TURF and WEED CONTROL with plant growth Regulators

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RECENT field experiments with one of the synthetic plant hormones of growth regulators, conducted by the USGA Green Section in collaboration with the Bureau of Plant Industry of the Dept. of Agriculture, have shown striking promise for the effectiveness of this group of chemicals in the control of clover and some of our more serious turf weeds. The application of aqueous sprays containing a spreader and 2, 4-dichlorophenoxyacetic acid, one of the growths regulating compounds, in preliminary exploratory tests on Kentucky bluegrass have given excellent control of clover without any apparent injury to the bluegrass.

Although these preliminary experiments have been limited to tests with only one of the so-called plant hormones, other related compounds may in the future prove to be even more selective and effective in their herbicidal action.

Pure 2, 4-dichlorophenoxyacetic acid is a white crystalline powder only very slightly soluble in water. In order to apply it in water solution at the necessary concentration, a carrying agent or binder must be used in the preparation of the spray mixture. For this purpose a proprietary compound sold under the trade name Carbowax No. 1500 was found to be ideally suited, since the hormones are readily soluble in it. It is an organic compound (a polyethylene glycol) which at room temperature is of the consistency of vaseline. Carbowax readily goes into solution in warm water. When used at a concentration of 0.5%, tests have shown that it has no effect on creeping bent turf cut at *putting green height.*

Preparation of the hormone solution to be used for herbicidal treatments, therefore, was quite simple. Nineteen grams (approximately 2/3 ounce) of the Carbowax No. 1500 was weighed for each gallon of solution desired. This was then melted in a small container on an electric hot plate. To it was added a carefully weighed amount of hormone. The strongest solution used contained 1,000 parts of the hormone per million of water (ppm.). This is a 0.1% hormone solution and required 3.8 grams (approximately 1/7 of an ounce or 1 level teaspoonful) per gallon. When the hormone was dissolved in the Carbowax the mixture was slowly added with stirring to the measured volume of tap water, sufficient water being used to produce the particular desired concentration of both hormone and carrier. For purposes of shipping, the Carbowax-hormone mixture without water added, was cooled and permitted to congeal, in which condition it was readily transported or stored until the solution was to be used, at which time it was melted and added to the required amount of warm water, or cold water in which it dissolves more slowly.

The solutions were applied to the turf as a fine spray,—in some cases with an ordinary 3-gallon knapsack hand-pressure sprayer and in others, with a smaller 1-qt. capacity pressure sprayer fitted with a valve outlet, permitting the use of a tire pump to build up from 60 to 90 pounds of pressure in the spray tank. This latter sprayer produced a finer spray than the knapsack sprayer and was much more convenient for use on the test plots as well as for spot treatment.

Through the courtesy of Mr. Richard Watson, Greenkeeper of the Chevy Chase Club, 4x4 foot plots were laid out on Kentucky bluegrass fairways in stands of clover estimated at from 60 to 85% growing in a rather shady location. Striking results in clover eradication are illustrated in the accompanying photograph. In this test the 2, 4-dichlorophenoyacetic acid was applied in a 0.1% solution with a 3-gallon knapsack sprayer, at a rate sufficient to give a uniform coverage. Application was made on August 28, 1944, at which time the stand of clover was estimated in both the control and treated plots at from 60 to 70%. On September 22, 25 days later, the spray-treated plots contained less than 1% clover, while the untreated control plots showed a slight increase to about 80%. The darkened clover stolons which remained on the treated plot were apparently dead while the blue grass had continued growth without distortion, discoloration or any other apparent indications of injury. When applied at half the concentration (0.05%) on comparable adjacent plots the hormone resulted in a reduction of the clover stand from 60 to

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Lawn pennywort eradication from Kentucky bluegrass lawn: left, treated with aqueous spray of 2, 4-dichlorophenoxyacetic acid at concentration of 0.1% with 0.5% Carbowax No. 1500 (application was made at the rate of 5 gallons to 1,000 square feet); right, untreated. Note the uninjured bluegrass in the treated plot. The bare areas indicate the extent of the destruction of the pennywort in the original stand. Hormone was applied on September 7 and the above photograph made 14 days later.

