

preceding the research worker's findings, because the man on the job has to face such problems and do something about them, sometimes before researchers are able to get to the problem. It is hoped that the USGA Green Section's program of research on specific golf-course turfgrass problems will

help in bringing results to the superintendent sooner.

Bentgrass putting-green turf which goes into the hot humid months in healthy condition fares best. These months are good indicators of the limiting management practice on putting-green turf.

Cultivation of Turf

The cultivation of turf is one of the most important phases of modern turfgrass maintenance. For many years turf growers have felt that they were working at a disadvantage because it was not possible for them to till their soil in the same way that farmers used tillage to maintain good soil tilth.

Porosity has become an important word to the golf course superintendent. We are likely to think of soils in terms of the solid phase of the soil, yet the roots of the plant grow in the pores, not in the soil solids. Pore space makes up about half of the volume of a good soil.

Pore space is of two kinds; there is capillary pore space, which is usually filled with water when soil is reasonably moist, and there is non-capillary pore space, which provides drainageways for water that gravitates through the soil and air spaces when the soil is well-drained. We have come to believe a good soil should have about equal parts of the two kinds of pore space.

The pore space of the soil can be characterized in other ways. It can be textural pore space. These are the pores that result from a coarse soil texture. The sand particles, or larger particles of the soil fraction, fit together in such a way that there is a rather large space left between them. This kind of pore space cannot be changed by management. Only the addition of different size soil particles can change it.

The other kind of pore space with which we are concerned is structural pore space. Structural pore space results from the aggregation of the finer soil particles. This type of porosity can be effected by management of various kinds. Trampling when the soil is wet tends to reduce the amount of non-capillary porosity which depends upon structural characteristics of the soil.

The trampling causes the rearrangement of the soil particles which form the aggregates and a consequent fitting more closely together so that we do not have the larger non-capillary pore spaces through which excess water can move rapidly.

Non-capillary pore space of a structural nature can be affected indirectly by watering practices. If a small amount of water is applied at one time, the surface of the soil will have to be kept wet or grass will not live. When the surface is kept wet any kind of traffic will tend to rearrange the soil particles and compact the soil. On the other hand, if the turf is watered in such a way that the water soaks deeply into the soil, it will support turf without having to be watered so frequently. Therefore the top is allowed to dry and trampling does not affect it so severely.

Cultivation the Best Tool

Cultivation is perhaps the best tool for managing soils for maintenance of structural porosity. Cultivation of putting greens has been practiced for many years even though the practice was not considered to be cultivation in the days when hollow-tined forks were the chief implements for this purpose. Mechanical devices for cultivating turf have been of fairly recent origin. While many attempts were made prior to World War II to develop mechanical devices for cultivation, it was not until after the war that really successful machines for this purpose began to appear on the market.

There are several types of machines which have been designed to cultivate turf. The first attempts were solid-tined spikers; these were solid tines built on rollers so that when the roller was pulled across the green the solid tine would penetrate the

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surface of the green, making small holes and breaking the turf. Other early attempts to develop mechanical spikers resulted in disk spikers. These also were pulled by hand across the green and the disk was serrated so that it did some slicing and penetrating of the turf.

Following the war, three new and distinct types of machines came on the market. One consisted of a series of drills that drilled holes into the soil. This machine did a very thorough job but had the disadvantage of being somewhat slow. Another machine had half round, curved, hollow spoons which were pushed into the turf as the revolving disk rolled forward. These hollow spoons are built in such a way that they enter and leave the soil at the same point so that they do not tear the turf severely. The spoons move under the soil so that the soil is stirred below the surface. The third type is a machine which has hollow tines mounted on a drum. These tines are pivoted in such a way that they are exerted from the drum as the tine comes down. If it strikes a rock or hard place it is pushed back into the drum and therefore does not break.

Cultivation has come to be an almost universally accepted practice on golf courses, and there are relatively few courses which do not have some sort of mechanical device for this purpose. The practice of cultivating turf as we know it at this time is relatively new and there are many variations of the manner in which the practice is carried on.

When to Cultivate

One of the important questions is *when* to cultivate. The time varies a great deal. Some golf courses need cultivation much more frequently than others. As in plowing, it is necessary that the soil be in good condition as far as moisture is concerned if the cultivation is to be successful. Cultivation of wet soils may result in even further compaction of the surface. If the soil is exceptionally dry, it may be difficult to get the cultivating drill, tine or spoon into the soil.

Another important consideration is to be sure that the grass is growing vigorously

Aug. 3

Turf Field Day, Rutgers University, New Brunswick, N. J. Dr. Ralph E. Engel.

