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Summer 1981

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SUMMER 1981

BETTER TURF THROUGH RESEARCH AND EDUCATION
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The Massachusetts Turf and Lawn Grass Council is a non-profit corporation. Its officers derive no benefits except the satisfaction of keeping Massachusetts and its neighbors first in turf. It was founded on the principle of "Better Turf Through Research and Education." We must support our University to accomplish this, and we can with a large and strong Turf Council. Membership is not restricted to Massachusetts residents or turf professionals alone, all are welcome to take part. Write today.

For more information write: Mass. Turf and Lawn Grass Council, attn.: Dr. Joseph Troll, RFD #2, Hadley, Mass. 01035, (413) 549-3295

Turfgrass Research Field Day
June 24, 1981 Raindate: June 25th

9:00 - 10:00 A.M. Registration
10:00 - 10:15 Welcome — Dr. John Denison, Dean, Stockbridge School
10:15 - 12:00 Field Tour of Turfgrass Research
12:00 - 1:30 P.M. Box Luncheon on Top of Mt. Sugarloaf
1:30 - 3:00 Guest Speakers:
    Dr. Kirk Hurto, Assistant Professor, University of Massachusetts
    James T. Snow, Senior Agronomist
    Northeast Region: United States Golf Association
    Informal Discussion Period

TURFGRASS RESEARCH

Evaluative Studies
- Turfgrass varieties
- Fungicides
- Herbicides
- Insecticides
- Growth Regulators
- Fertilizers

Management Studies
- Fairway grass selection and management
- Bentgrass fertilization program
- Kentucky bluegrass maintenance
- Turf clipping recycling studies on turfgrass nutrition
- Low maintenance
- Thatch modification
Editorial
Reprinted with permission from "Weeds Today", Vol. 11 No. 4

The Burial of the Two Million Dollar Teaspoon

EPA has reportedly contracted for the disposal of 30 million pounds of lawn fertilizer containing silvex. The cost of the "grave"? $2.1 million.

The EPA release reads, "This contract involves disposal of dry fertilizer-based products which contain no more than 1.5 percent of the active ingredient, silvex, which the Agency estimates to contain about 25 parts per billion or less of the toxic contaminant dioxin (TCDD). Over 95 percent of the material being disposed of consists of inert carriers for the fertilizer and weed-killer (such as corn cob grits or vermiculite)." Registrants of the products are to transport the materials to the disposal site and that could increase the cost considerably.

According to my calculations, the whole "kitten caboodle" contains about 5 grams of dioxin — one teaspoonful. Boy, are we ever a bunch of scaredy-cats, spending over $2 million to bury a teaspoonful of anything.

The grave, referred to as a "single burial cell," will reportedly hold 240,000 cubic yards. According to figures from the local trainmaster, that's about 1,500 box cars. With 100 cars per train, that's 15 trainloads.

Perhaps what we should do for slow-learners is park them by a railroad crossing to watch a 100-car train pass by — at the speed they usually do for you — then another, and another, until 15 trainloads have passed by. And in all that time, one itsy bitsy teaspoonful would have passed before their eyes — not in one car, not in one train, but in all 15 trainloads. Just think of the time, effort, energy and cost — to dispose of such a tremendous trifle — one teaspoonful. What should we call it, "Blum's folly"?

But that's just part of the story. There are about four million containers of various sizes with almost a million gallons of liquid silvex. EPA has considered having these containers emptied and rinsed and the material incinerated at sea. According to figures where the silvex going to sea would contain about two teaspoons of dioxin.

One EPA official reportedly estimated the total cost to taxpayers for silvex disposal and indemnities at $30 million. So that's $30 million to dispose of three teaspoons — one by land and two by sea. Wouldn't Paul Revere turn over in his grave if he could see what foolishness the bureaucracy of his great country is up to.

And what really gets your goat is the way we squander money frivously, and needlessly on such regulatory activities while funding for educational programs for pesticide applicator training are being cut. Who will pick up the burden for that program initiated by the feds? You guessed it, the feds would like to dump it in the states' laps. And where will the states get the funds — the most likely place is by charging those who are being regulated and never asked for the program in the first place.

2 + 2 = 4

We certainly don't have anything against education. In fact, some good old arithmetic for some of those folks in EPA might be a good place to start.

The average mind probably hasn't caught up yet with terms like parts per trillion. If you say 10 parts per something — well, 10 sounds like a fairly big number. But 10 parts per trillion is like 10 seconds in 320 centuries.

Come on EPA, get your rear in gear and do your homework. You're supposed to provide some responsible leadership instead of catching butterflies with bear traps.

