If you have a water system which covers the entire area, you can avoid this disadvantage. Apply the ammonium sulfate as suggested above and then water it in but this must be done at once or you will burn your grass badly. You must promptly wash this solution entirely off the leaves of your grass or you will injure the plants instead of helping them.

Avoid applying the solution to the borders of flower beds at the edge of the turf.

As a test, I sprinkled a patch 10 feet square with this solution last spring and did not water it in at all. It burned the grass so badly that it has taken six months of careful effort to get it right again.

Another DON'T is: Do not apply ammonium sulfate where you have seeded until germination has taken place and the young grass is at least a month old. Before that time the grass is too young and tender to stand the stimulant. It would be like giving cocktails to children.

A side-issue use of ammonium sulfate is as a weed destroyer. If you have thick patches in the lawn of such broad-leaved pests as chick-weed, creeping Charlie, or pennywort, scatter the ammonium sulfate over them dry in its powdered form; then sprinkle lightly with water—not enough to wash the ammonium sulfate off the leaves but just enough to dissolve it. It burns them badly, and while it will not kill them all it does discourage them mightily and gives your grass a chance to grow.

The great majority of lawns get so little nourishment that we can safely say most of them are starved; the grass has not enough food to flourish and increase and so the weeds come to fill in the vacant places. Ammonium sulfate would help such situations tremendously and I hope this method may prove as useful to others as it has to me. Even if it can not be used over the entire lawn, it will be found valuable for use in small areas where it is difficult to make grass grow, such as the heavily shaded spots or in places where there is a good deal of wear.

Additional Experiments in Grub-Proofing Turf

By B. R. Leach and J. W. Lipp

The usual steps in turf maintenance, such as planting, mowing, topdressing, etc., are the cause of no serious trouble to the average well-informed greenkeeper of today. On the other hand, the problems of controlling brown-patch, grubs, worms, etc., are still problems of serious import to even the best informed greenkeepers. Such a condition is due to the fact that the study of grass itself has progressed over relatively long periods, whereas the study of insect and disease control has been undertaken seriously only during the past few years. Promising methods have been developed, but considerably more research must be done before these methods are complete.

The Green Section has given considerable support in the last few years to research in insect and disease control. It would seem that the pushing of this field of research should constitute one of the major duties of the Green Section. It has come to a point where not the growing of turf but the keeping of turf after it is grown is of pressing importance and the cause of more financial loss than any other phase of green keeping at the present time.

Grub Control With Carbon Disulfide Emulsion

This method was originally worked out for the control of the Japanese beetle grub in turf but is now being extensively used in many sections of the country for the control of other grubs in turf. Eighteen tons of this material were used during 1926 at New Haven, Conn., for the control of the Oriental beetle grub in lawns. It has also proved satisfactory for the control of June beetle grub in lawns and golf greens. In short, the method has enabled greenkeepers to cope successfully with grub infestations formerly uncontrollable. Unfortunately the method is not simple and it is necessary for the operator to be thoroughly trained before undertaking the treatment of turf independently. In the hands of the experienced man the method is very efficient; in the hands of the inexperienced man the method is dangerous. Furthermore, while the carbon disulfide emulsion kills any grubs present in the turf at the time of treatment it gives no insurance against future infestation or injury. In the latter event another treatment must be made.

The Poisoned Soil Method

Several years ago, in view of the limitations of the carbon disulfide emulsion method in practice, the question of a simpler method was considered. As a result the work on the poisoning of soils was begun in 1921. Much information has been obtained and a greater knowledge of the factors involved has been secured. It now appears that the method offers a simple and fool-proof answer to the problem of controlling grubs and worms in turf. It is the purpose of this paper to give an account of the work and results to date and to indicate to the Green Section the points which should be cleared up by additional research along these lines.

Last year at the Green Section meeting in Chicago * the first account of this work was given. At that time it was pointed out that arsenate of lead, when mixed with the soil at the rate of 1,500 pounds per acre to a depth of four inches, had given control of grubs over a period of four years and that most golf course grasses grew well in soil so poisoned. Up to this year the field work was conducted on a small scale as is usually the case in the early stages of an experimental project. The results were so promising, however, that the field work this year was extended to take in about one-fourth acre of grass plats, each 10 by 10 feet. The results of this year's work are herein presented.

