to be a gradual improvement in running times as the height was lowered with lane averages of 5.36 seconds at 3 inches, 5.33 seconds at 2 inches and 5.26 seconds at 1 inch.

The significance of these means was tested. The statistical technique reveals that the one-tenth of a second difference in times is of no significance.

What may be worth noting, however, is the fact that 67 percent of the spikeless shoe cross-country runners clocked their best time on the one-inch turf. Considering the fact that only a third of the cleated subjects recorded their best times at this height, as might be expected in a three-lane experiment design, the possible influence of shoe type and traction suggests further study.

Indeed, it is possible that shoe type may have played a role in the origin of the belief in a clipping height/foot-speed correlation.

Conclusion

This study was conducted to determine if lower cutting heights on high-school football fields might be justified by a corresponding enhancement of athletic performance. No such relationship was observed.

Cool-season turfgrasses, like Kentucky bluegrass, grow most of their roots in spring and fall. It is during these times, which coincide with the outdoor school sports season, that cutting height will have its greatest influence on root growth.

The results of this study argue for sensible mowing practices that provide safer fields, promote better quality and produce healthier turf. Therefore, mowing cool-season high school football fields at 2 inches should be a standard, justifiable procedure.

Trotta is the head groundskeeper of the North Rockland Central School District, Garnerville, N.Y. He can be reached at turfipmguy@aol.com.

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Fine-Cut Fairways

PHOTOS BY FRANK H. ANDORKA JR.

Golfers' expectations for improved conditioning between tees and greens are forcing superintendents and mower companies to meet them

By Frank H. Andorka Jr.
Managing Editor

Call it expectation creep. First, golfers watched professionals putting on the glass-like greens at Augusta and clamored for the same conditions. Now, they see fairways mowed lower and demand the same. Jeff LeFever, senior marketing manager of golf for The Toro Co., says superintendents can't escape the spiraling expectations game.

"The conditioning demands that used to exist only for the greens are now moving into the fairways," LeFever says. "Expectations continue to rise for all aspects of course maintenance, and it's really putting pressure on superintendents to meet them."

With the price of golf rising, players are more focused on overall course conditioning, which means more scrutiny of fairways, experts say. Golfers demand lower mowing heights to increase ball roll, which allows even high-handicap golfers to hit the ball farther.

But the heavy fairway-cutting units, which produced a high-quality cut with greens-style reels, led to compaction and produced turf problems.

To meet those problems head on, mower companies produced lighter machines to meet changing superintendent needs. Golfers will never allow conditions to revert to where they were 10 years ago, says Dan Pierson, superintendent at Wilmington (Del.) Country Club.

"The appetite for better conditions never ends," Pierson says with a sigh. "If it's not one thing, it's another. It's just the next evolution of what's expected of superintendents."

How things have changed

Ralph Nicotera, vice president of sales for Jacobsen turf products, says the industry started a shift in fairway mowing practices in the late 1980s. Large, heavy machines, designed to mow fairways as quickly as possible, were in use before that time. But the heavier machines, though cutting with greens-style reels, exposed other issues in fairway maintenance.

"Superintendents were concerned about compaction on the fairways and the trend toward green-like conditions on fairways," Nicotera says. "Then they started coming to us and asking for lighter fairway mowers."

Not only did superintendents want lighter machines, they also asked for machines that could cut lower, LeFever says. Superintendents could get away with mowing fairways between 1 inch and 1.25 inches 10 years ago, but golfers won't accept that any longer, at least at the high-end clubs, LeFever says.

"We're at the point where golfers expect fairways to be mowed at .5 inches or lower," LeFever says. "Superintendents have to work much harder to keep fairways in perfect condition all the time."

Pierson says members at Wilmington expect him to keep the fairways between .4 and .45 inches.