2,4-D

What concerns many of us now is EPA's domino game. They suspended many uses of 2,4,5-T and silvex just before the RPAR decision was ready. The major basis for their decision has been largely shown to be faulty. But perhaps their math book says 1 wrong + 1 wrong = 1 right. They acknowledged that dioxin had not been found in 2,4-D, but now 2,4-D is under scrutiny and subject to guilt by association.

2,4-D provides one of the lowest cost, most efficient methods for controlling weeds. If you are truly concerned about water quality, remember that the trend is toward reduced tillage — to save soil and energy. As we reduce tillage, 2,4-D, still our major postemergence herbicide, will become all the more essential.

I like Steve Jellinek's story about the G.I. who walked into a French village after the American's had bombed it to drive out the Germans. He said, "Boy, we sure liberated the h___ out of this place." At the rate EPA is going, that's about how our farmers and even the food consumer will feel if EPA continues their bombardment.

If EPA wants to listen to the potheads who want to get rid of any chemical that kills marihuana, or to the mafia, that's their privilege, as long as that's all they do is listen. But remember that the Good Lord doesn't let man discover a 2,4-D very often. And if we fritter away the discoveries he does allow us, we know not when he will let man use his mind for such great discoveries again.

"The concern for man and his destiny must always be the chief interest of all technical effort. Never forget it among your diagrams and equations."

— Albert Einstein

"When a country chooses its technology, it chooses its future."

— E. F. Schumacher

"EPA, yours is a grave responsibility. Don't dig one for 2,4-D."

Ellery L. Knake
The herbicide 2,4,5-T (2,4,5-trichlorophenoxy acetic acid) has been a valuable asset for the past 25 years due to its excellent control of broadleaf plants. It has been especially important for clearing rights-of-way and in the production of pine timber and rice. However, recently it has been especially important for clearing operations. The proximity of these operations is possible to 2,4,5-T applicators.

Included with the information currently being compiled by EPA are data collected by researchers at the University of Arkansas. We were interested in collecting information which was lacking on actual human exposure to 2,4,5-T. For our study, field workers were tested who used 2,4,5-T in their regular spray operations. The proximity of these people to mixing and application operations should afford the maximum human exposure possible to 2,4,5-T applicators.

A great amount of investigation has already taken place with 2,4,5-T. The Council for Agricultural Science and Technology (CAST) has studied 2,4,5-T, along with other phenoxy herbicides. CAST reports issued in 1975 and 1978 state that these herbicides are beneficial and safe for use if precautions that must be taken with any pesticide are observed.

Although opposition to this opinion remains, the reputation of 2,4,5-T may have been clouded for the public by its past association. It was among the broadleaf defoliants used in Vietnam and, consequently, is sometimes still allied with the reputations of Agent Orange or dioxins. These compounds are presently being blamed for adverse effects on human life resulting from their use in the war in Vietnam.

To color the reputation of 2,4,5-T further, it is a fact that TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), a dioxin toxic to animal life, occurs as a byproduct during the manufacture of 2,4,5-T. When 2,4,5-T was first produced, levels of TCDD remaining in the herbicide could run as high as 32 ppmw, but the process today produces 2,4,5-T with only trace levels of less than 0.05 ppm. The compound used in our study contained 0.04 ppmw of TCDD. (This amount is equivalent to 1 drop in 7200 gallons of the spraying mixture). Although estimates had been made on human exposure prior to the study by our staff at the University of Arkansas, only limited information was available on the level of exposure to humans applying 2,4,5-T.

The study was carried out using crews engaged in their usual work activities in central Arkansas pine forests and rice fields. Twenty-two workers participated in the study. Some of these people have been involved in 2,4,5-T spray operations for several years. None of them have reported harmful effects as a result of working with the herbicide. As nearly as possible, investigators did not interfere with work habits of the crew members. Spray operations included a ground crew with backpack spray rigs, a tractor-propelled mist blower crew, and helicopter crews who make aerial application.

Our objectives were to analyze the 2,4,5-T content of the air around the worker to which his skin might be exposed, the air he breathed, and his urine, which can indicate the total internal dose to which he is subjected.

To accomplish the first analysis, we attached gauze patches to the clothing of the worker on the chest, upper back, bicep, and thigh areas just before each spraying operation began and removed them immediately after the spraying was complete. The gauze patches were placed in amber-colored glass jars containing methyl alcohol and transported to the laboratory for analysis.

