Aerification and vertical mowing (right) reduce thatch in bermudagrass turf as compared to no cultivation on left.

by Coleman Y. Ward, Agronomist, Mississippi State University

Turf grass research at Mississippi State University has placed increased emphasis on problems associated with the management of golf course putting greens and tees. A major reason for this emphasis is because it has been my experience that golf course superintendents readily make use of new research findings faster than any group of plant managers. Their concern inspires research workers and magnifies the importance of research findings on fine turf.

The golf turf research program at Mississippi State University has been designed to answer questions about four basic problems:

1. **How to control thatch buildup in bermudagrass putting greens.**
2. **Determination of the best nitrogen source, rate, and interval between application for maintenance of superior quality bermudagrass putting greens.**
3. **Determine the most suitable species for overseeding bermudagrass putting greens for winter play.**
4. **To measure the effects of fertilization and mowing on rapid heal of divots on bermudagrass and zoysiagrass tees.**

Thatch Control in Bermudagrass Golf Greens

The new hybrid bermudagrasses for putting greens in the South require large amounts of nitrogen fertilization to maintain desired putting qualities.

Unfortunately, such fertilization leads to a rapid buildup of undesirable thatch. Any golf course superintendent or golfer knows that a dense thatch layer causes many problems. In addition to causing an erratic putting surface, it also enhances the incidence of disease and harbors insects.

A nine-year study has been underway to determine the effects of three cultural practices on the prevention of thatch buildup on a 328 bermudagrass green. The data in Table 1 show that topdressing with soil several times a year, either as a prepared mixture or through the use of the "vertical mowed" soil cores brought to the surface in the process of aerification, greatly reduces the accumulation of thatch. The data also show that vertical mowing alone, while improving the putting quality by eliminating acute grain, is not an effective tool

Table I. The effect of aerification and vertical mowing on thatch control of 328 bermudagrass greens.

Aerifications[1] per summer	Vertical Mowing Interval			
	2 Weeks	4 Weeks	6 Weeks	No Vertical Mowing
	Millimeters of Thatch			
None	23	25	26	31
Three	9	12	11	13
Six	4	7	6	8

[1] Soil from cores used as topdressing.

for controlling thatch on bermudagrass greens. A combination of vertical mowing with soil topdressing provided the greatest control of thatch and a truer putting surface than either treatment alone. The use of a vertical mower every two weeks created a more uniform putting surface than less frequent intervals of vertical mowing.

Nitrogen Fertilization of Bermudagrass Greens

Bermudagrass greens need about twice the nitrogen required by bentgrass putting greens, or approximately two pounds per month during the growing season and one pound per month during the winter when overseeded cool-season grasses make up the playing surface.

A three year study has just been terminated, in which five sources of nitrogen have been evaluated at varying rates on Tifdwarf bermudagrass managed as a putting green.

Regardless of the source of nitrogen, approximately two pounds per month is needed to maintain ideal turf quality. This was especially true where ureaformaldehyde fertilizers were used as the only source of nitrogen. An earlier study completed in 1965 showed that it is best for a superintendent to use a combination of slow release and fast release sources of nitrogen for obtaining turf quality in bermudagrass putting greens. The less expensive soluble sources provide excellent turf quality, but there are peaks and valleys in the quality of putting greens where quickly available soluble sources are the only nitrogen source used.

The application of a ureaformaldehyde in very early spring and late summer at the rate of four pounds of nitrogen per 1,000 square feet combined with soluble nitrogen sources at monthly feedings will give a more sustained and constant putting quality. The use of natural organic nitrogen fertilizers on alternate fertilizer applications enhances turf quality and helps eliminate micronutrient deficiencies which sometimes occur when manufactured fertilizers represent the only nitrogen source.

Where soluble sources of nitrogen were used in these studies, it was necessary that irrigation be applied immediately after application to eliminate burning of the turf. Quickly available nitrogen fertilizers should be applied to turf when it is very dry or extremely wet. Severe fertilizer burning was found to result when temperatures and relative humidity were high and the turf was only slightly wet.

Overseeding Golf Putting Greens

Bermudagrass turf goes off color with the first frost each fall and dies back to the soil surface. The dead residue provides an undesirable putting surface for the winter season. To overcome this difficulty, bermudagrass putting greens are overseeded with cool-season grasses at high seeding rates to provide a temporary playing surface for the frost period. As temperatures increase the following spring, the cool season grasses are crowded out by the rapidly growing bermudagrass. Under ideal conditions, a smooth and unnoticed transition from cool season grass to hybrid bermudagrass occurs.

During the past ten years experiments have been conducted at Mississippi State University to determine: (1) the optimum time for overseeding putting greens in the fall, (2) the ideal species to use for overseeding, and (3) the cultural practices needed to obtain a quick stand in the fall and a smooth transition in the spring.

Time of Overseeding

Time of overseeding bermudagrass putting greens should largely be determined by seasonal climatic conditions of the area and special activities, such as tournaments scheduled for the golf course. The ideal date for overseeding annual ryegrass or a mixture of cool-season grasses will vary with geographical location. Our experimental results show that the superintendent has approximately a 30- to 50-day period during which successful overseedings can be made. Overseeding approximately two to four weeks before the first killing frost in the fall has given the most satisfactory results in the turf research program at Mississippi State. Overseedings made earlier than this date receive too much competition from the bermudagrass while overseedings made several weeks after the first killing frost are slow to cover and sometimes are lost to winter kill.

