ants are concerned, however, we should perhaps state that we have conducted no experiments, but Hugh I. Wilson, of the Merion Cricket Club, has done considerable experimenting with this method in the control of ants, and we understand he has discarded his other methods in favor of this one.

The cotinus, or June beetle—the one which in the late summer throws up mounds of earth on the green—is essentially a different insect to control.[1] We have said that this method will kill any of these species which are in the ground at the time the treatment is applied; but the eggs of the cotinus are laid everywhere—not only in the greens, but around the greens. As the grub of the June beetle gets larger, it comes up at night and pushes along on its back. It will travel many feet in the course of a night, so that while you may get the few cotinus grubs which are in the green, there are many outside which you will not get. We have often thought that the cotinus problem should be approached from another angle; and we believe it could be solved if the proper research were done on it; but, of course, the various phases of the Japanese beetle are now occupying all the time of the force at our Riverton laboratory. At present the only remedy we know is kerosene emulsion, which works well in limited areas.

We have also been asked whether the carbon disulfid treatment will kill earthworms. It would not be economical to use the method for this purpose. In all probability the best remedy for the presence of earthworms is some corrosive substance, such as corrosive sublimate.

Grass Experiments at Rothamsted, England

By C. V. Piper

At the Rothamsted Experiment Station, near London, England, an extensive series of experiments in the fertilizing of grass-lands has been carried on continuously for nearly 70 years, that is, since 1856. Specifically the tests are on a clay loam soil and the results are measured in hay yields. While the maintenance of grass-land for hay crops is not the same thing as its upkeep for producing turf, nevertheless the Rothamsted work is not without bearing on greenkeeping. It must be borne in mind that the results of parallel experiments in fertilizing differ with the soil and with the climate; also that the effect of fertilizers on such hay grasses as timothy and orchard grass does not directly concern golf courses. It is also to be remembered that there are many English plants that do not occur in America, and vice versa. Naturally the behavior of such plants can not be compared for the two countries. But with these limitations borne in mind, the Rothamsted results nevertheless carry lessons of high importance in the growing of golf turf.

These results are presented in a very technical book entitled "Manuring of Grass-Land for Hay" by Winifred E. Brenchley. The word manuring in England, it may be said, means the use of any kind of fertilizers, and not only of dung, as is the common significance of the word in the United States.

The data are presented first in the form of tables displaying the effects of each type of fertilizer on the mixed population of grasses and weeds that covered the land when the experiments began. The different fertilizer treatments were as follows:

1 The control of the June beetle is discussed at length in the articles beginning on page 60 of the April, 1921, Bulletin, Vol. I, No. 4.

(1) No manure.—Unmanured since 1855; unmanured since 1864, after barnyard manure; unmanured, after ammonium salts.

(2) Mineral manures.—Mixed mineral manure; mineral manure without potash; mixed mineral manure, after ammonium salts; mixed mineral manure, after sodium nitrate; superphosphate and potassium sulfate, after ammonium salts; calcium superphosphate.

(3) Sodium nitrate with and without mineral manures.—Sodium nitrate; sodium nitrate (275 pounds per acre) and mixed mineral manure; sodium nitrate (550 pounds per acre) and mixed mineral manure.

(4) Ammonium salts with mixed mineral manure.—Ammonium salts (400 pounds per acre) and mixed mineral manure; ammonium salts (400 pounds per acre) and mixed mineral manure without potash; ammonium salts (600 pounds per acre) and mixed mineral manure; ammonium salts (600 pounds per acre) and mixed mineral manure with sodium silicate.

(5) Ammonium salts alone or with incomplete mineral manures.—Ammonium salts alone, after barnyard manure; ammonium salts and calcium superphosphate; ammonium salts and mixed mineral manure without superphosphate.

The second part of the book relates to the behavior of each kind of grass or other plant as illustrated by its response to the treatments on all the plats. It is this part of the book which is of most interest to golfers, and especially as it relates to grasses used on golf courses. The results correlate so closely with experiments in this country that they must be regarded as highly significant. Some of the more important of these results, from the standpoint of golf grasses, are given below, followed by comments by the editors of THE BULLETIN. The editor's comments are printed within brackets [ ].

MOSSES.—The ingress of mosses was very marked on the unfertilized plats and was quite evident on those treated with chemicals only. Moss was discouraged by lime, by nitrogenous chemicals, and by organic manures.

[The use of lime on golf turf is undesirable, primarily because it encourages too many weeds. In the United States, mosses rarely appear in turf which is kept fertilized with nitrogenous fertilizers; lime is far less effective in the Arlington experiments.]

RHODE ISLAND BENT.—This grass, so important on northern golf courses in the United States, showed very marked decrease on most of the limed plats, and was not encouraged by the use of phosphates or by heavy dressings of mixed fertilizers containing phosphates and potash. It remained conspicuous on the starved soils and was more abundant on the plat treated with organic manures and on those receiving light dressings of mixed fertilizers.

[These results agree with American experiments, which show that lime is very injurious to the grass and that phosphate alone and potash alone are somewhat injurious. Acid fertilizers only should be used, especially ammonium sulfate, but barnyard manure and good compost (without lime) are desirable to use in addition.]

SWEET VERNAL GRASS.—At Rothamsted, sweet vernal grass was crowded out on the plats well fertilized with nitrogenous manures, and it was usually reduced by liming. Where ammonium salts were used, sweet vernal grass, Rhode Island bent, and the fescues were dominant. Sweet vernal grass did best on well-manured soil on which acid conditions prevailed.