To measure 2,4,5-T in the breathing zone, we attached a small pocket-sized air pump to the clothing of the crewman. The pump pulled air across an absorbing resin which trapped the 2,4,5-T present. This resin was taken to the laboratory, extraction made with methyl alcohol, and analysis performed with a gas chromatograph equipped with an electron capture detector.

Complete urine samples were collected from each crew member from one day before to four days beyond the spraying operation. Previous studies had shown that over 95% of the 2,4,5-T that enters the body is excreted in a 7-day period.

Analyses were carried out at Northrop Laboratories in Little Rock and at the Alzheimer Laboratory in Fayetteville. The methods used have been shown to be precise to the 10 parts per billion level. We attempted not only to determine how much exposure each worker was subjected to but also to note the relationship of the amount of exposure to his official work duties. All workers involved in the spray operation were included: supervisors, spray mixers, backpack sprayers, tractor drivers for the mist blower, helicopter pilots, and flagmen. Some workers handled the spray compound more than others, and some (backpack crewmen, especially) were in closer contact with the spray mist. Crewmen also had their individual techniques for performing their duties. Some wore protective clothing and were very careful; others...
seemed negligent in taking safety precautions. Our research crew made no suggestions and measured exposure without reference to work habits.

Total exposure was determined by the urine analysis and was measured in terms of milligrams per kilogram of body weight. This measurement can, in turn, be used with comparisons to exposure of laboratory animals in other studies. Mice (the most sensitive animal species studied) can tolerate levels of 20 mg/kg without showing any ill effects. Results from our tests indicated that workers who mixed the concentrate received the highest exposure with an average of 0.062 mg/kg, and backpack spray operators were second high with 0.047 mg/kg. The rice levee spray operator received less exposure than the backpack or mist blower crews. Helicopter flagmen received least with 0.001 mg/kg. Results averaged by crew showed that the backpack crew received the most exposure (0.058 mg/kg) followed by the mist blower (0.044 mg/kg) and the aerial crew (0.022). EPA had estimated that a backpack spray operator would receive an exposure of 7.0 mg/kg.

We compared the analyses of human exposure in these Arkansas tests with EPA estimates on exposure and with other studies on toxicity of 2,4,5-T (Figure 1). These comparisons show that actual exposure to crewmen in these field tests were well below those that EPA had estimated for human exposure in spray operations. Exposure levels to 2,4,5-T and the dioxin associated with it are also well below those found to produce toxicity symptoms in sensitive laboratory animals. When we divide 20 mg 2,4,5-T/kg body weight (a dose level showing no effect in laboratory animals) by 0.062 mg/kg (the highest 2,4,5-T exposure received by any group of workers in our study), we interpolate that the crewmen could likely have been exposed to 322 times more than they were without harmful effects.

By analogy, if a human takes a single overdose of as much as 3 times the prescribed dosage of aspirin, he would likely exhibit adverse effects. Since over 95% of the 2,4,5-T absorbed by humans is excreted within 7 days, toxic levels could not build up in the body even for individuals repeatedly applying the herbicide.

The results of our test alone cannot be considered conclusive, but the popular reputation that 2,4,5-T has acquired, perhaps through association with dangerous substances, appears to be unwarranted. Our data have been included in the information which was recently evaluated by the Scientific Advisory Panel appointed by EPA to study 2,4,5-T. Final EPA decisions have not yet been made, but a portion of the panel's recommendations reads as follows:

"After extensive review of the data, we find no evidence of an immediate or substantial hazard to human health or to the environment associated with the use of 2,4,5-T or silvex on rice, rangeland, orchards, sugarcane, and the noncrop uses."

EPA has several alternatives to choose from: 1) lift the current ban of 2,4,5-T for forestry, rights-of-way, and pastures; 2) increase the ban to include the use of 2,4,5-T on rice, rangeland, orchards, sugarcane, and non-crop uses; 3) continue to study benefits and risks of using 2,4,5-T; or 4) take some other course of action. Hopefully, the information collected by our research team will help expedite this important decision.
Investigation and Treatment of Localized Dry Spots on Sand Golf Greens

J. F. Wilkinson and R. H. Miller

Reprinted with permission from "Agronomy Journal", Vol. 70 No. 2

ABSTRACT

Several experimental sand golf greens were seeded in 1972 to 'Penncross' creeping bentgrass (Agrostis palustris Huds.) in Columbus. Localized dry spots became a serious problem during the summer of 1974. Despite heavy, frequent irrigation the soil remained hydrophobic, resulting in patches of dead or severely wilted turf. The turf and thatch would wet, but water would not penetrate the thatch/soil interface. Infiltration rate within the dry spots was studied in the laboratory using a permeameter, and by placing water droplets along horizontally positioned soil cores. Several wetting agent and soil cultivation treatments were utilized in a field study to alleviate the dry spots. The cause of the dry spots was investigated by observing individual sand particles under a scanning electron microscope.