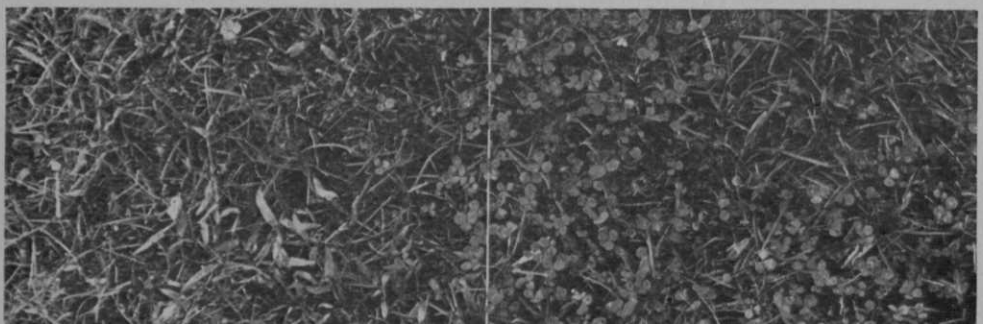
70% on August 28, to 30% by September 22.

However, some leaves developed later on stolons of plants that were not killed by these relatively mild treatments. It was evident that the clover might reestablish itself in these plots unless retreated. Light applications in the fall may prove to be relatively effective however, since the clover plants would then be exposed to unfavorable winter weather while in a weakened condition. For instance it has been shown that alfalfa and other forage legumes may suffer severe winter injury as a result of late fall cutting. It is not unlikely therefore, that stems of clover plants, which have been denuded as the result of light hormone treatment, may likewise be susceptible to winter injury. These experiments are therefore being continued in order to determine if complete control can be obtained through repeated application of a 0.05% solution of the acid.

For comparative purposes, plots were set up on old slow-growing as well as on relatively young vigorously growing bluegrass sods. An equal amount of clover was killed in both types of sod by the application of the 0.1% solution without injury to either old or young grass. Bare areas left upon removal of the clover were more conspicuous in the older grass, however, suggesting that for best results spray treatments should be accompanied by reseeding and fertilization, especially when a relatively large amount of clover is present.

Experiments on numerous turf weeds are also in progress at the present time. Lawn pennywort (*Hydrocotyle rotundifolia*), which has been remarkably resistant to arsenical herbicides as customarily applied for herbicidal purposes on turf, has been demonstrated to be even more sensitive than clover to the hormone spray. A series of plots was established on a well maintained private lawn where, in spite of fertilizing, reseeding and even the removal for several successive years of the top inch of soil, lawn pennywort had crowded out the Kentucky bluegrass each summer for the last 3 or 4 years. On September 7, 1944, when the plots were established, the turf consisted of an almost uniform stand of 60 to 80% of lawn pennywort. A single spray treatment of the 0.05% solution at the rate of 5 gallons to 1,000 square feet resulted in a complete kill of the established plants. Even on plots which received only 2½ gallons of this concentration per 1,000 square feet the

Clover eradication from bluegrass sod; left, treated with 0.1% solution of 2, 4-dichlorophenoxyacetic acid; right, untreated. Note uninjured bluegrass and crabgrass as well as bare areas in the treated plot where the clover had been growing. The applications were made on August 28, 1944, and photographed on September 22.



lawn pennywort was reduced to less than 1% of the original infestation. When the spray concentration was doubled (0.1%) all established plants of lawn pennywort was completely eradicated at both 2½ and 5 gallons of solution per 1,000 square feet without any injury to the established grass. These data were obtained on September 20 from the dublicate randomized 4x4 foot plots which were treated on September 7. The lawn pennywort seeds prolifically, however, and on October 2 when the plots were again examined thousands of new seedlings had developed in all of the plots. It was apparent that the seeds of lawn pennywort were not injured by any of the treatments used and that repeated applications are necessary in order to kill the plants that develop from them.

