

tilizers was a slow one, due to some unfavorable factor. During the latter part of June and during July decomposition of these fertilizers was rapid and the grass became soft and succulent. Scald soon spread through this tender grass. Similar injury was observed on golf courses, and in many cases the strong odor in the vicinity of the greens testified to the rapid decomposition of the fertilizers which were applied even weeks before that time. Whether this sudden decomposition of the accumulated slowly available fertilizers was sufficient to release nitrogen and other foods too fast for the welfare of the grass is not definitely known. Many cases were observed which certainly might readily be explained in this manner. The checking of the spread of this injury by corrosive sublimate and calomel in some of the plots at Arlington, as is shown in figure 11, indicated that some living organism was responsible for the injury. Whether the actual damage was due to some unknown plant parasite which was able to destroy the grass under these particular conditions, or whether the corrosive sublimate and calomel held in check the microorganisms causing disintegration of these fertilizers, remains for future work to disclose. Attention is called to this injury at this time to warn readers against the indiscriminate repetition of applications of such fertilizers during seasons when it is obvious that the grass is not able to use these plant foods. If the grass does not respond to a normal application of such fertilizers it is probable that decomposition has not been accomplished, and further piling on of such material is not likely to aid the turf but is merely inviting disaster at any time that conditions become suitable for rapid decay. Cottonseed meal, soy bean meal, bone meal, and urea were some of the fertilizers that seemed to favor this particular type of injury.

SOME PRACTICAL APPLICATIONS OF THE FOREGOING OBSERVATIONS

It is recognized that observations and experimentation such as are detailed in the foregoing often appear extremely confusing to those who would like to put such findings into practical use. Many readers who have been struggling against small brown-patch will probably emit sighs of relief when they look at figure 1, for instance, only to have new hopes rudely strangled when they see an illustration of the results with this same fertilizer in figure 11. The individual who is looking for some simple cure-all for turf ailments will find little encouragement in this report, and it is probably safe to predict that such expectancy is most likely doomed for similar disappointment for many years to come. However, for those who are willing to admit that turf culture is a complex problem with consequently complex solutions, this report may serve some useful purpose in checking turf losses.

In interpreting these results it must be remembered that the tests were made at Arlington and that results with the same treatments may vary with different soil and climatic conditions. However, these tests are supported by observations on golf courses in widely different sections of the country. In working out a solution for any complex problem it is to be expected that contradictions will be relatively frequent. Time, with added hundreds of observations, will be needed to work out the many details and exceptions. Even if these observations were to serve no other useful purpose they would at least be of service in showing that some of the recent dogmas, like old ones, must be subject to revision if progress is to be made toward ultimate solution. All information must be given out in the light of

present knowledge, and what may seem the best treatment today may be found to be inadequate, or even harmful, when subjected to the tests that time alone can give. The original golf ball was replaced by the gutta and the rubber ball in turn. In spite of certain admitted advantages of its predecessor, a new implement or a new method is presented to meet changed conditions. Likewise changes must be made in greenkeeping practice, and it should be possible to make such changes without denying the merits of the methods replaced or modified. These perhaps superfluous remarks are inserted here to refute the attitude of many individuals who have watched these developments at Arlington during the past few years and who have hailed some of the results as a complete reversal of previous practices. To those who choose extreme interpretation, some of these results will seem to be reversals of previous reports, but to those who regard them critically and judiciously they will appear merely as modifications of earlier principles which will need further modification in the future as knowledge advances.

The phase of this report dealing with lime will no doubt prove of greatest interest and be of most practical use to clubs. The exclusive use of sulphate of ammonia as a fertilizer for putting greens during recent years now appears to be responsible for some of the difficulties in maintaining good greens. The undeniably beneficial effect of sulphate of ammonia on turf has led to overenthusiasm and overconfidence in its properties as a turf producer. Correlated with the overuse of sulphate of ammonia has been an overemphasis of the need for acid soils to produce fine turf. Although the finer turf grasses undoubtedly thrive in an acid soil, it now appears that excessive acidity can not be tolerated. These grasses may thrive in an extremely acid soil during certain seasons, but during the hot summer months on such soil they are more likely to be injured by brown-patch and scald.