The hydrophobic condition was restricted to the upper 2 cm of soil. Infiltration rate within the dry spots was 20% of that for normal turf. Hydro-Wet and Aqua-Gro reduced the severity of the dry spots, but a combination of coring plus wetting agent proved most beneficial. Maintaining moist soil conditions was the best defense against the dry spots. Allowing the soil to become dry makes the hydrophobic condition worse.

Scanning electron micrographs provided evidence of a coating surrounding individual sand particles. The coating had the appearance of fungal mycelium and was organic and acidic in nature. No specific fungus was isolated that could be shown to be the cause of the dry spots.

Additional index words: Aeration, Agrostis palustris, Coring, Creeping bentgrass, Infiltration rate, Hydrophobic soil, Scanning electron microscope, Wetting agent.

LOCALIZED dry spots in soils have been observed extensively in the past. The hydrophobic condition has been studied in turf, citrus, and forest areas (7, 10, 12, 14, 15). In turf, the symptoms generally are irregular patches of dead or wilting plants, despite adequate irrigation or precipitation (10, 12, 13). The problem has not been considered serious in the past since it does not interfere with plant growth or crop production on a widespread basis. However, localized dry spots on fine turf areas such as putting greens can severely disrupt use of the area.

The hydrophobic condition appears worse in coarse vs. fine textured soils (7, 12). The condition generally is restricted to a few cm at the soil surface (12), however, one report indicates it may be present to a depth of 1/2 m (2). Percent moisture within the dry zones has been measured at 0.5% (1, 2), while moisture in an adjacent area is 5 to 6%. The condition has been found on young as well as old turf installations (12).

Preventive measures on turf have been concerned primarily with maintaining adequate soil moisture (6, 9, 12, 13). The non-wettable condition appears to be made worse by allowing the soil to dry (1, 12, 13). Corrective measures for existing dry spots include combinations of wetting agents and soil cultivation (coring and spiking) (10, 12, 13). Cultivation is intended to provide channels for water movement into and through the dry spots. These treatments are most successful if begun before the dry spots become serious (13).

Numerous attempts have been made to elucidate the cause of the hydrophobic condition. The most widely held explanation is fungal mycelium or extra-cellular organic material coating individual soil particles rendering them hydrophobic (2, 4, 14). Attempts at isolating a fungus from dry spots have proved unsuccessful. An organic coating does exist, and limited scanning electron microscope (SEM) work has suggested the presence of fungal hyphae associated with individual soil particles from localized dry spots (5). Further indications are that the coating is polar, and results from formation of Ca or Mg soaps of fatty acids (12, 14, 15, 16). Numerous fairy ring fungi restrict water infiltration in turf areas, however, this generally is considered a physical barrier effect where a dense mycelial mat is evident (6, 8, 9).

The objective of this investigation was to more

Table 2. Effect of three wetting agents applied 15 May 1975 with and without coring on the severity of localized dry spots in July. Turf quality rating 1-9, 9 no damage, 1 dead turf.

<table>
<thead>
<tr>
<th>Cultivation</th>
<th>Wetting agent</th>
<th>Rate (L/ha)</th>
<th>Date</th>
<th>Turf quality rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>8 July</td>
<td>23 July</td>
<td>31 July</td>
</tr>
<tr>
<td>Hydro-Wet</td>
<td></td>
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<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>Aqua-Gro</td>
<td></td>
<td>2.1</td>
<td>0.65</td>
<td>0.35</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>0.65</td>
<td>0.35</td>
<td>0.35</td>
</tr>
</tbody>
</table>

L.S.D. (P<0.01)

|               |               | 2.1         | 0.65          | 0.35                |          |

|               |               | 2.1         | 0.65          | 0.35                |          |

*Published with the permission of the Director of the Ohio Agric. Res. Dev. Ctr. and submitted as journal article No. 6077. This research was supported partially by the Ohio Turfgrass Foundation. Received 31 May 1977.

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Fig. 1. Comparison of cores taken from dry spot (right) and normal (left) areas after irrigation for 1 hour.

Fig. 2. Core taken from a dry spot showing no penetration of water past the thatch/soil interface after 1 hour of irrigation.

Fig. 3. A water droplet which would not penetrate the soil within 2 cm of the soil surface on a core taken from a localized dry spot.

Fig. 4. Percent moisture — tension curve of the sand rootzone mix used on the greens.

