TIMELY TURF TOPICS

Issued By The

UNITED STATES GOLF ASSOCIATION GREEN SECTION

ROOM 307, BUILDING 4
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BELTSVILLE, MD.

GROWTH-REGULATING SUBSTANCES GIVE PROMISING RESULTS AS TURF HERBICIDES: It has been recognized for numerous years that the turf grasses are not so sensitive to growth-regulating substances as are many other plants. In the November, 1940, issue of TURF CULTURE an article was published summarizing the various attempts on the part of the Green Section staff to stimulate turf grasses with growth-regulating substances of various sorts. Regardless of whether applications were made to established turf, to stolons, or to seed, no noticeable results could be observed as the result of applications of any of the several compounds tried. It was not, however, until August of this year that the possible advantage of this lack of sensitivity was recognized. The particular compound (2, 4-dichlorophenoxyacetic acid) with which the experiments to date have been concerned is only one of many such compounds. It, however, is one which is easily manufactured, is relatively inexpensive and to which many of our common weeds are decidedly sensitive. Moreover, fair stocks of it are already available in the hands of the manufacturers.

When weeds which are sensitive to 2, 4-dichlorophenoxyacetic acid are sprayed with 0.1%, and in some cases .05%, solutions of it the compound is absorbed by the weeds through their leaves and often within 48 hours the first modification of growth of the weeds is evident in growth curvatures. These are particularly conspicuous in plants such as narrow-leaf plantain or dandelion and less so in the small-leafed plants such as clover, heal-all and lawn pennywort. This curvature stage is followed by a yellowing of the leaves which, when the rate of application is sufficiently high, eventually turn brown and completely disintegrate. Applications made in late August and early September required from 1 to 3 weeks for death to take place, depending on the weed involved and also the growing conditions. Obviously, since ultimate death depends on a modification of the growth of the plant, quickest results may be expected from applications made at a time of year when the weeds in question are growing most rapidly. Narrow-leaf plantain treated after the middle of October has been much slower to react to the chemical than it was when treated early in September. It is conceivable in fact that many of the plants may not die until growth is resumed next year. As a matter of fact, experiments are under way at present to determine whether or not applications made in late fall and winter when labor is available (so long as the foliage of perennial weeds is still present to absorb the chemical) may be effective next spring when growth of the weeds is resumed.

As has been indicated, plants vary widely in their sensitivity to growth-regulating substances in general and to 2, 4-dichlorophenoxyacetic acid in particular. Kentucky bluegrass is the most resistant of any of the turf grasses so far treated, showing no injury even when cut at 1-inch height. There is some indication of slight sensitivity of fescues and more of creeping bent when cut at putting green height. Experiments have indicated that applications to putting green turf in early fall cannot be at a concentration greater than .05%. The number of applications and the frequency at which they can be made without serious injury to the bent have not as yet been determined. Tests have not as yet been made on Bermuda grass turf cut either at fairway or putting green height.

Of the weedy grasses and weeds so far observed in treated turf crabgrass shows no sensitivity whatsoever; goose grass gives only a slight reaction; wild garlic has given no reaction; broad-leaf plantain, Ajuga reptans, and several species of Antennaria have

given only very slight reactions; clover, knotweed, dandelion and narrow-leaf plantain have been very effectively controlled with single applications of the 0.1% solution at the rate of 5 gallons to 1,000 square feet; whereas heal-all, chickweed and lawn pennywort have been effectively controlled with the .05% solution applied at the rate of 5 gallons to 1,000 square feet.

It should be remembered that these experiments have been conducted primarily during the month of September. It cannot now be predicted with certainty what may be the results from applications made at other times of the year. Most of the turf applications have been made by means of a fine spray. It is important that the spray be uniformly distributed and a satisfactory coverage of the vegetation obtained. At the same time, until further experiments can be conducted, it is advisable not to wet the soil with the spray since very little is known to date concerning the effect which this material may have on the soil when applied at these rates. A sizable series of 10x10-foot plots has been established, however, to determine what, if any, may be the results of applying the growth regulator dry either mixed with sand or fertilizer to weed-infested turf. The effect naturally has been much slower in becoming evident and no conclusions can be drawn from this test until next season.

When applied in spray to turf which is severely infested with one or more weeds the treatment should be accompanied by an application of fertilizer and seed. Tests have shown that the seed and fertilizer can be applied to the weed-infested turf and topdressed lightly to cover the seeds to some extent, immediately before the turf is sprayed with the 2, 4-dichlorophenoxyacetic acid. In one series of experiments directed to clover control, a careful study of plugs of turf taken from the seeded portions of both the treated plots and the untreated checks showed a greater number of seedlings in the plots which were sprayed than in the ones which were not sprayed. This may well have been due to the fact that the seedlings could not become established in the already densely populated soil on the weed and clover-infested plots. When the undesirable vegetation was removed by the 2, 4-dichlorophenoxyacetic acid, however, the development of the germinating seedlings was not restricted by competition with established perennial plants.

