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BETTER TURF THROUGH RESEARCH AND EDUCATION

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The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster "Better turf through research and education".

More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

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Trees and Shrubs on the Golf Course

The rapid development of our cities, towns and road systems and even some modern trends in farming practice all take a toll of our tree population. This fact has lead to an increased interest in tree preservation and the importance of tending and planting trees is becoming more appreciated. Trees help considerably in making man's general environment more enjoyable and fortunately this point is recognised by members of golf clubs.

On the golf course, trees and shrubs not only help beautify the land but they provide shelter, privacy and colour. Careful siting of trees or even one specimen tree can "make a hole" either by influencing the line of play — through its mere physical presence on the fairway or by influencing judgement of distance or direction. The golf course provides almost unlimited possibilities for the use of trees and shrubs and it is unfortunate that unwise planting sometimes results in hindrance to play and/or at least partial failure of the new trees. This is largely due to:—

1. Lack of knowledge on the most suitable type of tree for the land.
2. Inadequate thought on the planting scheme.
3. Inadequate care with planting.
4. Inadequate after-care.

The following general points should therefore prove of some value.

Greens and Tees

Trees to be grown near greens/tees should possess characteristics which will have the minimum adverse effect on the health of the grass sward. Species which are deep rooted, allow some light penetration due to lightness of foliage, which are strongly branched and relatively free from insect pests and disease should be favoured. No tree posesses all these requirements and careful selection is necessary to obtain those best suited. At the same time some species which do not fulfill the above requirements, say because of the dense shade caused by their thick foliage, might be used if correctly positioned bearing in mind the sun's path.

Height of the trees is of no great consequence providing it is borne in mind when planting that the outer limit of the matured tree's foliage should not be within 15 ft. of the edge of the green or tee. This might necessitate planting such species as Birch some 25—30 ft. from the green but this is more desirable than having to lop branches back and contend with roots of more closely planted trees as they develop. Tall growing trees i.e. those which reach a height of say 35—45 ft. should be planted furthest away from the greens/tees and dense planting should be avoided around the south east to south west sides. Such planting restricts air circulation, causes excessive shade and leads to green-keeping problems. The use of shrubs near greens is debatable although discriminate planting can be very effective without hindering play. Good backgrounds can be produced with such low growing species as Gorse, Broom and Rhododendron. These are best used sparingly behind well defined greens where approach play is easily controlled. In such situations the shrubs are ornamental without forming a hazard.

Fairways

Only limited tree planting within fairways is desirable as here the trees should be strategically placed to help dictate the line of play and yet provide a fair hazard. Such trees could be regarded as specimens and should be picturesque and symetrical. Deep rooted species which are high branched should be preferred because they have the minimum adverse effect on the turf and do not hinder a player's swing or impede maintenance work.

As leaf fall in the autumn can be a nuisance, species with smaller crisp leaves that blow easily in the wind e.g. Oak, Birch and in some situations Beech should be preferred to trees with larger leaves e.g. Sycamore and Poplar. Some conifers can be used such as Larch and Pine as their needles cause little trouble.

Shrubs within fairways are not advised as generally their formation does not enable them to provide a fair hazard.

Rough

Almost any type of tree can be used in the rough though species should be chosen bearing in mind type of land and its locality. The tree planting in most cases should not cover too great an area of land. Small carefully shaped plantations and coppices should be preferred to large woods or tree belts which could hinder air circulation. On the fairway fringe of any tree plantation it is desirable to use smaller growing lightly leaved species and planting should not be too dense.

In some situations shrubs can be used to add colour and bottom cover to tree areas but they should not be situated where they would provide an unfair hazard. Generally speaking small groups or short bands of shrubs discriminately placed should be preferred to continuous bands all along the edge of the plantation.

Planting and After Care

If good quality trees and shrubs are obtained and planted correctly a high establishment rate can be expected.

1. In exposed situations plant small plantations and/or coppices and not individual specimens here and there. These frequently fail due to exposure.
2. Plant in good top soil in a hole large enough to accommodate all the roots.
3. Do not plant too deeply and do ensure that the roots are spread out to their full extent with some top soil worked around them.
4. Complete all planting during the tree's dormant season i.e. late autumn to early spring.
5. Firmly stake and tie all half and full standard trees.
6. Adequately firm the soil during replacement but do not over consolidate.

It should be appreciated that some maintenance is necessary until the trees and shrubs are well established. Vegetation should not be allowed to smother the plants and occasional cutting of long grass and weeds should be done. Alternatively the vegetation around the base of the trees can be sprayed with a suitable chemical such as Paraquat/Diquat using a special type of sprayer.

Stakes and ties should be maintained in a satisfactory state and if there is danger of damage done by wild life e.g. rabbits the plantations, coppices, or individual specimens should be protected by a wire netting surround. Rabbit netting 42 in. wide, 18 gauge, 1¼ in. mesh should be used. It should be fixed to stout stakes and the bottom 6 in. of the wire should be buried horizontally below the turf surface.

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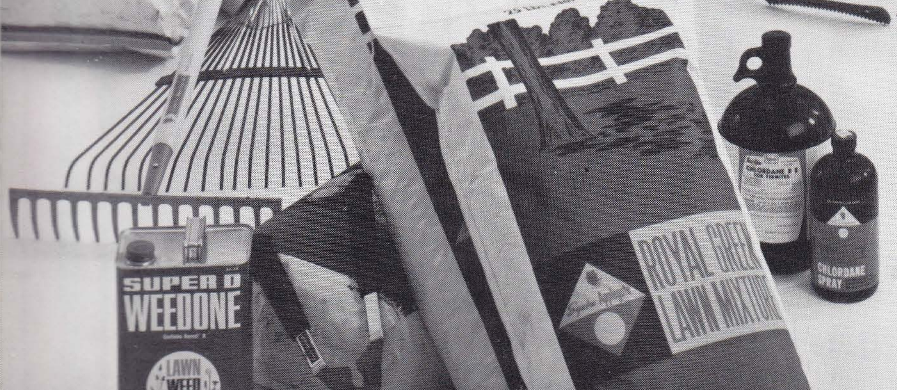
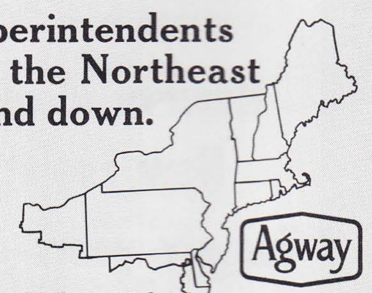
How Agway helps bring golf to you in living color

Agway serves golf course superintendents everywhere in the Northeast from the ground down.