Fig. 5. Comparison of infiltration rates measured on a perimeter on dry spot and normal area cores with and without thatch.

Fig. 6. A thin section made from a Castolite impregnated soil core from the surface of a localized dry spot showing no apparent barrier to water movement.

MATERIALS AND METHODS

Localized dry spots became a serious problem on several experimental golf greens at the Ohio State University turfgrass research plots in Columbus during the summer of 1974. The greens were constructed in 1972 with a root zone consisting of 85 to 90% sand (Table 1). Similar mixtures are used widely in greens construction to ensure adequate infiltration and minimum compaction. The greens were seeded to 'Pencrest' creeping bentgrass (*Agrostis palustris* Huds.) and have been maintained under putting green conditions. 

*Nature of the Dry Spots.* When the dry spots first appeared, several 2 cm diameter cores were removed and placed in a horizontal position. Depth of the hydrophobic condition was determined by placing water droplets at 1 cm intervals along the core.
Fig. 7. SEM's of sand particles taken from localized dry spots showing a coating surrounding the particles. (A) × 41, (B) × 82, (C) × 82, and (D) × 820.

and measuring infiltration time (sec). Percent soil moisture was determined by irrigating the greens, allowing them to drain for 24 hours, and removing and drying (100°C) samples from both dry and normal areas.

Water infiltration was measured by forcing 8 cm diameter metal cylinders into the thatch and soil. A 5 cm water head was placed within each cylinder and time (min) for complete infiltration was measured. Additional samples were taken with a double-cylinder, hammer-driven 7.5 cm diameter core sampler for laboratory determination of infiltration. The cores were placed on a permeameter with a 5 cm water head. Infiltration rates were determined with and without thatch.

Correction of the Dry Spots. Several cultivation and wetting agent treatments were used in an attempt to alleviate the hydrophobic condition (Table 2). On 15 May 1975, half of several greens were aerified (cored). Three wetting agents at four rates were applied perpendicular to the cultivation to produce 3.2 m² plots. Severity of the dry spots was evaluated on three dates in July 1975 using a rating scale of 1 to 9, 9 indicating no damage and 1, dead turf.

Causes of the Dry Spots. Several techniques were used to elucidate the cause of the hydrophobic condition. Particle size distribution analyses were run on several dates to determine if there had been a migration of fine particles downward through the profile causing a layering effect.

In July 1975 several undisturbed cores were taken from dry and normal areas and air dried. The cores were impregnated with an unsaturated, thermalsetting polyester (Castolite), and thin sections were prepared as described by Brewer (5) for microscopic examination.

Additional samples were taken in August 1975 and dried at 70°C. Individual sand particles were observed from both dry and normal areas with a SEM after gold coating. Following this, samples from dry areas were (a) ashed at 900°C, (b) washed with 5% HCl, or (c) washed with 5% NaOH and inspected again with the SEM.

RESULTS AND DISCUSSION

The dry spots first appeared as irregular shaped patches of dead or severely wilted turf in July 1974. The soil within these areas was dry despite frequent irrigation and normal soil moisture levels in adjacent areas (Fig. 1). The soil remained dry even though the amount and frequency of irrigation was increased. Water penetrated the turf and thatch, but would not penetrate the thatch/soil interface (Fig. 2). Irrigation water puddled momentarily on the dry spots and flowed off into the normal adjacent turf and soil.

Several turf-thatch-soil samples were taken at the time in an attempt to isolate a fungus. Several fungal species were found (Helminthosporum, Alternaria, Curvularia), but all species were present in both dry and normal soil samples. No active mycelium could be observed at this time within the thatch or soil. Only after heavy, frequent irrigation (1 hour twice per day) for 2 weeks did turf recovery begin. Heavy irrigation continued during 1974 to avoid a reoccurrence of the dry spots.

Mushrooms became a problem on the greens, appearing between mowings in April 1975. Two fungal species, Conocybe and Naucoria, were identified. A
mat of mycelium was present in the vicinity of the mushrooms throughout the thatch and upper 1 cm of soil. The mushrooms continued to appear between mowings for about 2 weeks, but did not appear to affect turf quality or cause localized dry spots.

Cultivation and wetting agent treatments were made in May 1975 in anticipation of the dry spots reoccurring. They did reoccur in mid-July, however, there was no evidence of a mycelial mat within the thatch or soil at the time.

Nature of the Dry Spots. The hydrophobic condition apparently was restricted to the upper 2 cm of soil since water droplets placed within this region would bead up and not infiltrate for 0.5 to 2.0 min (Fig. 5). Water droplets would rapidly infiltrate at greater depths. Restriction of the hydrophobic condition to the upper 2 cm is confirmed by the fact that coring, which normally removes an 8 to 10 cm deep plug, alleviated the dry spots by providing channels for water movement into the soil. (Table 2).