The Chemicals Used for Poisoning Soil

Arsenate of lead: Experiments have been conducted with this material during the past five years. It is a standard insecticide of commerce, used in many phases of agriculture such as the spraying and dusting of fruit trees, vegetables, etc., and can be purchased from almost any agricultural supply house. It has been selling for 14 to 15 cents per pound in 500-pound lots. It is a white, fluffy, insoluble powder, readily mixed with soil. Since the compound is insoluble it can not be washed into the soil.

Barium silicofluoride: Another compound which has been under experimentation for the past two years is barium silicofluoride, a white insoluble powder made from a by-product of the acid phosphate

* See Green Section Bulletin, February, 1926, pp. 34-39.

industry. The laboratory work resulting in the discovery of this material and its value as a soil poison for grubs was carried out by Mr. Lipp in the course of a study in which more than 30 compounds were tested for their value in this connection. A report of this laboratory work with barium silicofluoride will shortly be published. During the past year extensive field tests with barium silicofluoride have been carried out by the writers and at present the material looks promising from many angles. As yet, however, the results are not conclusive enough to warrant making any recommendations regarding its use in practice. Judging by the results so far obtained, it would appear that barium silicofluoride is worthy of extensive testing in those sections of the country, particularly the far west, where the soils are inclined to be alkaline in nature. Whether it will be equal or superior to arsenate of lead in the eastern and middle sections of the country can not as yet be said.

Another result of Mr. Lipp's work on arsenical substitutes was the discovery that mercurous chloride, commonly known as calomel, was also very toxic to the grub in the soil. Unfortunately the compound is too expensive ($1.30 per pound) to be used as a grub poison, but it was felt that it might have some value for the control of brown-patch. The writers have accordingly some plats of creeping bent at Riverton growing in poisoned soil, the plats having received several topdressings during the season, said topdressings being poisoned with arsenate of lead and calomel. These results are very interesting in view of Montieth's* work during the past summer showing the value of calomel as a control for brown-patch.

The Experimental Plats

Moorestown, N. J. The plats at Moorestown were established and planted in the early part of September, 1925. An account of them was published in the February, 1926, number of THE BULLETIN of the Green Section. They consist of poisoned and unpoisoned plats of creeping bent, perennial rye, German mixed bent, Chewings fescue, sweet vernal grass, Canada bluegrass, Kentucky bluegrass, *Poa trivialis* and meadow fescue. The results during the past year with these grass plats have been excellent and the grass growing in the poisoned soil has at all times been superior to that in unpoisoned soil, with the exception of *Poa trivialis* and Canada bluegrass. The absence of grubs and worm casts in the poisoned soil plats is pronounced as compared with the unpoisoned soil. These plats have not been weeded during the past season. The unpoisoned plats were heavily infested with weeds while the poisoned plats were virtually free from weeds. The results indicate that poisoned soil has a decided value from the standpoint of weed control.

Riverton, N. J. The grass plats at Riverton, begun in the spring of 1926, cover about one-quarter of an acre and include over one hundred plats each 10 feet by 10 feet in size. The experimental ground is located in the rough near the ninth tee. The land was ploughed and harrowed early in April and a coat of mushroom soil applied. Incidentally this was probably the first plowing this piece of land had received in the last 20 years. After leveling, the land was divided into plats and each plat given the treatment called for in the general plan of experimentation. Owing to the difficulty of securing

* See Green Section Bulletin, October, 1926, pp. 221-226.

certain chemicals and the necessity of manufacturing them in quantity in the laboratory, the work of seeding and the planting of stolons was delayed until the middle of June. As a result of this late seeding and the subsequent hot summer, the stand of grass, especially the seeded area, was nothing to boast about, and even today the German mixed bent plats are bare in spots. This of course will be remedied. The creeping bent plats with few exceptions have filled in beautifully. At the present time the various plats are in such condition that the experimental results are obvious.