[This grass occurs abundantly on some American golf courses, especially on poor soils over the northern half of the United States. Observations on this grass in the United States indicate that it behaves quite as in England, but certain American plants which do not occur in England are always present where sweet vernal is abundant.]

SHEEP'S FESCUE.—Sheep's fescue was discouraged or almost suppressed by complete mineral fertilizers. It was usually encouraged by keeping the soil starved, much so by ammonium sulfate and somewhat by organic manure. This grass was present generally in some abundance, except in the heavily fertilized plats. It was always abundant on the plats where Rhode Island bent and sweet vernal were plentiful. Generally speaking, ammonium sulfate is the best fertilizer to use.

[Sheep's fescue is perhaps the most desirable of all grasses for the rough and for cops and steep slopes. It is not desirable in fairways. If fertilized at all, ammonium sulfate gives best results.]

VELVET GRASS.—Velvet grass (not velvet bent) was entirely suppressed by the use of heavy dressings of sodium nitrate or of complete fertilizers. Liming usually effected a marked decrease. Potash also discouraged the grass. The grass was greatly encouraged by heavy dressings of nitrogenous fertilizers, especially ammonium sulfate with phosphorous and potash included.

[Velvet grass is very abundant on the Pacific Coast and makes a satisfactory fairway turf, even if pale and not attractive. On putting greens it is a nuisance, but can be kept in check by the radical method of cutting out the grass and replacing with good turf. From the Rothamsted results it would appear that it could be kept out by using either sodium nitrate or lime, but both of these injuriously affect the bents and red fescue. Apparently it is the best practice in America not to use lime or sodium nitrate on putting greens, but to remove the velvet grass bodily.]

KENTUCKY BLUEGRASS.—In the Rothamsted experiments, this grass was encouraged on all the plats which were limed, and was discouraged by the omission of lime. It was not much affected by fertilizers, except phosphates and ammonium salts.

[In our experiments at Arlington Farm, bluegrass turf seemed entirely unaffected by lime. At Rothamsted, however, they measured the results by the hay yield, not by the turf. In the Rhode Island experiments, the alkaline fertilizers gave more hay on most of the plats, but the acid plats produced the finest turf. It may be that the plats of bluegrass at Arlington which were limed would have produced more hay, but the lime apparently did not benefit the turf at all.]

WHITE CLOVER.—White clover was most abundant on plats fertilized with chemicals only. It was suppressed on plats treated with ammonium sulfate; with barnyard manure and fish guano alternately; and with sodium nitrate. The results of liming were uncertain.

[Our American data show that the use of ammonium sulfate is a perfectly effective method of discouraging white clover. Lime should not be used.]

WEEDS.—Many of the weeds recorded in the Rothamsted experiments are tall-growing species, which do not survive under continuous mowing. Such are not discussed here. Buckhorn or plantain is encouraged by starvation and by sodium nitrate. It is entirely suppressed by using ammonium sulfate; or by using barnyard manure and fish guano alternately. It seems to be decreased by liming. Sorrel seems to be encour-

aged by organic manures and ammonium salts and not encouraged by starved soils, sodium nitrate, or heavy manuring. On very acid soils it is discouraged by liming. [In the United States, sorrel seems conspicuously a plant of the poor soils. It is rarely troublesome in putting greens. On fairways it is usually on the starved spots.] Grass-leafed chickweed, at Rothamsted, was discouraged by ammonium salts and was encouraged by liming. [This weed is becoming increasingly plentiful on American golf courses, especially on putting greens. Apparently the best remedy is ammonium sulfate.]

SUMMARY.—In general, the Rothamsted results uphold the methods on golf courses now generally followed in America. Considerable allowance must be made in some cases, as the Rothamsted results are based on hay yields, not on the quality of the turf. This point deserves emphasis, as many greenkeepers assume that methods which are desirable in raising different crops, should be equally desirable in growing turf. No greater error can be made than to use such reasoning. If it were true, all plants should occur under any given condition in nature, and furthermore all plants should presumably be cultivated by the same methods. The fact that experiments on grain and hay crops do not necessarily apply to turf culture is not at all a criticism on the records of scientific agriculture. Nearly all of such contributions refer to crops and to some other end-result than turf. If one wants good crops of red clover or alfalfa, ordinarily lime must be used. If one is growing rhododendrons, lime, if used, is nearly always fatal.

QUESTIONS AND ANSWERS

All questions sent to the Green Committee will be answered in a letter to the writer as promptly as possible. The more interesting of these questions, with concise answers, will appear in this column each month. If your experience leads you to disagree with any answer given in this column, it is your privilege and duty to write to the Green Committee.

While most of the answers are of general application, please bear in mind that each recommendation is intended specifically for the locality designated at the end of the question.

1. RIDDING TURF OF MUSHROOMS.—We are sending you a specimen of mushrooms which at times are abundant in our turf and are exceedingly objectionable. We shall be glad to have your recommendations for getting rid of them. (Minnesota.)

Answer.—The mushroom you send is the most common of the fairy-ring fungi and is technically called *Marasmius oreades*. One of the common recommendations for destroying this mushroom is the use of iron sulfate in the strength of 1 pound to 1½ gallons of water, making 3 applications at intervals of 2 weeks. We are not certain, however, that this procedure will be advisable where the question of saving the turf must be considered, as there is a possibility that the iron sulfate will kill the grass also. We would therefore suggest that you experiment with it first on a small scale before undertaking a general treatment. Another plan would be to treat the mushroom growths heavily with Bordeaux mixture. This will not destroy the grass and will probably kill out the