Similar tests are in progress in the Bureau of Plant Industry on such widely distributed turf weeds as dandelion, plantain, chickweed, knotweed, yarrow and others. In these experiments, which will be reported at a later date narrow-leaf plantain and dandelion were found to be very susceptible to this hormone, whereas broad-leaf plantain is relatively resistant.

Preliminary tests have also been conducted on creeping bent cut at putting green height. As is to be expected, the creeping bents at this height are much more sensitive to the treatment than is the blugrass. It is obvious that considerably more tests will have to be made to modify the rate of application before 2, 4-dichlorophenoxyacetic acid can be recommended for clover or weed control on putting greens. However, the fact that small areas of bent turf which were well drenched with the hormone solution at 0.1% concentration recovered completely after 6 weeks although the clover was permanently eradicated, would lead one to believe that it will not be impossible in subsequent experiments to determine rates which can be used that will kill the clover and at the same time not seriously injure the putting green turf. Repeated light applications may be the answer, since it has already been demonstrated in another experiment that the bent turf will tolerate an application of a 0.05% solution at the rate of 5 gallons to 1,000 square feet.

The effect of the hormones on the plants which results in their ultimate death and complete disintegration is strikingly different from that obtained with other types of herbicides. There is not at any time any evidence of burning. The action is not a local physical one but rather a systemic physiological one. The first evidence of injury is likely to appear within 24 to 48 hours after application and is evident in severe twisting and bending of stems and leaf petioles accompanied by an inhabition of overall growth. The leaf blades of the affected plants may retain their green coloration a week to 10 days after treatment, after which time they gradually turn yellow and eventually become brown and die. In the case of the clover the darkened defoliated stems were in evidence on the surface of the ground for some time before complete disintegration ensued. During this stage distinct growth responses in the nature of abnormal swellings and gall formations were in evidence on the underground parts of the affected plants. Eventually there is a complete disintegration of the plant tissue, with practically no trace left.

It is obvious that hormones may not be effective when used in connection with the eradication of weedy grasses, particularly crabgrass. The sensitivity of plants differs widely from species to species. For instance, the narrow-leaf plantain is killed and completely disintegrated by the hormone whereas the broad-leaf plantain shows only growth curvatures of the petioles. Also in the lawn pennywort plots there was present to a limited extent a second weed, *Ajuga* reptans, which remained uninjured by the hormone.

Although the use of hormones for the selective control of clover and weeds in turf has not progressed beyond the experimental stages of development, preliminary estimates indicate that the cost of the spray material will not be prohibitive for general use. In comparison with other herbicides the actual amount of chemical required for effective dosages of the hormones is considerably less. For instance, at the strongest hormone concentration (0.1% applied at the rate of 5 gallons to 1,000 square feet), only 19 grams or approximately 2/3-ounce of 2, 4-dichlorophenoxyacetic acid was used per 1.000 square feet. This would amount to about 1¾ pounds per acre. Quotation on pure 2. 4-dichlorophenoxyacetic acid by a reliable manufacturing concern has been as low as $2.00 per pound delivered. The cost of the Carbowax included in the spray mixture at 0.5% will amount to approximately $2.75 per acre at current prices when 5 gallons of spray are applied per 1,000 square feet .

Very little is known concerning the effects of 2, 4-dichlorophenoxyacetic acid on the soil. It would seem advisable therefore in applying the herbicidal spray to turf to avoid soaking treatments that allow penetration of the hormone into the soil, at least until further information on the soil phase of the problem is obtained. Applications at the rate of from 3 to 5 gallons to 1,000 square feet in a fine spray are usually sufficient to wet the foliage thoroughly and uniformly without wetting the soil.