Percent moisture in the dry spots averaged 3.0 % 24 hours following irrigation, whereas moisture in the normal areas averaged 6.8%. This 3.8% difference in soil moisture can be critical in a sandy soil. The percent moisture-tension curve (Fig. 4) shows a sharp break between available and non-available moisture occurring at 6%. Although the 3% moisture found within the dry spots is somewhat higher than found in other dry spot studies (1, 2), it was low enough in this case to cause considerable turf injury.

Infiltration into the dry spots required about 4.5 min with a 5 cm water head, whereas infiltration into the normal areas was complete in under 2 min. In a natural situation of rainfall or irrigation, infiltration into a dry spot would be much slower since a 5 cm water head would not be present. The water would flow off the dry spot and infiltrate into the adjacent normal soil.

Infiltration into dry spot cores was much slower than into normal cores placed on a permeameter (Fig. 5). Removal of thatch did not significantly influence infiltration into the dry core. This confirms that the hydrophobic condition extended into the soil, and was not merely a function of the thatch layer. Dry spot cores on the permeameter for 1 hour were broken apart and were found to be saturated. Despite this, water infiltration did not increase to the level of the normal cores.

Correction of the Dry Spots. Both coring and wetting agent treatments partially alleviated dry spot severity (Table 2). Hydro-wet and Aqua-Gro reduced injury caused by the dry spots on several rating dates, whereas Grozyme had no effect. Aerifying alone reduced the severity of the dry spots considerably, however, a combination of the wetting agent plus coring was most beneficial.

Allowing the soil to become dry made the hydrophobic condition worse (1, 12, 13 Abstr.). Maintaining adequate soil moisture is the best defense against dry spot problems. Since the break between adequate and insufficient moisture in coarse soils is so sharp, maintaining adequate soil moisture can be difficult during periods of high evapotranspiration.

Cause of the Dry Spots. Thatch, which does become hydrophobic when allowed to dry out, had been eliminated as the problem source by the infiltration studies. Thin sections made from Castolite impregnated cores indicated nothing which would hinder water infiltration (Fig. 6). Pore size appeared more than sufficient to allow for adequate water penetration.

Particle size distribution analyses at several depths did not indicate a migration and layering of finer particles. However particle size distribution analyses made 2 years after construction of the particle greens
This may explain the mixture appearing in coarser textures (Fig. 7). This coating had the appearance of an amorphous covering interspersed with fungal mycelium and did not occur on samples from normally wet areas (Fig. 8). Several sand particles were found bound together by the coating in numerous cases (Fig. 9). This may explain the mixture appearing coarser textured 2 years after construction of the greens. Repeated washing and sieving apparently broke the sand particles apart and a finer texture was indicated.

The coating was organic since ashing removed it. Washing the sand with 5% HCl did not remove the coating, whereas 5% NaOH did, indicating the coating was acidic (Fig. 10). Earlier work suggested the dry spots are caused by organic coatings which are hydrophobic (12, 14, 15, 16). Speculation is that the non-wettable coatings are Ca or Mg soaps of fatty acids. This would be possible in this case since the root zone mix was alkaline and contained approximately 15% free CaCO₃.

The hydrophobic condition described can best be attributed to an organic coating surrounding individual sand particles. Identification of this coating by work done in conjunction with this research indicates it may be the result of mycelial growth which took place before the dry spots appeared (11). The fungi were not active when the dry spots appeared, perhaps due to high temperatures or insufficient moisture. As a result, it was impossible to isolate any causal organism.

**LITERATURE CITED**

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Aquatic weeds can be found in almost any body of water. Farm ponds, man-made reservoirs, natural lakes, irrigation and drainage ditches, livestock watering troughs, swimming pools, aquaria, and ornamental pools in shopping malls all provide suitable sites for the growth of some type of aquatic weed. Even low, poorly drained areas on golf course grounds can support the growth of gelatinous masses of the blue-green alga *Nostoc,* much to the chagrin of golfers who must walk over or around the slippery mats!

**Problems Caused by Aquatic Weeds**

Aquatic weeds cause problems as diverse as the sites they inhabit. Some are obvious; for example, the loss of recreational value due to the hindrance of boating, fishing, and swimming activities. Millions of dollars are spent each year on the installation and maintenance of extensive filter systems and on the copper sulfate treatment of municipal water supplies for the control of taste and odor causing diatoms and blue-green algae.