As indicated elsewhere in this issue, to apply 2, 4-dichlorophenoxyacetic acid at the rate of 5 gallons of a 0.1% solution to 1,000 square feet requires 1-3/4 pounds of the growth regulator and 8 pounds of the Carbowax to be used as a carrier and spreader.

One of the manufacturers has indicated that "at the present time the price on 2, 4-dichlorophenoxyacetic acid ranges from $.85 to $1.10 per pound." Figuring on the basis of a cost of $2.00 a pound for the 2, 4-dichlorophenoxyacetic acid in order to allow amply for the cost of handling, freight, etc., before the material reaches the consumer, the cost for one application at the heaviest recommended rate would be $3.50 per acre. The cost of the Carbowax 1500 when purchased in 510-pound lots (55-gallon drums) is at present 30¢ a pound, f.o.b., South Charleston, W. Va. Allowing for the added cost of freight, it is estimated that the cost of Carbowax may be on the average about $2.75 an acre, bringing the total cost per acre of materials to $6.25. Lists are being compiled at present of the various manufacturers which are in a position to manufacture 2, 4-dichlorophenoxyacetic acid.

LAWN PENNYWORT CONTROL: Lawn pennywort (Hydrocotyle rotundifolia) has been found to be an extremely difficult weed to control with the customary herbicides. With 2, 4-dichlorophenoxyacetic acid, however, it is relatively easy to kill. Applications of 2, 4-dichlorophenoxyacetic acid at the rate of 5 gallons of .05% solution to 1,000 square feet killed all of the established lawn pennywort in turf in which it was present to the extent of 80% of the entire plant population. However, since lawn pennywort seeds prolifically subsequent treatment will be necessary to kill the seedling plants as soon as the seedling leaves are sufficiently large to absorb the chemical. Equally satisfactory results were obtained with 2½ gallons of 0.1% solution as with the 5 gallons of .05% solution as long as uniform coverage was secured. When the lawn pennywort has succeeded in crowding out the turf grasses to the extent that it had on the areas under test, applications of seed and fertilizer must accompany the eradication program in order to establish a satisfactory turf as soon as possible and thereby insure against subsequent invasion of other weeds.

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CLOVER CONTROL IN TURF: Clover is frequently considered to be a desirable component of turf on private lawns, parks, cemeteries, etc. On golf courses, however, it is a turf weed of the first magnitude. Moreover, wartime curtailments in maintenance programs in general have served to encourage rather than discourage the development of clover, with the result that its control is rapidly becoming one of the leading maintenance problems on both greens and fairways.

Unfortunately many of the accepted turf herbicides are not so effective against clover as they are against some of the other troublesome turf weeds such as crabgrass, chickweed, etc. It is extremely difficult to apply these materials at rates sufficiently high to burn the clover seriously without also injuring the permanent grasses at least temporarily. The principle on which these herbicides operate is that of plant starvation, accomplished by judicially burning the foliage at short timely intervals. If this starvation of the clover plants is accompanied by a fertilization and seeding program designed to encourage the grass to crowd out the gradually starving clover plants a reasonable control can eventually be effected. For many years sulfate of ammonia has been the accepted remedy for removing clover since, in addition to burning the clover leaves, it supplies a readily available source of nitrogen to the grass plants, thus enabling them to compete more successfully with the clover. Also it makes the soil more acid and this in itself discourages the clover.

The Green Section is particularly happy at this time to report recent tests which have been made here in Washington in collaboration with Drs. John W. Mitchell and Paul C. Marth, of the Bureau of Plant Industry, Soils and Agricultural Engineering, which demonstrate the effectiveness of a plant growth regulator known chemically as 2, 4-dichlorophenoxyacetic acid, in the selective control of clover in fairway turf. This material operates on an entirely different principle from previously used herbicides. Instead of depending on a simple burning of the tops of the plant, the growth regulator when applied to turf is absorbed by the clover plant, and the acid, or a derivative of it, greatly reduces the general growth of the plant and hastens the death processes. Thus the killing effect is a physiological and systemic one rather than the physical and superficial burning which is the basis of the herbicidal effects of the arsenicals and other materials commonly used for the killing of turf weeds.

Applications in the late summer and early fall of the 2, 4-dichlorophenoxyacetic acid at the rate of 5 gallons of a 0.1% solution to 1,000 square feet have reduced clover stands from as much as 75% to less than 1% without any apparent injury to the Kentucky bluegrass in the plots. A careful examination of the surface inch of the treated turf showed many of the stolons completely disintegrated and the majority of the remaining ones brown and flaccid with no signs of life. The few stolons which were still apparently alive had almost all lost their leaves and in most cases had not produced many new leaves. Experience has shown that weakened plants which go into winter in a defoliated condition are readily winterkilled and it is entirely possible that the injured clover in this instance will not survive until spring.