To correct conditions brought about by excessive use of sulphate of ammonia an application of lime has been found to be effective. On the acid soil at the Arlington turf garden lime was found to increase the vigor of bent turf and greatly reduce the amount and severity of both large and small brown-patch as well as scald. When lime is applied to turf and increases the vigor of grass it follows that more clippings may be removed by the mowers and in consequence the fertility of the soil may be more rapidly depleted. To counteract this condition adequate supplies of fertilizer must be supplied if a vigorous turf is to be maintained. The use of lime alone or in excess will soon bring about a starved condition of the turf and lead to a condition more objectionable than that resulting from the opposite extreme.

Lime will not benefit all soils. On many courses the soil and compost used on greens have been abundantly supplied with lime. Sand containing a relatively high percentage of lime has been used in some regions, and in many cases the water supply contains sufficient lime to neutralize any acid applied in the normal use of acid-reacting fertilizers. In any such instance an application of lime would probably prove to be mere waste, or may even be harmful.

In these experiments there was nothing to indicate that the use of lime would preclude the use of sulphate of ammonia on turf. There has apparently been a tendency to overestimate the value of the acid reaction of soil brought about by sulphate of ammonia. Lime has been regarded as incompatible with acid-reacting fertilizers be-

cause it neutralizes acids. The acid theory, however, has never been any too well established, because the influence of nitrogen in the readily available form in which it exists in sulphate of ammonia has usually been confounded with soil acidity. Many of the benefits attributed to acidity have been observed on greens where sulphate of ammonia has been used repeatedly but where tests revealed that the soil actually was almost neutral. The residue of lime already in such soils and the use of hard water containing much more lime than necessary to neutralize the acid residue from sulphate of ammonia prevented any increased acidity of the soil. Nevertheless the enthusiastic users attributed the decided benefits to the acidifying of their soils, without further inquiry. Sulphate of ammonia has other virtues than its acid residue and these amply justify its continued use on golf courses.

There is nothing to indicate that the use of lime alone will entirely prevent brown-patch. Its use on certain soils in reasonable amounts, however, will undoubtedly reduce the extent of the brown-patch damage and will greatly lessen the amount of mercury fungicides required. To completely control both large and small brown-patch it will still be necessary to rely on the mercury fungicides.

There is no simple laboratory means for testing soils to determine exactly whether lime will prove beneficial. The degree of acidity tolerated by grass apparently varies in different types of soil. If grass fails to show the customary response to such fertilizers as sulphate of ammonia it indicates that soil conditions are unfavorable. Plugs of turf if sent to the Green Section office will be tested for acidity and suggestions will be given as to whether lime is likely to prove of benefit. In most cases the ultimate decision can best be made following some simple test such as that conducted on the Upper Montclair course as mentioned on page 91.

The use of organic fertilizers on greens apparently needs more attention than it has been given in the past. If a heavy application of such fertilizers is used and fails to produce the results that can reasonably be expected, such failure may be due to some unfavorable condition. If such be the case it should be apparent that further applications are apt to be likewise ineffective. If small amounts of food can not be digested and utilized, large amounts are no more likely to be beneficial whether the user be animal or plant. Large accumulations of unused foods on turf may prove disastrous if they are suddenly broken down and released for immediate use. If slowly available fertilizers fail to give the desired results at any time it would be well to use moderate amounts of some quickly available fertilizer, such as sulphate of ammonia or phosphate of ammonia. The color of the turf and amount of clippings removed from the greens are good indicators for guidance in the use of fertilizers.

APPLYING LIME TO TURF

In applying lime to turf it must be remembered that it, like any chemical, should be distributed evenly to prevent a mottled appearance due to overdosage in one place and shortage in another. It should be remembered also that, like any chemical, its use can be abused, and such abuse leads to burning and other injuries to turf. For those with long experience in turf work this warning is probably not necessary, since they can perhaps well remember the futility of the use of too much lime in the so-called "whitewash era" when greens regularly were coated with layers of lime. However, there