Lynn Kellogg (right), superintendent, Oak Hill C. C., Rochester, N.Y., and Agway's Bob Carson discuss condition of the greens in preparation for the 1968 U.S. Open. Carson is an Agway specialist in professional turf maintenance.

HUMAN SAFETY in the use of AGRICULTURAL CHEMICALS

by Irma West, M.D.

Anyone who applies, stores, transports, disposes of, formulates, mixes, or manufactures agricultural chemicals has assumed a particularly important obligation with respect to the safety of his operations. He must have a special knowledge, adequate training, proper equipment, and sources of technical help and information to call upon when special problems or emergencies arise.

There are several fundamental "facts of life" which should be understood at the outset by persons responsible for safe use of agricultural chemicals. First, there are tremendous differences in the degree and kind of hazard they may present to people. A number of chemicals are of very little hazard, even when misused. However, it is practically never safe to say any are harmless. Pesticides for example, would not be of much use if they did not have some adverse effect on plant and animal life. There are a few agricultural chemicals which are among the most dangerous materials ever used by man. Examples are TEPP (tetraethyl pyrophosphate), parathion, Phosdrin, Thimet (phorate), and Demeton (Systox). Therefore, the prospective user must find out before he buys or uses any chemical just what the hazards are, and how to protect himself, his employees and the public. Furthermore, in order to make an accurate estimate of the cost of using any chemical, the hazard must be known because a sizeable part of the expense can be in the time, equipment and services necessary to assure safety.

Second, it should be understood what the term "hazard" means. It is not the same as toxicity (poisoning ability), although toxicity is often a very important part of the overall hazard. The hazard is the summation of all the potentially harmful effects which could occur during a particular use of a particular pesticide. There are a number of factors in addition to acute and chronic toxicity which can contribute to the hazard. Among them are: (1) flammability, (2) explosibility, (3) ability to cause chemical burns or irritation of the eyes (conjunctivities), skin (dermatitis or rashes), and breathing passages (including chemical pneumonia), and less frequently (4) ability to cause allergic responses such as hives, hay fever, and asthma. Any chemical can present one or more of these dangers from a very mild to severe form.

Factors greatly increasing the hazard are (1) the ability of a substance to enter the body readily through the intact skin, and (2) the ability to easily emit vapor into the air (a liquid with high vapor pressure or a gas). Any highly toxic chemical which is a gas or a liquid with a relatively high vapor pressure and which can easily be absorbed through the skin is particularly hazardous to humans. Examples are tetraethyl pyrophosphate (TEPP) and cyanide gas.

The third "fact of life" is that technical information about health and safety in the use of chemicals does not come from the same group of experts who advise on how to use chemicals effectively. The applicator, extension service man, various field men, and the entomologist are among those called upon to advise on the selection of a pesticide to destroy a specific pest. The group technically qualified to advise on health and safety come from entirely different fields. They are—industrial medicine, human toxicology, industrial hygiene, public health and related health fields. For advice on safety with respect to wildlife, still another technical group must be called upon, such as the biologist, the ecologist, and the conservation expert. It is important to seek advice from the group technically equipped to provide it.

Experience has shown that more children under five years die of accidental pesticide poisoning than any other group of people, and that arsenic and phosphate ester pesticides (such as parathion and TEPP) are the most serious offenders. Children will find almost anything that is left accessible, and because of their small size and increased susceptibility, it takes a very small dose to be lethal.

Examples:

Case 1. A group of families with their children were picking berries on a berry farm. They were followed by a spray rig. On the spray rig was a five-gallon can of TEPP concentrate. A four-year old girl put her finger in the can which her older brother had opened. She died within twenty minutes.

Case 2. A three-year-old boy was admitted to the hospital in a serious condition. He had been nauseated and vomiting during the previous night. The child's shirt was found to be stained with an oily substance. The child had been playing in a shed on a ranch near where a container of parathion, which had been left on a shelf seven years before had spilled on the floor. The child recovered.

The greatest number of poisoning deaths from pesticides are the result of suicide. At least some of these deaths could have been prevented if toxic pesticides had not been left within the reach of emotionally upset persons. Persons who have a history of attempted suicide or are emotionally upset are not good candidates for employment in any job where toxic chemicals are easily available.

Of growing concern are the increasing number of incidents where toxic pesticides are spilled during transportation or storage, and neighboring cargo such as food or clothing and bedding becomes contaminated (see Table). IT CANNOT BE EMPHASIZED TOO OFTEN THAT SPILLS OF CONCENTRATES OF TOXIC CHEMICALS WHEREVER THEY OCCUR ARE AN EMERGENCY REQUIRING IMMEDIATE AND EXPERT ATTENTION. The chemical or common name of the chemical must be immediately available in order to know what the hazard is, how to decontaminate, and to inform the physician to whom anyone is taken who has been exposed to the spill. Each operation where toxic pesticides are stored, transported or used should make advance plans for exactly how to handle spills of each chemical on the premises. (See chapters on Safe Transportation and storage of Pesticides in "Safe Use of Pesticides," listed in the references at the end of this paper.)

Another group at special risk where pesticides are manufactured, formulated, transported, stored, or applied are the workers, particularly farm workers. In California, over half of the cases of occupational disease from agricultural chemicals occurs in the farm worker. Fatal poisoning is fortunately not a frequent occurrence but completely preventable deaths occur each year. Parathion, Phosdrin, Demeton (Systox), TEPP, methyl bromide, arsenic, paraquat and ammonia have been the agricultural chemicals involved in fatal cases among workers in California. Most of the serious nonfatal cases were attributed to the phosphate esters, parathion, Phosdrin, Thimet. (For further information see Occupational Diseases in California Attributed to Pesticides and Other Agricultural Chemicals . . . 1965, listed with references at the end of this paper.)