Plan of the Experiments

Roughly speaking, the plats are divided into two classes: (1) Plats in which the soil was poisoned to a depth of 2, 3, or 4 inches with arsenate of lead or barium silicofluoride before the grass seed or stolons were planted. These plats received topdressing which is itself also poisoned. (2) Plats which were not poisoned previous to planting but which have been topdressed with soil containing poison. For the purpose of comparison so-called check plats are scattered at intervals throughout the area which have received no poison at all, either before planting or in the topdressing.

As an indication of the scope of these tests it may be said that arsenate of lead at the rate of 1,500 pounds per acre has been put into plats to a depth of 2, 3, and 4 inches, also 750 pounds to a depth of 2 inches and 1,125 pounds to a depth of 3 inches. A series of plats as outlined is planted to German mixed bent seed and a duplicate set planted to creeping bent stolons. This entire layout of plats poisoned with arsenate of lead has been duplicated, using barium silicofluoride instead of arsenate of lead. In addition a series of plats, unpoisoned to begin with, has received topdressings throughout the season containing various amounts of the poisons. Let it be understood at this point that no plat contains both arsenate of lead and barium silicofluoride. The two compounds have been kept distinct and apart.

Another phase consists in treating poisoned and unpoisoned plats of both grasses with such fertilizers as ammonium sulfate, ammonium nitrate, synthetic urea, etc. As stated above, other series of plats, poisoned and unpoisoned, have been treated with calomel.

Does the Poisoned Soil Method Fit in With the General Scheme of Turf Maintenance?

The management of the golf green is a complicated affair from both the practical and chemical angles. In the latter respect it involves the use of animal manures, stimulating fertilizers such as ammonium sulfate, and mercury compounds for the control of brown-patch. It is fairly obvious that the introduction of another step in this already complicated chemical scheme must be very carefully considered in order that no chemical incompatibility may arise.

From a theoretical standpoint, at least, arsenate of lead is admirably fitted to be used in soil for grub control without interfering with other chemical steps in green keeping and without the lead arsenate in turn being affected. Experimental work conducted during the past five years shows that when arsenate of lead is applied to ordinary ground at the rate of 1,500 pounds per acre, 500 pounds or one-third of the total amount is broken down chemically, resulting in the forma-

tion of some soluble arsenic and a basic arsenate which is non-poisonous to the grub. It is pretty generally recognized that such fertilizers as phosphates, potash salts, and calcium compounds hasten the breakdown of arsenate of lead in soil when they are present in more than normal amounts. Fortunately, from the golf course angle, these chemicals have not been found essential or desirable in the growing of good turf, so that their action in the above respect is not of serious moment. Such fertilzers as ammonium sulfate, nitrates, etc., are not believed to exert any chemical action on arsenate of lead, while the mercury compounds, themselves toxic to grubs in a measure, exert in all probability only a slight chemical action on arsenate of lead. It may be said at this time that extensive work is being done by the writers to determine the ultimate effect of all these materials upon arsenate of lead and barium silicofluoride. We have no reason to believe at this time that any of the present recommended fertilizers or brown-patch treatments will fail to prove compatible with arsenate of lead, with the possible exception of ammonium phosphate.

Effect of Arsenate of Lead on Greens

As stated above, when arsenate of lead is mixed with the soil of a golf green at the rate of 1,500 pounds to the acre (3½ pounds per 100 square feet) one-third of the poison is acted upon by the soil, resulting in the formation of soluble arsenic and a basic arsenate which is non-toxic to the grub. This chemical reaction all takes place within a few weeks. At the end of this time a chemical equilibrium is established and the remainder of the arsenate of lead remains in the soil apparently unaffected. It is this unaffected arsenate of lead thoroughly mixed in the soil which causes the mortality of the grubs and worms. Experiments show that turf so poisoned remained grub-proof over a period of five years. How much longer this will continue we are unable to say at this time.