"If we had cut them that low in the past, we would have had complaints from the high-handicappers who believed they needed longer grass to get good loft on the ball," Pierson says. "Now

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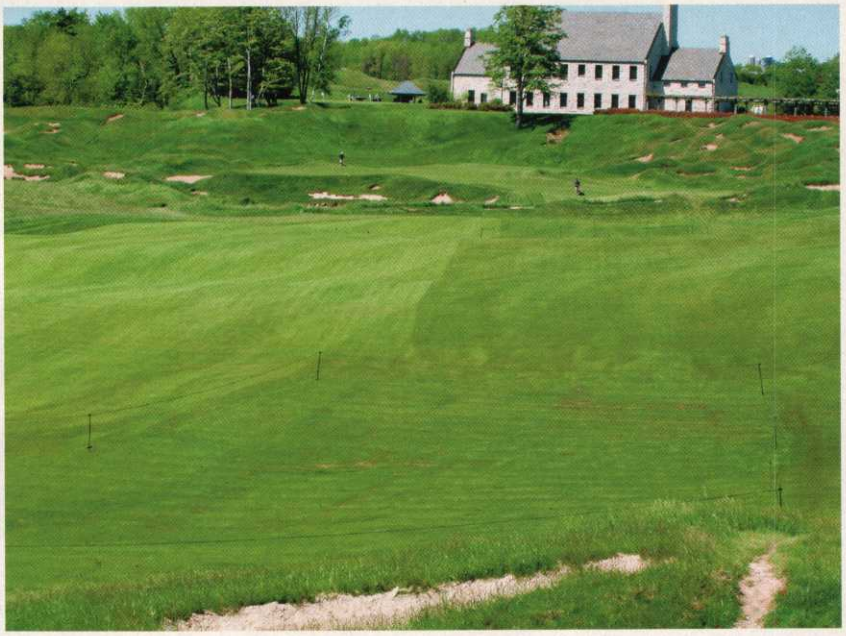
with better equipment and more influence by the low handicappers, we have no complaints."

But lower mowing heights have produced other problems for superintendents. Just like the greens, fairways mowed at lower heights demand more maintenance. Nicotera says superintendents started shifting some of the greens-style maintenance practices to the fairways in the mid-1980s.

"More superintendents than ever are aerating fairways more often and topdressing to reduce compaction," Nicotera says. "Superintendents are being forced to focus as much attention on the agronomic conditions of their fairways as they do on their greens."

The shift toward lower fairway heights isn't happening everywhere, says Gregg Breningmeyer, director of sales and marketing for John Deere Golf & Turf One Source.

"The movement hasn't trickled down to the municipal courses and lower-end clubs because the expectations aren't nearly as high," Breningmeyer says. "If you're paying $30 for a round of golf, you expect $30 fairways. If you're paying $120 for a round, you want $120 fairways."



Despite new mower technology, Dan Pierson, superintendent at Wilmington (Del.) Country Club, says some superintendents are mowing fairways in the old style – up one side and down the other like a Zamboni – to create a split fairway effect like this one on No. 18 at Whistling Straits Golf Course in Sheboygan, Wis.

Mower companies adapt

Nicotera says Jacobsen redesigned its fairway units in the late 1990s. The machines are lighter with higher horsepower tractors and smaller reels, which allow superintendents to mow lower, similar to greens' heights. The smaller reels follow the contours in the fairways more closely and provide a finer finish.

"The heights of cut can now go down to between eleven-sixteenths of an inch and five-sixteenths of an inch," Nicotera says. "With the old machines, those heights would have been unheard of. Even our larger fairway units, the 3800s, can get down to three-eights of an inch."

Reels have narrowed from 30-inch cutting-deck widths in the past with 7.5-inch diameter reels to 22-inch cutting-deck widths with 5-inch diameter reels, Nicotera says.

"We've essentially taken the greens reel frames and added fairway steel stock to the blades," Nicotera says. "It's what our customers wanted."

Toro added front and rear rollers to its fairway units to improve fairway conditioning, LeFever says. The company will also add a groomer option in January.

"The lower heights of cut mean that superintendents need to pay more attention to after-cut care," LeFever says. "We want to give superintendents the amount of customization necessary to help them meet the new golfer needs."

Mike Koppen, group product manager for John Deere Co., says different regions of the country need different fairway mowers. Southern courses with coarser bermudagrass fairways need heavier-duty machines that hug the turf more closely. Machines designed for Northern golf courses don't take as much abuse from bentgrass fairways, so they can be lighter.