Example:

Case 3. Mr. X came to work for Mr. C., a California seed grower. Mr. X was handed a large shaker of gray powder and told where to apply it. The shaker of 10% phorate (Thimet) was not labeled. The worker was not given any information about the hazards involved in using this highly toxic pesticide. He was not provided with protective clothing, such as gloves, goggles, and impervious coveralls, to prevent skin contact. He was not provided with an approved, clean respirator to prevent breathing the dust. He was not provided with washing facilities so he could shower and change to clean clothing before going home, thus avoiding bringing home contaminated clothing which could endanger him and his family, particularly young children. No one on this ranch knew the proper first aid to administer when Mr. X became ill. No pre-arrangements had been made with a local physician so that poisoning would receive prompt and adequate care. There was considerable dealy in identifying the pesticide, since there was no label on the shaker and the original container could not be found. Since medical treatment for pesticide poisoning is quite different depending on the particular material, any delay in providing the physician with the name of the pesticide can mean a serious delay in proper treatment. This case of poisoning was entirely unnecessary. It could have been so easily prevented. No one comes equipped with the knowledge he needs to use hazardous chemicals safely. He must first be taught exactly what to do and why. If the boss doesn't have the knowledge, training, or equipment, he cannot pass it on to others who work for him.

SUMMARY
BASIC RULES FOR SAFETY

A review of the serious to fatal agricultural chemical poisoning cases reveal that one or more of these basic safety rules were broken.

1. Before opening any container of an agricultural chemical, workers should be informed if there are risks to themselves and others, and they should receive instructions and equipment for safe handling. READ THE LABEL EACH TIME BEFORE USE.

2. Whenever there is a choice, the less hazardous chemical should be used and no more than is necessary.

3. There should be on-the-job safety supervision. New employees and those not trained in handling chemicals need constant supervision. No one should work alone with a hazardous chemical.

4. Pest control equipment should be of proper design, well maintained and regularly cleaned so as to minimize spills or other pesticide exposure to operators or maintenance personnel. The mouth should never be used to siphon. Cross-connections or siphons which could contaminate wells and water supplies should be avoided.

5. Washing facilities should be readily available and any spills or splashes of chemicals should be immediately washed from the skin and the clothing changed. Hands should be washed before smoking or eating. Lunches, drinking water, and tobacco should be kept away from farm chemicals. A shower followed by a change of clothing after each day's work is mandatory. Work clothes should be cleaned separately and not taken home for laundering. Contaminated boots, tools or

other items should not be taken home. They can be a hazard to the family.

6. The employer should provide, maintain and clean whatever protective clothing or equipment (gloves, respirators, etc.) is needed for safe work with chemicals. Different pesticides may require different kinds of protective equipment.

7. Special care is necessary in handling concentrated pesticides. It is at this point that the greatest hazards lie, particularly if the chemical is toxic and readily absorbed through the skin. In the transferring of concentrates from drums, either threaded taps or drum pumps should be used. Measuring and pouring from jars and cans is asking for trouble.

8. Pesticides must be properly labeled and stored in original containers. All toxic chemicals should be stored separately under lock and key away from foodstuffs, medicines, clothing, toys and the like. They should never be stored in containers which can be confused with food, beverages or medicines. No pesticide containers, empty or otherwise, should be left where children, pets, livestock, or irresponsible persons have access. Empty containers should be burned, or decontaminated and buried, preferably at an authorized dump, right away.

9. Toxic chemicals or any items contaminated by toxic chemicals must not be transported in passenger sections of vehicles, nor with foodstuffs or other commodities which could be a hazard if contaminated in a spill.

10. Persons who have been accidentally overexposed to a toxic chemical or have symptoms of poisoning, should never operate an auto, truck, aircraft or any other vehicle. They should be taken promptly to the doctor. Plans for handling emergencies must be made in advance with the doctor. Medical supervision should be provided for all work with hazardous materials.

11. Workers should know basic first aid for chemical injuries as follows:
(a) give mouth-to-mouth artificial respiration if breathing has stopped, wash face and use handkerchief if face is contaminated; (b) decontaminate skin by washing, remove contaminated clothing, use gloves; (c) if chemical splashes in the eyes wash for 15 minutes with clean water; (d) if chemical swallowed and victim fully conscious give water, induce vomiting by gagging only if victim is conscious and no solvents or corrosives are in the formulation; (3) take victim to a physician or nearest emergency hospital as soon as possible and bring the container and label.

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Temporary Soil Sterilants

Temporary and no-residual soil sterilants are most useful in turf, garden, plant-bed, greenhouse and cropland areas to remove undesirable vegetation where selective herbicides are not available or cannot be used. They can be used to temporarily prevent weed encroachment or to eradicate spots or patches of perennial weeds such as bermudagrass, quackgrass, nutsedge or johnsongrass. Some of the temporary sterilants are listed below with comments about each of them.

METHYL BROMIDE

Trade name: Dowfume MC-2

Controls weed seeds, plants, and most harmful fungi, nematodes and soil insects when used at 1 to 2 lbs per 100 sq ft of surface or per 100 cu ft of soil. Plastic or other airtight cover required and it should be supported by bagged straw or other means to keep it off the ground to allow uniform gas circulation. Contains 2% chloropicrin as a warning agent since methyl bromide is a colorless and nearly odorless toxic gas. Best results obtained if soil temperature is above 60°F at 4-inch depth. Vaporizing unit should be suitable for good seed germination. Cover may be removed after 24 to 48 hours and seeding can be started after another 48 hours. Fumigation and aeration time should be increased if the temperature is lower than 50-60°F.

WARNING: Methyl bromide should be applied **only** by experienced persons.

(SMDC) — sodium methyl dithiocarbamate (anhydrous)

Trade names: Vapam, VPM

General purpose pre-plant soil fumigant for weeds, nematodes and certain soil fungi and insects. Can be applied on small areas with sprinkling can or hose proportioner. Plastic cover may be used but not required. Use 1 to 1½ quarts of concentrate (4 lbs/gal) per 100 sq ft. Soil should be moist when treated. Immediately after application "seal" gas in with water — 8 to 16 gal/100 sq. ft. When plastic cover is used, use half the rate listed above and water seal is not required. For field application use thin injection shanks spaced 5 inches apart. Inject fumigant 4 inches deep into good seedbed and roll soil immediately. Light watering in field helps prevent gas escape. Aerate or disc soil lightly 7 to 10 days after treating. Residual effect lasts about

21 days. At soil temperatures below 60°F allow at least 30 days before planting.