Species to Use

Annual ryegrass seeded at 30 to 50 pounds per 1,000 square feet is the most commonly used species for overseeding golf putting greens in the South. However, in recent years golfers have demanded a finer textured putting surface. This led to the evaluation of such species as *Poa trivialis*, the bentgrasses, and the fine fescues. In these studies it soon became evident that no one single species is completely satisfactory.

While annual ryegrass has excellent emergence and wear resistance, it often fades out too abruptly in the spring. Kentucky bluegrasses and the bentgrasses have very weak seedlings and do not provide adequate putting surfaces in the fall and early winter, yet they provide superior quality in the late spring. Therefore, to insure a more uniform and persistent turf quality throughout the winter season, a mixture containing either annual ryegrass or creeping red fescue as the base grass together with lesser amounts of *Poa trivialis*, Kentucky bluegrass, and creeping or colonial bentgrass provides a hedge against failure which may result when a single species is used. A typical mixture is shown in Table 2.

Experiments conducted last winter with the perennial ryegrasses NK-100 and Norlea show these varieties to have excellent potential for use in overseeding golf putting greens.

Table 2. Species and mixtures of cool season turfgrasses for overseeding bermudagrass greens in the South.

I. Mixtures for golf courses with high intensity traffic (250 or more rounds daily).

A. *Species*	*Pounds per 1000 sq. ft.*
Annual ryegrass	20
Poa trivialis	7
Colonial bentgrass	2
Kentucky bluegrass	2
Total	31 pounds

or

B. Annual ryegrass alone at 40 to 50 lbs. per 1000 ft.

II. Mixtures for golf courses with moderate traffic (50 to 200 rounds daily).

A. *Species*	*Pounds per 1000 sq. ft.*
Creeping red fescue	15
Poa trivialis	5
Colonial bentgrass	1
Total	21 pounds

or

B. Creeping red fescue alone @ 25 lbs. per 1000 sq. ft.

Management of Overseeding Greens

An experiment was conducted last winter to determine the optimum rate of nitrogen fertilization during the winter for overseeding putting greens; and the value of vertical mowing and spiking in early spring. The object of the experiment was to aid in a smoother transition from the cool-season grasses to bermudagrass turf. The results of this study show that one pound of nitrogen applied monthly provides adequate turf quality until mid-spring, when the nitrogen rate should be increased to two pounds per month to encourage a more rapid development of the bermudagrass. When only one pound of nitrogen is used per month throughout the spring, the cool-season grasses provide too much competition for the bermudagrass and they delay its recovery from dormancy. Spiking and vertical mowing at weekly intervals for a period of three weeks in early to mid-spring aided the emergence of bermudagrass.

Divot Injury Study

Severe divot injury often occurs on golf tees, especially those on par-3 holes where irons are used for the tee shot. Management practices are needed to obtain rapid healing of such divots. Two management practices available to the superintendent to speed divot recovery are mowing and nitrogen fertilization. A study was initiated in 1966 and repeated in 1968 to determine the effects of nitrogen fertilization rate and closeness of mowing on the rate of recovery of divots on Tifway bermudagrass and Meyer zoysiagrass. The divots were made using a cup cutter in 1966 and a golf wedge in 1968.

The treatments and some results are shown in Table 3. Bermudagrass recovers rapidly from divot injury regardless of the nitrogen fertilization or mowing regime. However the recovery time can be reduced 50 per cent by increasing the nitrogen fertilization rate from four pounds per 1,000 square feet to eight pounds during the growing season. Mowing the tees at one-inch height gave slightly faster recovery than mowing at one-half inch. In this study, the divots were completely removed and the rate of healing was measured at weekly intervals across the divots. Divots in Tifway bermudagrass healed in 15 to 20 days with the high nitrogen fertilization

Shade tolerance of bermudagrasses is one phase of the Turf Research program at Mississippi State University.

rate, against approximately 25 to 40 days with a low nitrogen rate. Meyer zoysiagrass recovered much more slowly and required the greater part of a season to recover from divot injury. These dates indicate that the tee size should be increased to allow for more recovery time where Meyer zoysia or similiar shade resistant grasses must be used because of trees or other shading structures in the tee area. Since golfers prefer a growing height on the tee of one-half inch or less, nitrogen fertilization should be the chief tool used to enhance a rate of recovery of divot injury on golf tee turf.

THE AUTHOR

Coleman Ward was raised on a farm in east central Texas, and it was only natural for him to receive his B.S. and M.S. degrees at Texas Tech. He has taught agronomy at universities in New Mexico, Florida, and Texas as well as Mississippi. He is a member of the USGA Green Section Committee and in 1967 was named Professor of the Year in Agriculture at MSU.

Table 3. Divot recovery of Tifway bermudagrass and Meyer zoysiagrass.

Nitrogen Fertilization lbs/1000 sq. ft.[1]	Mowing Height Inches	*Per Cent of Divot Injury Recovery* 1 Week	2 Weeks	3 Weeks	4 Weeks	8 Weeks
				Tifway bermudagrass		
4	½	19	25	41	47	100
8	½	35	44	77	89	100
4	1	26	32	58	61	100
8	1	43	49	80	94	100
				Meyer zoysiagrass		
4	½	2	4	17	48	86
8	½	3	4	21	53	95
4	1	12	20	28	46	76
8	1	15	25	36	57	87

[1] Nitrogen applied monthly @ 1 and 2 lbs. from NH_4NO_3