Aug. 9

Texas Turfgrass Association Field Day, Cedar Crest Golf Course, Dallas, Tex. Grover Keeton.

Aug. 19, 20

Twenty-third Annual Turf Field Days, University of Rhode Island, Kingston, R. I. Dr. J. A. DeFrance.

Sept. 8, 9

Turf Field Days, Pennsylvania State University, State College, Pa. Prof. H. B. Musser.

Sept. 15

First Annual Rocky Mountain Turfgrass Conference, Colorado A. & M. College, Ft. Collins, Colo. Prof. A. M. Binkley.

Sept. 17

Utah Turfgrass Conference, Salt Lake City, Utah. A. R. Emery, 721 East, 3120 South, Salt Lake City, Utah.

Sept. 21, 22

Eighth Annual Regional Turf Conference. State College of Washington, Pullman, Wash. A. G. Law.

Sept. 27, 28

Midwest Regional Turf Foundation Field Days, Purdue University, Lafayette, Ind. Dr. William H. Daniel.

Sept. 30

Northern California Turfgrass Conference, University of California, Davis, Cal. Dr. R. M. Hagan.

Oct. 4, 5

Southern California Conference on Turf Culture, University of California, Los Angeles, Cal. Dr. V. T. Stoutemyer.

Oct. 7, 8

Arizona Turfgrass Conference, University of Arizona, Tucson, Ariz. J. S. Falkner.

at the time cultivation is accomplished. On putting greens it is important that the turf heal rapidly any scars that are made. If the grass is growing well, scars will be healed very shortly. If the grass is growing rather slowly, scars may last for a much longer period.

Some operators are still concerned about what is accomplished by cultivation. Cultivation tends to break up a compacted layer at the surface of the green where it so often forms because of trampling when

the soil is wet. Cultivation improves the structural porosity just as plowing improves the structural porosity of the field soil. Improvement of porosity allows better penetration of water. It allows for better diffusion of air. These conditions, in turn, promote deeper and more profuse root growth. On putting greens that have a tendency to form a thatch, dry spots often form. These are localized dry spots. Cultivation tends to break through the layers of thatch and thus prevent the formation of such dry spots. Cultivation aids the movement of fertilizer downward to the root zone. Cultivation is also important in seedbed preparation. Many turf growers have found that they can prepare a seedbed without complete destruction of established turf and without disturbing the existing level or contour of the surface. Plowing, or disking, on the other hand, completely destroys the turf that is present and frequently calls for a releveling job.

How Surface Is Affected

Another question concerning cultivation is: "How does it affect the playing surface?" It is obvious that no kind of cultivation can be practiced on a putting green without doing some damage to the putting surface. The surface is roughened and must be smoothed again before putting can follow. There are many practices for accomplishing this end. Some operators break up the plugs after they have dried sufficiently by dragging with a flexible steel mat or a piece of chain-link fence. Other operators remove the plugs from the green. Whichever practice is followed, mowing will generally pick up the pieces of grass and small plugs that have not been worked back into the surface of the green, so that

it is left in fairly acceptable condition. In some cases, it may be necessary to topdress with a better soil material than that which existed within the green.

One of the severe criticisms that the superintendent often hears from his members is that the greens are disturbed by cultivation at the very time that they are in the best condition of the season. It seems unnecessary to the golfer to disturb an excellent putting green by cultivation just at this time. It is important that golfers understand the need for this, because it is at the time when grass is growing best that cultivation can be done with the least amount of net harm. If the superintendent waits until the greens begin to slow in their growth and become poor, cultivation will leave its mark upon the green for a long time. If, on the other hand, cultivation is accomplished when the green is healthy and vigorous, the scars following the operation will be healed in a relatively short time and the green will recover completely within just a few days. Correct treatment of healthy grasses will often prevent their becoming sick later on.

It is expected that cultivation will come to be practiced with even less disturbance than accompanies it at the present time. However, the good that results from this practice so far outweighs the relatively small inconvenience that comes to the players that it is extremely important for golfers to appreciate the advantages resulting from the operation.

Turf management techniques have been revolutionized by the practice of cultivation with modern machinery. These developments tend to make the superintendent's job a little easier and his turf a great deal better.

Soluble, High Analysis Fertilizers — 1954

In November, 1950, an article appeared in the USGA JOURNAL titled "What about Liquid Fertilizers?" Our readers were urged to examine carefully the prices of liquid fertilizers in comparison to the conventional, dry-type fertilizers. It was pointed out that liquid fertilizers had some special

uses but ordinarily they could not hope to compete with conventional fertilizers in expense or ease of handling.

The picture has changed somewhat in the four years since publication of that article. The use of these materials has been increased remarkably by farmers, garden-