(DMTT) — 3, 4-dimethyltetrahydro-1, 3, 5 (2H) thiadiazine-2-thione

Trade names: Mico-fume, Mylone

Soil fumigant used pre-plant to control most weeds, soil insects, fungi and nematodes. Temporarily sterilizes soil for 14 to 20 days — about 30 days if soil temperature is below 60°F or if soil has been wet since treating. Use 5/8 to ¾ lb active ingredient per 100 sq ft. Apply dry or as water suspension. Mix thoroughly with top 5-inches of soil and wet soil thoroughly after application.

CYANAMIDE — calcium cyanamide

Trade names: Aero Cyanamide, Cyanamide, Calcium Cyanamide

A granular or pulverized material primarily for weeds. Incorporate with top 1 to 3 inches of soil at 5 to 8 lbs/100 sq ft. Soil moisture activates conversion to several intermediate products such as hydrogen cyanamide and nitrite. These are the most toxic to plants and germinating seeds. Commercial cyanamide contains 21% BN and about 40% calcium, both of which are available later for plant use. If soil is dry at time of application a light watering is helpful. Allow 3 to 4 weeks between treatment and planting.

STEAM OR HEAT

In special cases such as greenhouses and pots, steam can be used to sterilize soil. This method is limited by cost and practicality. Temperatures held at 212°F for 30 minutes will kill almost all living organisms in the soil.

WARNING ! ! ! SOME OF THE ABOVE CHEMICALS CAN BE VERY TOXIC IF HANDLED IMPROPERLY. FOLLOW LABEL DIRECTIONS AND PRECAUTIONS EXPLICITLY ! Do not use soil fumigants or sterilants in or near rootzones of desirable plants.

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Environmental Influence on Bentgrass Treated with Silvex

by Lloyd M. Callahan, Ralph E. Engel, and Richard D. Ilnicki

Abstract. Colonial bentgrass *(Agrostis tenuis* Sibth*)* and creeping bentgrass *(Agrostis palustris* Huds*)* exhibited the most tolerance to ½, 1, 1½, and 3 lb/A of 2-(2.4.5-trichlorophenoxy) propionic acid and a low pH medium. Injury from treatments was slight to moderate when applied from early to mid-spring, severe when made from late spring to early summer, and very severe when made from late summer to early fall. Silvex appeared to cause the most injury at the 1 and 1½ lb/A rates. Injury was much less from the lower rate of ½ lb/A. Root fructosan concentrations decreased with increasing rates under cool temperatures and increased with increasing rates under high temperatures. Bentgrass appeared to tolerate silvex treatments better under low available moisture conditions than under high moisture levels.

INTRODUCTION

Safety of the phenoxy herbicides to certain turfgrasses has caused increased concern in recent years. Turfgrasses exhibit variable degrees of tolerance or susceptibility to phenoxy compounds. Two such turfgrass species which are considered very sensitive to phenoxy herbicides are Colonial bentgrass *(Agrostis tenuis* Sibth) and creeping bentgrass *Agrostis palustris* Huds). Both species are commonly used for turf purposes. The phenoxy herbicide 2-(2,4,5-trichlorrphenoxy) propionic acid (silvex has gained common acceptance in turfgrass weed control. This zuxin-type compound will either stimulate or inhibit plant growth.

Temperature, light, pH, and the physiological condition of the plant prior to and following a phenoxy treatment have been considered important factors influencing the activity of phenoxy compounds. In general, phenoxy absorption into plant foliage increases, within physiological limits, with increasing temperatures (1, 6, 9). The translocation of 2,4-dichlorophenoxyacetic acid (2,4-D) intensity (16). The kinds and amounts of ions taken up by plant roots may be influenced indirectly by pH (7). The alteration of the nutritional status of the plant may result in a changed metabolism and growth, thus altering the sensitivity of the plant to phenoxy herbicides. The response of plants following 2,4-D treatment indicates that phenoxy effectiveness is greater at an acid pH than at higher pH levels (11).

Most plants undergo a period of maximum susceptibility to phenoxy herbicides. The commonly susceptible period usually is the early seedling stage (8). As plants mature, they appear to become less sensitive. Schmidt (12) reported a 20% reduction in stand density of spring seedlings of bentgrass occurring at 6 weeks of age and younger from treatments of the amine salt of 2,4-D. Also, all ages of bentgrass seedlings treated in the fall were critically injured.

Table 1. Foliage injury of Colonial bentgrass grown in the greenhouse under three moisture levels following treatment with silvex.[a]

Silvex lb/A	Moisture level	Foliage injury ratings[b] Weeks after treatment 1	2	3	4	5	6	7	8
1	High	6	6	6	7	7	7	7	7
	Medium	6	7	7	7	7	7	7	7
	Low	7	8	8	8	8	7	7	7
1½	High	6	6	6	7	8	8	8	8
	Medium	7	7	7	8	8	8	8	8
	Low	7	7	8	8	8	8	8	8

[a]Averages of three replications.
[b]Injury ratings: 1 = no visible injury; 10 = complete kill.

The root dry weights, fructosan concentrations, root lengths, and root numbers were greater under low moisture than under medium or high moisture levels, regardless of silvex treatments (Table 2). Root length showed a

Table 2. The effect of three moisture levels on root dry weights (mg), fructosan concentrations (mg/g dry wt), root length (cm), and root numbers of colonial bentgrass treated with silvex.[a]

Silvex lb/A	Root responses: Dry weights H	M	L	Fructosan concentration H	M	L	Root length H	M	L	Root counts H	M	L
0	117	119	153	4	7	20	15	17	21	162	248	321
1	29	31	45	3	4	5	13	16	19	52	124	152
1½	12	42	53	2	2	4	12	15	18	53	138	189

[a]Averages of three replications.
[b]H = high, M = medium, and L = low moisture levels.

Phenoxy injury to bentgrasses has suggested root injury. This view is supported by the observation that a-phenoxy-propionic acids exhibit an inhibitory action on root cell elongation (2). Other reports showed that 2,4,5-tricholro-phenoxyacetic acid (2,4,5-T) and silvex are active in inducing root growth (5).

Carbohydrate losses in plants treated with phenoxy herbicides can be correlated with increasing temperatures, according to Hewitt and Curtis (4). This temperature influence combined with phenoxy applications could accelerate plant weight losses and carbohydrate depletion at a critical rate.