"We developed our Extra Strength and Precision (ESP) cutting units for Southern golf courses," Koppen says. "The ESP system makes the blades more durable and offers [fewer] chances for the reel-to-bedknife adjustment to loosen, meaning the blades stay sharper longer. In the North, you don't need that kind of technology because you're cutting bentgrasses, which are easier on the machines."

Superintendents also want mower companies to provide more comfort for operators, Koppen says. To that end, Deere has added floating seats that cradle the operators while they mow, even over bumpy terrain.

"Mowing undulating fairways can take a physical toll on the people using the machines," Koppen says. "When they get fatigued, they don't concentrate as well, leading to mistakes that damage the turf."

Nicotera says the new, lighter fairway units don't last nearly as along as the older models. He said the lighter mowers' average life is six years.

What the future holds

Pierson expects demands for perfect fairway conditions to grow as golfers visit courses and compare conditions.

"It's the same process we went through with greens," Pierson says. "As golfers play other courses, they'll come back to their home courses with new ideas about what the fairways should look like. We'll have to manage those expectations carefully." ■

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The Triumph of a Self-Made Man

BY FRANK H. ANDORKA JR.

Mark "Doc" Grace danced precipitously close to the edge of disaster in 1994. His sod farm, a family operation in Owings, Md., since 1955, could no longer compete against the bigger farms that moved into his area.

Grace's expenses mounted — he had a wife, three kids and a mortgage. Just when he thought he would have to give it all up, his neighbor, a meat cutter, walked in and asked if he could hit some golf balls on one end of the farm.

It seemed the man couldn't find the time or money to get a tee time at the local courses. Grace, whose only previous experience with golf was as a caddy for his high-school chemistry teacher ("I was flunking the class — I needed to do something to ingratiate myself to him"), told him to go ahead. Soon, the neighbor brought seven or eight friends and they all hit golf balls on the outer edges of the sod farm — and Grace saw the light.

"I decided to open a driving range," Grace says. "I had no idea how to build one or what it would take to run it, but watching them hit the balls inspired me."

Grace educated himself by reading industry magazines on maintenance and ownership topics. He taught himself how to build and run a driving range. He learned how much to charge for a bucket of balls. With his new knowledge and understanding, Grace set out to make a success of his range.

Grace's story recalls a different era in golf course maintenance, when hard work, self-education and learning on the job might be enough to launch a superintendent's career. But today, when even the most entry-level maintenance job requires a four-year degree, Grace's story reads like something out of the yellowed pages of a history book. It also contains a lesson that there still are opportunities for self-made superintendents to succeed with a willingness to commit to lifelong learning.

Ten years later, Grace's self-education continues. He still reads and learns all he can about how to run a golf operation, and it's a good thing — he's added a nine-hole par-3 course and a nine-hole regulation course to his portfolio at Mellomar Golf Park to complement the driving range. That required more knowledge than how to shag golf balls, so Grace focused on becoming his own architect and superintendent.

IN AN ERA WHEN THE MOST ENTRY-LEVEL JOB REQUIRES A FOUR-YEAR DEGREE, 'DOC' GRACE'S STORY READS LIKE SOMETHING OUT OF A HISTORY BOOK

When he built his par 3, he read everything possible on golf course architecture. Grace also leaned on the advice of a young engineering student who had worked for him in high school, doing odd jobs around the course for the chance to use the range.

"He was ambitious, and he went to work for the construction company that built the course," Grace says proudly. "Now he's in charge of a construction crew that's handling a huge renovation in Florida. He definitely has talent."

Of course, building the track was only the beginning. Grace knew he needed to increase his agronomic knowledge, so he went to one of the most respected superintendents in the area, Keith Herschberger, with a proposition.

"I told him I didn't want to get paid," Grace says. "I told him I was willing to do anything he wanted me to do on his course. But the catch was that I could ask him any questions I wanted about how to care for a golf course. He was completely understanding and helped me immensely."

Grace realizes how lucky he is to be in a business where people are willing to help out others without letting egos get in the way.

"I've been able to rely on a lot of people who didn't have any reason to help me out other than their love of what they do for a living," Grace says. "I've been lucky to know so many of them as I've gotten into this business."

Money is still tight, but it's getting better. To this day, Grace doesn't keep an official maintenance budget (although he says he'd be

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