Effect of Arsenate of Lead Upon Grass

The fact that a portion of the arsenate of lead applied to the soil undergoes a chemical change, resulting in soluble arsenic, gives rise to a soil condition unsuitable for the growth of many plants. Grasses, however, particularly the bents, are an outstanding exception. Experimental work covering three years shows that, far from being injured by the arsenate of lead, these grasses are actually stimulated by the presence of this material in the soil. Bent grass growing in the poisoned soil is more vigorous and dense and has a better color than that growing alongside in unpoisoned soil. The result would seem to indicate that in the case of poisoned turf the use of nitrogenous fertilizers will not be necessary to such a great extent. Unfortunately the superiority of the grass growing in poisoned soil can not be shown by photographs. It is necessary to see the actual turf to appreciate the difference.

Weed Growth in Poisoned Soil

The term "weed" as used in this connection refers to any plant growth whose presence is undesirable in fine turf. Among those which may be mentioned are crab grass, chickweed, dandelion, sour dock, etc. Most of these weeds do not grow well in poisoned soil.

They are stunted in their growth and the percentage of the germination of weed seeds is very small. The poisoned plats at Moorestown, planted in the fall of 1925, were not weeded during the growing season of 1926. Practically no weeds were present in the poisoned plats at any time during this growing season, whereas the untreated plats alongside were heavily infested with chickweed, crab grass, and dandelion. The results indicate that the poisoning of turf will result in the reduction of the bill for weeding in the course of the season.

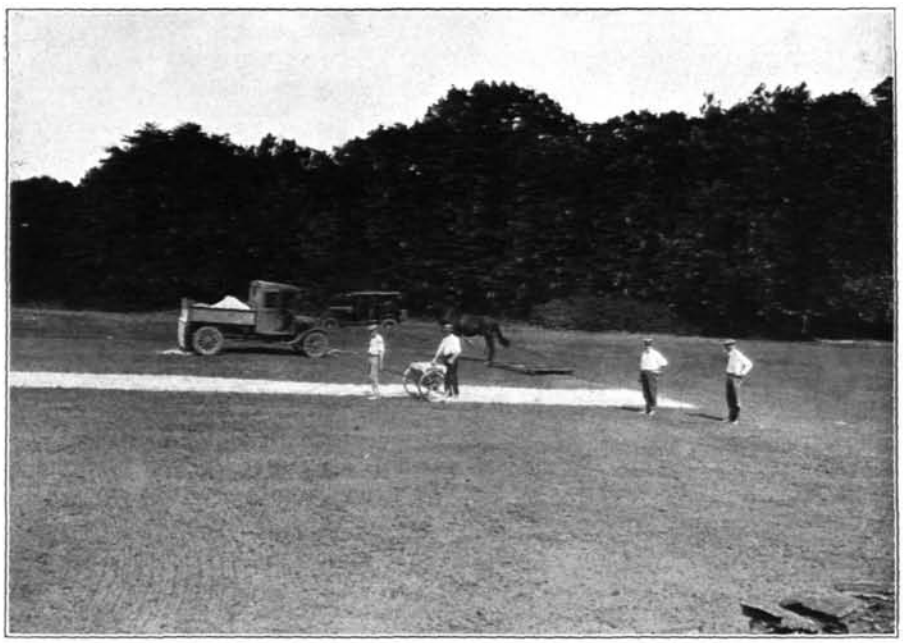
View of experimental plats at Riverton C. C., October 1, 1926

The Method in Practice

The Building of a Poisoned Green

The plowing, application of compost, disking, smoothing, contouring, and other steps prior to the planting of the seed or stolons should be carried out in the usual way. The area of the green should then be calculated accurately. Let us suppose that the area of the green in question is 5,000 square feet. For this area 175 pounds of arsenate of lead (3½ pounds per 100 square feet) should be thoroughly mixed with a cubic yard of dry soil or sand. The use of heavy clay or loam is not advisable. Begin by mixing the entire amount of arsenate of lead with about one-quarter of the cubic yard of soil. This should be done by spreading the soil in a layer on a hard (preferably concrete) floor, spreading the arsenate of lead on top of the soil layer and turning the mixture over several times with shovels until the poison has been thoroughly mixed with the soil. Spread this mixture on the floor in turn and cover it with one-half of the amount remaining of the original cubic yard of soil and again mix thoroughly by

turning over with the shovel. Spread this mixture out again and add the remainder of the original cubic yard of soil, and mix as before. If properly done this should result in a cubic yard of soil evenly impregnated with the arsenate of lead. There is some labor connected with this operation, but it has been found necessary in practice for the following reasons: (1) Arsenate of lead is a light, fluffy powder and any attempt to dust it on the surface of the soil results in a large loss due to its blowing away. (2) It is a very difficult matter for the novice to apply 3½ pounds of arsenate of lead evenly to 100