In grasses, the fructosans account for the greatest part of the water-soluble carbohydrates and is the constituent most likely to fluctuate in concentrations at different seasons (14). Weinman and Reinhold (15) state that fructosans constitute the principal carbohydrate in colonial bentgrass. They report that the fructosan content in the roots of bentgrass generally increased during fall and winter, probably due to slowing and even cessation of aboveground plant growth. Thus, phenoxy effects on root development and food reserves suggest serious plant responses may occur from phenoxy herbicide treatments.

This study was conducted to determine the effects of silvex on bentgrass grown under various environmental influences. The specific environmental factors studied were the influence of temperature, day length, and pH on silvex action, the influence of soil moisture level on bentgrass response to silvex, and the effects of season and stage of growth and development of bentgrass to silvex treatments.

MATERIALS AND METHODS

Colonial and creeping bentgrass were treated with ½, 1, 1½, and 3 lb/A of propylene glycol butyl ether esters of silvex at various stages of growth and under several environmental invluences. Tests were conducted on outdoor turf, in a growth chamber with solution cultures, and under greenhouse conditions with solution and soil cultures.

Treatments of the foliage of bentgrass plugs and seedlings used in solution and soil cultures were made with an endless conveyer-belt spray table of the type described by Shaw and Swanson (13). A hand-pump compression sprayer with a pressure gauge was used for treating out-door turf plots.

Prior to foliage treatments of the solution culture tests, the roots of all the seedlings were excised 3.5 cm below their crowns to permit accurate measurements and analysis of new growth. Root fructosan concentrations of all treated and nontreated plants were determined by the procedure reported by McRary and Slattery (10) and expressed as milligrams per gram dry weight.

The general experimental design followed throughout these investigations was a completely randomized factorial. All tests included three replicates.

Growth chamber tests with varied temperature, light, and pH. Colonial bentgrass seedlings, 10 weeks of age, were treated with several rates of silvex and maintained in complete nutrient solution in a growth chamber with alternate temperatures of either 75 or 97 or 50 to 60 F. The solution cultures were tested at two pH levels. When a solution was pH 4.8 was desired, monobasic potassium phosphate was used. For a pH 7.0, dibasic potassium phosphate was used. The solution cultures were changed twice daily for the 20-day test period. Each pH level was evaluated under short and long-day conditions.

The seedlings for each test were germinated and grown in sand cultures in the greenhouse under conditions similar to those to be tested in the growth chamber.

Test of soil moisture influence on phenoxy action. Colonial bentgrass plugs, 4 in in diam grown outdoors, were

Table 3. Foliage injury of ¾-in colonial bentgrass turf following treatments with silvex at five periods throughout the season.[a]

Treatment date	Silvex lb/A	Foliage injury ratings[b] Weeks after treatment: 1	2	3	4	6	8	10	12	24	36	48
Aug. 25, 1961	½	2	4	4	3	2	2	2	2	2	1	1
	1	4	6	7	6	4	4	4	4	3	3	2
	1½	4	7	8	7	5	5	5	5	4	3	2
	3	5	8	9	9	8	8	8	7	6	4	2
Oct. 1, 1961	½	1	3	3	3	2	2	1	1	1	1	1
	1	2	4	4	4	2	2	1	1	1	1	1
	1½	3	5	6	6	4	4	2	2	1	1	1
	3	3	6	7	7	6	6	2	2	1	1	1
Apr. 4, 1962	½	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	2	2	1	1	1	1	1
	1½	1	1	1	1	2	2	2	1	1	1	1
	3	1	1	2	2	3	3	2	1	1	1	1
June 1, 1962	½	2	2	2	2	2	1	1	1	1	1	1
	1	3	3	4	3	2	2	2	2	1	1	1
	1½	4	4	5	3	2	2	2	2	2	1	1
	3	5	5	6	5	3	2	2	2	2	1	1
July 20, 1962	½	1	2	2	2	2	1	1	1	1	1	1
	1	2	6	6	6	4	3	2	1	1	1	1
	1½	2	6	6	6	4	3	2	2	1	1	1
	3	3	7	7	6	5	3	2	2	1	1	1

[a]Averages of three replications.
[b]Injury ratings: 1 = no visible injury; 10 = complete kill.

Table 4. Plant counts of live Colonial bentgrass in plots following treatments with silvex at five periods throughout the season.[a]

Silvex lb/A	Treatment dates: Aug. 25, 1961	Oct. 1, 1961	Apr. 4, 1962	June 1, 1962	July 20, 1962
0	24	13	27	40	38
½	25	10	26	34	34
1	16	14	15	23	26
1½	14	5	23	18	16
3	11	12	25	21	10

[a]Plant counts are averages of 180 counts for three replications.
[b]Plant counts recorded March 24, 1964.

Table 5. Root dry weights (mg), fructosan concentrations (mg/g dry wt), and root lengths (cm) of creeping bentgrass following excisions of sod-plugs at various intervals after the silvex treatment.[a]

Silvex lbs/A	First excision (roots in nutrient solution)			Second excision (roots in soil)[b]		
	Dry weights	Fructosan	Length	Dry weights	Fructosan	Length
	2 Weeks[c]			10 Weeks		
0	21	4	8	12	6	18
½	5	5	5	4	6	12
1	2	4	4	3	5	11
1½	7	4	3	1	15	8
3	1	16	1	0	101	3
	4 Weeks			12 Weeks		
0	22	5	8	15	5	18
½	2	7	7	6	5	13
1	2	5	4	4	5	12
1½	1	8	3	1	25	9
3	0	122	2	0	216	6
	6 Weeks			14 Weeks		
0	23	6	9	17	6	19
½	7	4	7	7	6	15
1	2	8	4	5	5	15
1½	2	14	3	2	7	13
3	0	75	2	0	80	11
	8 Weeks			16 Weeks		
0	30	5	10	20	1	20
½	4	6	8	12	5	15
1	2	4	5	3	8	15
1½	1	18	3	3	5	13
3	0	52	3	1	72	13

[a]All sod-plugs were treated with silvex April 21, 1963.
[b]Sod-plugs from nutrient solution were transplanted to soil and grown for 8 weeks after first excision.
[c]Weeks after treatment.

cut back to 1 in in depth and mounted on top of a soil mixture in 1-qt cans. The mechanical analysis of the prepared woil was 54% sand, 32% silt, and 14% clay.