Aquatic weeds impede the flow of water in irrigation and drainage ditches, a situation which is particularly serious in the water-limited western states. According to 1976 Bureau of Reclamation figures, over 47,000 miles of waterways in 14 western states were seriously infested with aquatic weeds.

A more subtle effect, particularly from shoreline and free-floating weeds, is the loss of surface and ground water through transpiration. Water hyacinth plants, for example, release 30-40% more water from their leaf surfaces than that which is lost by evaporation from a free water surface. Because of their high water requirements, shoreline plants such as salt cedars or tamarisks, cottonwoods, and willows can actually cause ground water levels to drop during the day while they are actively transpiring.

Fish populations are also adversely affected by excessive weed growth. Although some aquatic plant growth is desirable for oxygen production and as habitat and protection for young fish, too much vegetation prevents predation of young fish by the larger fish. This results in overpopulation, stunting and a general decrease in fishing quality.

It is well known that summer fish kills can be caused by plant die-off with subsequent decomposition and loss of oxygen; however, winter fish kills can be just as common. Ice and overlying snow prevent the penetration of light to the underwater microscopic algae which produce oxygen. If the pond or lake suffered from extensive weed growth the summer before, their decomposition may also add to the depletion of oxygen. The severe winters of 1976-77 and 1977-78 in Indiana, for example, probably caused total fish kills in over 50% of the farm ponds and in many larger reservoirs and lakes. The cure for this situation is a good weed control program early in the summer and the maintenance of open water by means of pumps or aerators.

Another effect of aquatic weeds on ponds and lakes is to cause their gradual filling in, a process which eventually results in dry land. To the casual observer, this process goes unnoticed. Indeed, many farm pond owners erroneously assume that their pond is the same depth as it was when first constructed. Runoff of sediment, leaf litter and the fall die-back of aquatic and shoreline vegetation contribute to this process. In a practical sense, it is essential that maximum pond depth be redetermined each year on the installation and main-
nutrients can greatly stimulate the growth of aquatic weeds. For example, one pound of phosphorus will support the growth of 500 pounds of algae (assuming the other nutrients are present in sufficient quantities); thus, preventive measures work only where the source of nutrient input is localized and can be easily controlled.

**Mechanical Controls**

Mechanical methods such as hand-pulling, raking, or dredging are effective but time consuming, laborious, and expensive. Some fairly simple mechanical methods are often overlooked such as dragging a chain between two tractors across the bottom of a pond to uproot the vegetation. Mechanical harvesters are also available. However, one of the drawbacks of mechanical control is in the transportation and disposal of huge amounts of wet vegetation.

Current research is aimed at finding uses for this vegetation and includes using it as a supplement in livestock feed and as a mulch for gardens. Since cattle reject wet plants, considerable expense must be taken to dry the vegetation and formulate it in the correct ratio with other feeds before the plants are acceptable. The technology is still in the research stage.

**Biological Controls**

Some of the most spectacular successes in the biological control of weeds has occurred in the aquatic area. Insects are currently being used for the control of alligatorweed, and there are several promising candidates for the control of water hyacinth. In the past few years, much publicity has been given to the grass carp or white amur, an herbivorous fish that consumes aquatic vegetation without feeding on other animal life even when starving. This fish has been confused with the common carp (Cyprinus carpio) and with the Israeli carp which is a common carp bred for greater meat production.

Although they are in the same family of fishes, the grass carp is in a different genus (Ctenopharyngodon idella). The grass carp does not disturb or roll the water with sediments nor does it breed naturally in our waters to crowd out native game fish. However, since the fish is an exotic originally imported from northern China, there remains much skepticism concerning its possible benefits. It has been allowed by law in only four states: Arkansas, Mississippi, Alabama, and Kansas. It can be sold by permit in Florida, Iowa, and Missouri, but its sales and shipment are prohibited in all other states.

**Chemical Controls**

The major means of attacking aquatic weeds is the use of herbicides. However, the list of herbicides registered for use in water seems to get smaller each year. Silvex, formerly one of the standard treatments for emergent broadleaves and certain submersed plants such as watermilfoil, can no longer be used. However, compounds are still available to control many of our aquatic weed species. A partial list of these is provided in Table 1.