Applying poison to green with topdressing spreader

square feet. For these reasons the arsenate of lead is mixed with the soil first, thereby preventing the loss by blowing and giving a large bulk which can be spread over the surface to be treated with less chance of error. In this connection please remember that the poison must be evenly distributed over the area to be poisoned. Any carelessness in this respect will result in a spotty, uneven control of the grubs.

Having mixed the arsenate of lead with the soil as outlined above, it should be carried by truck to the green in the process of construction. It can be applied to the surface of the soil by hand or by machine. If it is done by hand, divide the green off into 6 or 8 strips of approximately equal area and spread the poison out of buckets. After one strip has been covered it is usually possible to tell whether it is being put on in the right proportion by comparing the area treated and the amount used with the area left to be treated and the amount of poisoned soil left in the truck.

Another and decidedly better method in large scale operations involves the use of a topdressing spreader. Adjust this machine so that

it will feed as lightly as possible. Starting on the outer edge of the green, run the machine around the green, gradually working toward the center. Watch the area already covered and the amount of material left, so that there will be no danger of running short before the total area is covered. Any poisoned soil left, after the whole green has been covered in this way, should be scattered over the green by hand. As soon as it has all been spread on the surface the material should be worked in to a depth of 3 inches with a disc harrow. Do not set the discs so that they will go deeper than 3 inches and be sure that

Disking in the poison

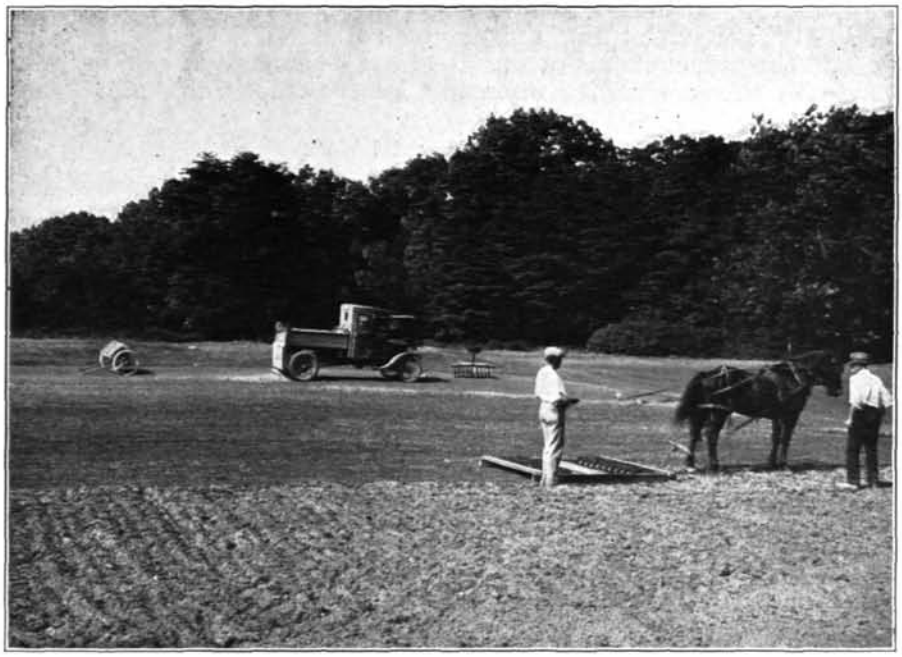
the driver laps each time so that the green will be left fairly smooth. This disking should be done both ways across the green. After disking, harrow with a spike, spring-tooth, or, preferably, a Meeker harrow. When properly used, these implements leave the green smooth. The green is now ready for seeding or planting stolons. If stolons are used, they can be covered with ordinary, unpoisoned soil, since only a light covering is used.