All the containers were filled with 1240 g of the soil mixture, leaving about ¾ in between the soil surface and the top of the cans. Each can of soil then was saturated with water and allowed to air dry, three separate times. The cans were saturated with water again, covered, and allowed to stand for 2 days. The weight of water remaining was determined, and considered equal to field capacity.

Bentgrass plugs of uniform size and recorded weight were mounted on top of the soil in the separate cans. The combined weight of each can was checked twice per day. Each time the moisture level in a separate set of cans dropped below field capacity, or to either ½ or ¼ field capacity for 8 weeks following silvex applications. Five days after the plugs had been transplanted into the soil, silvex treatments of 1 or 1½lb/A were made.

Season of phenoxy treatment on turf. Colonial bentgrass turf maintained at ¾-in mowing height was treated with ½, 1, 1½, or 3 lb/A of silvex August 25 and October 1, 1961, and applied on 2 by 12 ft sub-plots randomized within each replication. Plant counts were taken in each sub-plot with a 10-point quadrate and are based on 60 counts per plot. Plant counts were recorded for colonial bentgrass.

Tests on bentgrass recovery from phenoxy treatment and root pruning. This test was designed to determine the recovery of bentgrass at several root excision intervals following an initial silvex treatment.

Creeping bentgrass plugs 2 by 2 in. in diam were treated with silvex April 21, 1963, and roots were excised from a different set at 2, 4, 6, and 8 weeks following treatment. The plugs were maintained in aerated solution cultures during the first root excision intervals in the greenhouse.

The plugs remaining after each root excision were transplanted to soil in plastic pots.

The extent of root growth following the first series of time-spaced root excisions after the initial silvex treatment was determined. Each set of plugs was maintained in soil for 8 weeks following each of the first series of root excisions.

RESULTS AND DISCUSSION

Temperature, day length, and pH responses. Rootgrowth of colonial bentgrass grown in the growth chamber showed greater injury with high temperatures than with low temperatures (Figure 1). The most detrimental silvex rates under high temperatures appeared to be 1 through 3 lb/A. These rates appeared most severe on plants grown at pH 4.8 and long-day conditions.

In general, silvex injury to bentgrass roots under low temperatures seemed to be greater from 1½ and 3 lb/A (Figure 1). The severity of injury generally followed the trend of increasing with increasing rates. High rates caused most severe injury at pH 4.8 and short-day conditions. Bentgrass appeared to exhibit the most tolerance to silvex when grown under cool temperatures, a long photoperiod, and a low pH medium.

The bentgrass plants receiving no silvex grew best in a nutrient solution of pH 4.8 with long days at both the high and low temperatures.

Soil moisture responses. Treatments of 1 and 1½ lb/A of silvex on colonial bentgrass truf grown at three soil moisture levels produced little variation in foliage response (Table 1). These rates generally caused moderate to severe burn from high to low moisture levels, respectively.

The root dry weights, fructosan concentrations, root lengths, and root numbers were greater under low moisture than under medium or high moisture levels, regardless of silvex treatments (Table 2). Root length showed a gradual increase, while the average number of roots showed a sharp increase with decreasing moisture level. Root length appeared more closely correlated to moisture level than to silvex rate. The 1 lb/A rate of silvex appeared to reduce the number of roots more than 1½ lb/A. Compared with those receiving no silvex, however, both rates caused very high reductions.

The non-treated plants suggested that a correlation seems to exist between root dry weight and fructosan content (Table 2). Dry weights and fructosan concentrations of roots of silvex-treated plants tended to increase with decreasing moisture level. They appeared to increase gradually from high to medium moisture and increased sharply from medium to low moisture. Plants grown with high soil moisture showed the greatest decrease in root dry weights when treated with 1½ lb/A of silvex. With medium and low moisture, those plant cultures treated with 1 lb/A showed the most reduction. The 1½ lb/A rate seemed to cause the greatest reduction of fructosan at all three moisture levels. Increases in dry weights and fructosan content of roots appeared highly correlated to decreases in moisture level.

The trends observed here tend to indicate that silvex rates and moisture level are not highly dependent upon each other in producing their effects on bentgrass. These results agree with the findings by Erickson and Gault (3) that plants grown with very low available soil moisture are much less susceptible to auxin herbicides than plants with adequate moisture for normal growth.

Seasonal responses. Seasonal treatments of colonial bentgrass turf with several rates of silvex show grass responses that appear to correlate with temperatures and stage of plant growth.

Foliage injury of bentgrass from treatments applied April 4, 1962, showed slight burn only from the 3 lb/A rate. Silvex treatments applied June 1, 1962, caused much greater short-term burn than the April treatments. Summer treatments of silvex at the 1 through 3 lb/A rates applied July 20, 1962 were severe. Foliage responses following August 25, 1961, applications caused the most severe burn. Injury was slight to moderate at the ½, and low to highly severe at the 1 through 3 lb/A rates. Injury