Although it has not yet been possible to test the herbicidal activity of this chemical on clover or any of the other turf pests throughout the year, since these experiments were not initiated until August of this year, it is reasonable to presume that, so far as clover is concerned, late summer or fall may be the best time of year for effective application. Applications made then may make it possible for winter weather to complete the job that the application of 2, 4-dichlorophenoxyacetic acid initiates. A repeated application may be necessary in late spring if any significant amount of clover survives. Because of the relatively low concentration of 2, 4-dichlorophenoxyacetic acid which is required as compared with herbicides as they are customarily used, it is easier to consider rates in terms of 5,000 rather than the usual 1,000 square feet. 3½ ounces of this chemical made up in 25 gallons of solution will treat 5,000 square feet, or for larger areas the rate may be expressed as 1 3/4 pounds in 200 gallons of solution per acre. This is the rate recommended for fairway or lawn purposes.

In the short time in which these tests have been under way it has not been possible to work out the rates which can be used safely and effectively on putting green turf for the control of clover. It has been determined that creeping bent turf cut at putting green height will tolerate 5 gallons to 1,000 square feet of a solution of half the above

concentration without any conspicuous discoloration. Therefore it appears at present to be possible, by reducing the amount of 2, 4-dichlorophenoxyacetic acid applied, to control the clover on putting greens by repeated applications. It is to be hoped that current experiments may form the basis for recommendations for the use of this material on putting greens next season.

It is obvious that when large stands of clover are killed there is not sufficient grass left from which to develop a satisfactory turf even though it remains uninjured. Therefore it is essential to accompany the application of 2, 4-dichlorophenoxyacetic acid with a reseeding and fertilizing program when dense stands of clover are to be removed. When the clover has not crowded out the turf grasses to so serious an extent, a fertilizing program alone may be sufficient. Since fall is the best time of year for establishing new grass in most of the areas where clover is a problem, this is another point in favor of fall applications of 2, 4-dichlorophenoxyacetic acid to remove clover. Experiments have been performed which show that seed and fertilizer may be applied either immediately before or after the chemical application so that the grass can germinate and become established as the clover dies. From 1 to 3 weeks may be necessary after treatment before the clover is killed since, as has been stated before, the effect is not one of immediate burning but rather one which results from modified growth processes throughout the entire plant.

It should be remembered that in a long-time maintenance program white clover can usually be controlled by proper fertilizing practices which should be initiated and followed conscientiously after the clover has been killed by the growth regulator or any other treatment. Generally speaking, clover thrives much better in turf which has been limed than in turf which has been growing in acid soil. Excessive liming therefore should be avoided where clover is a problem. Also because of the nitrogen fixing bacteria in the root nodules, white clover grows well in soil which is low in nitrogen. Consequently on soils of low fertility it is able to compete more successfully with turf grasses (which must depend on the soluble nitrogen in the soil) than it can on fertile soils. Therefore, applications of high nitrogen fertilizers while encouraging the grass also discourage the clover.

PREPARATION OF CARBOWAX-GROWTH REGULATOR HERBICIDE SOLUTION: To prepare a solution of the growth regulator, 2, 4-dichlorophenoxyacetic acid, in water it is necessary to use a carrier or binder. For this purpose Carbowax 1500, which has been demonstrated to be harmless to even the most closely cut creeping bent turf when applied in quantities at least twice as great as those necessary for herbicidal purposes, has proved both satisfactory and convenient.

The Carbowax-growth regulator solution may be prepared as follows. For each pound of Carbowax 1500 use 3.5 ounces of the 2, 4-dichlorophenoxyacetic acid. The Carbowax should be melted and while in that state the 2, 4-dichlorophenoxyacetic acid dissolved in it with stirring. This step in the procedure may be performed at any time since the growth regulator can be stored in the Carbowax very satisfactorily. As soon as the Carbowax cools to room temperature it hardens to its original consistency. For a 0.1% solution, which is the concentration necessary to kill dense stands of clover in fairways in early fall, 1 pound and 3.5 ounces of this Carbowax-growth regulator mixture should be allowed to 25 gallons of water. For a .05% solution, which is sufficient to kill lawn pennywort, heal-all and various other mat weeds, which are particularly sensitive to the growth regulator, 1 pound and 3.5 ounces of this mixture is sufficient for 50 gallons of water. At the time the spray solution is to be prepared the Carbowax-growth regulator mixture should again be melted and then mixed slowly with stirring with a gallon or two of warm water. The resulting soupy material can then be added slowly with stirring to the remainder of the water, producing a clear solution. When warm water is available for the entire volume of solution this will be even more satisfactory since the melted Carbowax mixture can then be added directly to the required volume of water, provided some stirring device is available. 200 gallons of this spray mixture should be applied per acre. This is approximately the equivalent of 5 gallons to 1,000 square feet.