Of course, all contouring of the green should be done before the poison is applied. This is fairly obvious when one considers that the finished job calls for the upper three-inch layer *all over the green* to be impregnated with the poison. If the contouring is done after the application of the poison it means that this three-inch poisoned layer will be removed in places, leaving these places devoid of poison, and heaped up on places already having a poisoned layer.

In the last analysis, all that is required in a seemingly complicated operation of this sort is a clear mental picture of the ultimate results desired and the judicious use of common sense. The method as outlined above is not theoretical but is the result of extensive experience in building poisond greens at the Riverton Country Club and at the

new course of the Huntingdon Valley Club at Willow Grove, Pa. The Riverton Club has finished three poisoned greens. The remaining 15 greens will ultimately be poisoned according to present plans. All the greens, 28 in number, at the new Huntingdon Valley course have been poisoned. Several other clubs in the vicinity of Philadelphia are experimenting with this new method.

The handling of these greens in the future will be the same as that of the unpoisoned greens, except that all topdressings must contain poison.



Smoothing after disking

Topdressing With Poisoned Soil

The above discussion has considered only the question of greens poisoned prior to planting, but it is fairly obvious to us, as a result of conferences and meeting with golf maintenance authorities, that the question of being able to secure protection from injury by grubs and worms by means of topdressing with poisoned soil is of great importance. This is the case because the average club with reasonably good greens is not desirous of tearing up, poisoning and replanting. For this reason a great deal of experimental work has been done the past season in the topdressing of turf already established, but unpoisoned. In these experiments arsenate of lead, at the rate of 5 pounds per cubic yard of soil, was applied to turf twice a month uring the growing season. The application resulted in the stimulation of the growth of the grass and at the present time there are few or no worm casts on these plats as compared with the untreated plats.

In order to preserve the appearance of the plats no diggings have

been made to ascertain the grub population, but the appearance and condition of the grass seems to indicate that there has been no grub injury as compared with the check, or untreated plats. Frankly, it is too early to tell whether or not one year's topdressing with poisoned soil will give a grub and wormproof top layer. But if the results in worm control are any indication, it is possible that the continued topdressing with poisoned soil will attain this desired result in the course of two or three years.

In topdressing greens which were poisoned to a depth of three inches before planting, use 2½ pounds of arsenate of lead per cubic yard of topdressing. In topdressing greens which have not been poisoned prior to planting, use 5 pounds of arsenate of lead per cubic yard. The poison should be mixed with a small bulk of soil and then gradually mixed with the remainder of the cubic yard, as outlined above.

Future Experimental Work

Extensive work is now under way on the compatibility of fertilizers with these soil poisons. This work, as well as the work of testing the compatibility of the mercury compounds with these poisons, should be continued. At least one year's work, and probably two years' work, will be required in order to obtain all the necessary data on these points.

The question as to whether a grubproof layer can be built up, on a green already established, by means of topdressing with poisoned soil can not as yet be definitely answered, although the experimental results to date appear favorable. This question can not be entirely answered by means of small experimental plats. Fortunately the greens at the Riverton Country Club and at other country clubs near Philadelphia which are receiving these poisoned soil topdressings can be kept under observation until the desired data are obtained.

During the past year some very interesting results in controlling the June beetle with poisons have been obtained. Observations and results indicate that a method can be evolved whereby this insect can be controlled at a low cost for labor and materials. In view of the promising outlook experimental work along this line should be continued.

ANNUAL REPORT OF THE CHAIRMAN OF THE GREEN SECTION OF THE UNITED STATES GOLF ASSOCIATION FOR THE YEAR 1926

TO THE MEMBERS OF THE GREEN SECTION:

That an organization should suffer such misfortune as the Green Section has during its sixth year and still function efficiently speaks well for its vitality and usefulness. In the loss of its former Chairman, Dr. C. V. Piper, the Green Section has been dealt a blow from which complete recovery is doubtful, and must at best be slow. The long, though temporary absence of his colleague and successor, Dr. Oakley, has of necessity placed a burden on untried shoulders.

Nevertheless, the Green Section's sixth year has been one of accomplishment and growth. Gratifying progress has been made in the control of brown-patch, and previous years of work in the grub-