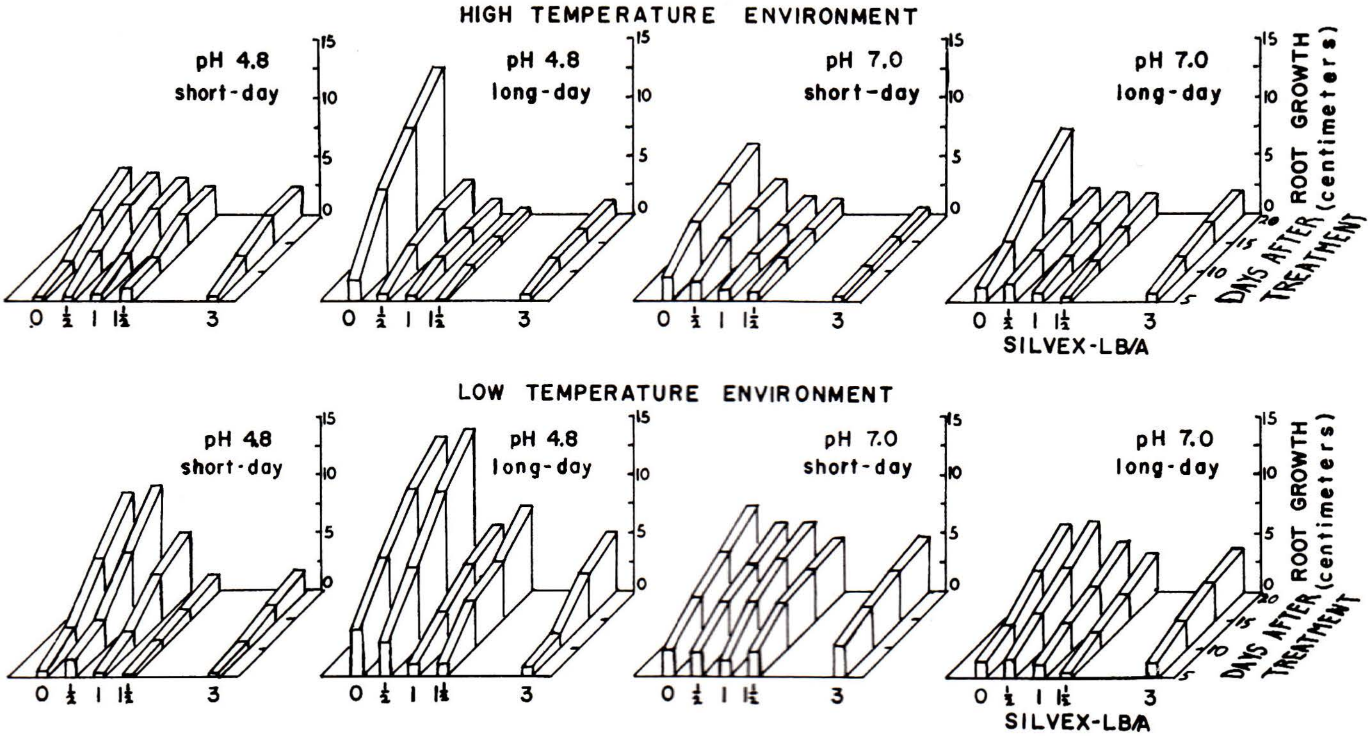

Figure 1. Length of root growth from silvex treatments on 10-week old Colonial bentgrass seedlings grown in nutrient cultures under various environmental conditions.

from treatments at this season persisted for well over a year. The bentgrass turf also received severe injury from the 3 lb/A treatment applied October 1, 1961. Injury, however, was not as severe nor did it persist as long as that caused from the August treatments (Table 3).

Plant counts of colonial bentgrass for the five treatment dates recorded March 24, 1964, (Table 4) showed the highest percentage of live bentgrass occurring in spring and summer treated plots. The greatest bentgrass reduction occurred in plots treated in late summer to early fall. The lowest number of plants appeared to occur in the plots treated with the 1 through 3 lb/A rates of silvex for most of the treatment dates.

Recovery of bentgrass when roots were exicsed at various intervals after silvex treatment. Recovery of bentgrass roots, under greenhouse conditions when roots were excised at several intervals after silvex treatments April 21, 1963, showed little difference between root responses to corresponding silvex rates at the first excision intervals (Table 5). A second series of root excisions, 8 weeks following the first, indicated that root removals at shorter intervals gave greater plant injury. Root length development showed a sharp decrease with increasing silvex rate after the period following the second root excisions.

Root dry weights showed a marked decrease with increasing silvex rate for all excision intervals. The most critical decrease appeared to occur with treatments of 1, 1½, and 3 lb/A (Table 5).

Fructosan concentration in the roots generally increased with increasing silvex rate. The fructosan contents were very high with 3 lb/A of silvex. These high concentrations are indicative of sudden inhibition of plant metabolic processes from silvex treatments which could prevent depletion (Table 5).

In general, those investigations into the effects of silvex on bentgrass grown under various environmental influences indicate that injury to the treated foliage was generally mild. The results further indicate that a direct correlation cannot be made between severity of foliage burn and intensity of root injury. The lack of foliage injury suggests that the plants can hide subtly the critical responses of the roots to the silvex treatments.

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sod production

by Floyd Hilliker

If you're thinking about growing sod as a sideline, forget it. Sod growing is lucrative, but takes very special requirements including the right soil, good geographic location, and heaps of capital.

THE POPULARITY of "instant lawns" has rocketed Michigan's sod growing industry from 1,000 acres in 1955 to over 22,000 acres last year. But this 2,000 percent growth, while making Michigan the nation's number one sod growing state, doesn't guarantee "instant money" to the growers. James Beard, Michigan State University crop scientist, points out that only certain geographic areas and certain selected soils, can even be considered for sod growing on a sound economic basis. In addition, the grower must invest in specialized equipment which cannot be written off on other crops.

Ted Bosgraaf, president of Blue-Grass Sod Farms, Inc., near Hudsonville, in the southwestern corner of Michigan, explains something about geographic necessity, "We've got 280 acres in sod now. Geographically, we fill orders from the Indiana border to the Straits of Mackinac. Actually, we find over 80 percent of our business is close by, in the small area covered by Grand Rapids, Holland, Muskegon, and Grand Haven, maybe 60 miles at the most any one way. You can't store sod. It has to be cut fresh, delivered fresh, and put down fresh, not more than 1 day later. You have to be located pretty close to your market."

Prof. Beard states that Michigan sod growers are all within 12 hours trucking time from a population concentration.

Soil for sod

Soil site selection is vital. Ted Bosgraff uses a muck soil which his family has also cultivated successfully for onion growing. Michigan State research confirms that organic soils are advantageous for sod. They usually have smooth, relatively flat surfaces so that the sod can be cut more easily and uniformly than on mineral soils. The sod weighs less per square yard, making it easier to handle and lay, and a larger payload (more square yards of sod per load) can be trucked on highways. Under favorable conditions, a crop can be produced every 12 months, compared to about 18 months for mineral soils.

MSU crop scientists, however, point out that organic soils have certain disadvantages. Natural drainage is usually poor, and the grower has the added expense of developing ditches and tile drainage. Sometimes, pumps must be installed to lift water from field level to higher-level ditches.

During fall and early spring, excess water may make organic soils so unstable that trucks, tractors, and other equipment must be fitted with extra-size balloon tires and extension rims to travel in the fields. Some growers just fit wagons with balloon tires to haul sod to nearby roads where it is loaded on trucks. Other growers construct gravel roads at intervals across their fields.

Organic soils are also more likely to contain undecomposed woody roots. These must be removed during seedbed preparation because soil used for sod must be absolutely free of stones, gravel, stumps, logs, or any material which may interfere with tillage and harvesting operations.

An additional problem with muck soil is that more time must be spent on installing irrigation facilities and growing windbreaks to lessen blowing during the establishment period.

Mineral soils are recommended for sodding athletic fields, golf greens, and tees, which account for a large part of the sod market. In these uses, the type of play involved often results in a cleavage plane between the sod and the existing soil, making it desirable to have the two as much alike as possible. This places a disadvantage on muck soil. Over 40 per cent of the sod now grown in Michigan is produced on mineral soils primarily by growers having relatively small operations, usually in the vicinity of large population centers.

The biggest drawback of growing sod on mineral soils seems to be the 18-month development period, and the smaller payload that is possible because the sod is heavier than sod from organic soils.

Goodbye topsoil

Soil selection and preparation is similar for both mineral and organic soils. The depth of the effective surface layer is important because each harvest removes a thin layer of soil. The total number of crops possible from any one field are governed by the initial depth of the surface soil, the character of the subsoil, the management practices used to improve the subsoil and thus deepen the surface layer, and the depths of drains, ditches, and the water table or the possibilities of effectively lowering the water table for future production.

The choice of grass seed is dictated by market demand. Ted Bosgraaf uses a mixture of Merion and either Delta or Park bluegraas, on a one to one basis. Michigan State recommends mixtures similar to these, but points out that other bluegrasses are similar to Merion in sunlight and soil requirements and do not require the higher levels of management. In the cooler climates, in shaded areas or on soils with a high sand content, red fescue or a mixture of red fescue and Kentucky bluegrass is recommended. A necessary characteristic of all grasses planted is that the root stock, or rhizomes, must compact the soil with the grass surface, so it will not break when cut.

The best time for seeding is between August 15 and September 15. This takes advantage of the usual rainfall in this period and avoids the competition of numerous annual broadleaved weeds and weedy grasses which are most serious with spring seeding. The rate of seeding, according to Michigan State, can run as low as 20 pounds an acre. On their organic soil, the Bosgraafs use about 55 pounds an acre.

A Brillion grass seeder is widely used in Michigan for seeding large acreages of sod; however, seed can be sown with cyclone or wheel-barrow type grass seeders. The seed should be broadcast on the surface and then firmed with a cultipacker or similar covering apparatus that firms the seedbed but doesn't bury the seed too deeply. Seed should be in the upper 0.25 to 0.05 inch of the soil surface.

To achieve maximum rate of maturity, MSU recommends that each grower follow a regular soil testing program for determination of pH and available phosphorus and potassium. If the soil is strongly acid, below pH 5.5, it should be limed to raise the pH above 5.5 for organic soils and 6.0 for mineral soils. They recommend either pulverized or finely ground limestone.

For weed control, a recommended practice, such as the Bosgraafs use, is a selective weed killer, chosen according to the kinds of weeds being brought under control. This should be applied three or four times during the summer.

Mow, mow, mow

Once the turfgrass is growing and reaches a height of about 4 inches, regular mowing begins. It should be mowed at least every second day, or even every day, until harvest.

Sod is ready for harvesting when it has knitted sufficiently to permit handling without tearing. Sod planted in mid-August can sometimes be harvested as early as mid-June of the following year, depending on growing conditions.

Blue-Grass Sod Farms uses equipment similar to that recommended by MSU. Two men work together, operating a cutter and a roller. The cutter goes first with a horizontal blade beneath the soil, and a vertical blade to cut the turf in strips. The cutter leaves the strips 6-feet long by 18 inches wide, with a thickness of turf other than grass from one-fourth inch to one-half inch. The roller follows close behind, rolling the turf into compact round bundles and leaving it piled behind the machines. Two men can cut and roll 700 yards an hour this way. A crew then picks up the bundles of sod and stacks them carefully on wooden pallets, 50 yards to a pallet. It is delivered palletized to the customer.

Ted Bosgraaf estimates their sales run 60 percent residential and 40 percent commercial. They do not sell directly to homes, but through landscape companies. Their cutting schedule for all sales must be closely integrated with delivery schedules during harvesting, to achieve the earliest delivery.

While being cautious on the disadvantages involved in switching from food to sod production, Prof. Beard is very enthusiastic about sod as an income crop in Michigan for growers who can meet the necessary conditions. He points out that the 22,000 acres of sod-producing land in Michigan yielded an average price of between 27 to 30 cents per square yard, or a gross per acre of somewhere between $1,200 to $1,500 in 1967. He feels this is quite high a return per acre as compared to that from some crops grown in Michigan. This is not land actually being removed from food production, as it can be returned to food at a later date if desirable. He goes on to say, "Our figures indicate that the sod industry in Michigan totals some $30 million in gross returns to the grower. If you consider all phases, including growing, shipping, and laying, the industry totals nearly $90 million per year."

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FROM

MASSACHUSETTS TURF AND LAWN GRASS COUNCIL INCORPORATED

RFD #2, HADLEY, MASS. 01035

This past spring the Golf Course Superintendents Association of America initiated a public relations program. A Chicago firm was hired to raise the image of the superintendent in today's turf industry. We here at the University of Massachusetts are optimistic about the goals of this program, for we believe it is much needed.

One of the main functions of this public relations push was to put into the limelight the superintendent of the golf courses where the P.G.A. tour played. It was hoped that by means of the press and other news media the public could be educated concerning the problems of the superintendent. Pictures and an article about the superintendent were released to the national wire services; and interviews with the superintendent were arranged at television and radio studios.

Up to the present time, this program has been the best means of educating the American public on the problems of a golf course superintendent. However, the efficiency of this public relations program leaves much to be desired. The newspapers, more often than not, failed to publish the articles and, when they did, the article merited only an obscure corner where it went unnoticed. The television and radio interviews, when used, were normally aired on the late, late news broadcast, long after the majority of the public had retired.

A more efficient way of introducing the superintendent would be at the tournament itself. The superintendent could then comment on the actual conditions of the course along with the play-by-play broadcast of the tournament. In this way, the announcers would obtain a professional description of playing conditions.

Normally, during the presentation ceremonies after a tournament, the board of directors, the president of the club, and the members are bestowed with the credit for the condition of the course.

Wouldn't it be refreshing to see a superintendent receive the honor he deserves during this ceremony?

THE EDITOR

PHOSPHORUS STUDY

Phosphorous mobility in soil and its uptake by Kentucky bluegrass and creeping bentgrass is being investigated by workers at the University of Massachusetts.

To date the results of the project, sponsored by The Massachusetts Golf Association, are inconclusive.