<table>
<thead>
<tr>
<th>Aquatic weed</th>
<th>Herbicide</th>
<th>Rate</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae (phytoplankton, filamentous, Chara)</td>
<td>Copper sulfate</td>
<td>2.7 lb/A·ft.</td>
<td>Do not use in trout waters</td>
</tr>
<tr>
<td>Copper chelates (Citrin Plus)</td>
<td>0.6-1.2 gal/A·ft.</td>
<td>Do not use in trout waters</td>
<td></td>
</tr>
<tr>
<td>Endothall (Hydrothol 191)</td>
<td>1.1 pts/A·ft.</td>
<td>F = 3 days; L, D = 7 days</td>
<td>Do not use for crop irrigation</td>
</tr>
<tr>
<td>Simazine (Aquazine)</td>
<td>1-3.4 lb/A·ft.</td>
<td>I, L, D = 12 months</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Submersed plants</th>
<th>Herbicide</th>
<th>Rate</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(coontail, watermilfoil, pondweeds such as sago, curly/leaf, leafy)</td>
<td>Endothall (Aquathol K)</td>
<td>1.3 gal/A·ft.</td>
<td>S = 1 day; F = 3 days, I, D = 7 days</td>
</tr>
<tr>
<td>Diquat</td>
<td>1-2 gal/SA</td>
<td>S, L, I = 10 days</td>
<td></td>
</tr>
<tr>
<td>Simazine (Aquazine)</td>
<td>3.4-6.8 lb/A·ft.</td>
<td>I, L, D = 12 months</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Free-floating plants</th>
<th>Herbicide</th>
<th>Rate</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(duckweed, watermeal)</td>
<td>Diquat</td>
<td>1 gal/SA</td>
<td>S, L, I = 10 days; D = 14 days</td>
</tr>
<tr>
<td>Simazine (Aquazine)</td>
<td>3.4-6.8 lb/A·ft.</td>
<td>I, L, D = 12 months</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rooted-floating plants (waterlilies, spatterdock)</th>
<th>Herbicide</th>
<th>Rate</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-D (Aquakleen)</td>
<td>200 lb/SA</td>
<td>Do not apply to waters for I, D, dairy animals</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emerged plants (cattails, perennial grasses)</th>
<th>Herbicide</th>
<th>Rate</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalapon (Dowpon + wetting agent)</td>
<td>15 lb/SA</td>
<td>Restrict spray to plant foliage</td>
<td></td>
</tr>
</tbody>
</table>

---

*a Consult your appropriate state agency for specific recommendations and use restrictions.

*b These are liquid formulations which are also available as granules.

*c Treated water may be used for sprinkling bent grass immediately.

F = fishing; I = irrigation; L = livestock; D = domestic use.

SA = surface acre.
along with the restrictions on the use of water following treatment.

Treatment is recommended for late spring or early summer when plants are young and relatively susceptible. Furthermore, water at colder temperatures contains more oxygen than does warm water, thus providing a greater margin of safety for fish populations; for example, saturated water at 65 °F contains 9.2 ppm oxygen whereas water at 85 °F contains only 7.5 ppm. However, treatment must not be made when the water is too cold (less than 60 °F). Although plants grow at these temperatures, they may not be metabolizing rapidly enough to take in sufficient quantities of the herbicide. In addition, consideration must be given to spring rains and the possibility of washing the herbicide downstream.

There is no substantial evidence that fall treatments are particularly effective. By then, seeds or algal spores have been produced to provide for growth the following season. Also, treatment one year will not guarantee that a second year's treatment will not be required. At the very least, herbicide should be kept on hand to provide for spot treatment the second year.

**Herbicide Persistence and Toxicity**

Most of the aquatic herbicides cleared for algae and submerged plants are contact materials with very short persistence in water. Thus, the waiting period for use of the water is usually relatively short. An exception to this is the herbicide Aquazine (simazine). As with other triazine herbicides, the chemical can persist for the entire season; thus, the restriction—a 12 month waiting period for livestock watering, irrigation, and domestic use—is more severe than for other chemicals. There are no restrictions on fishing or swimming, however.

One potential problem with Aquazine is the possibility of injury to trees and other plants along the shoreline. The chemical is absorbed by the roots and translocated to the leaves which then show typical triazine injury symptoms. The chances of this happening are difficult to predict and are probably dependent on the amount of root biomass exposed directly to the chemical in the water. On the plus side, Aquazine is one of the few herbicides that has broad spectrum activity and controls algae and submerged and free-floating flowering plants.

One of the most frequent concerns regarding aquatic herbicides is their potential for toxicity to fish, livestock, or wildlife that happen to wander to the water's edge soon after treatment. Once diluted, mammalian toxicity is very low and there are few, if any, reported cases of mortality to livestock, ducks, geese, etc. However, several compounds, even when diluted, are relatively toxic to fish. Table 2 compares the use rates (in ppm) of the most common aquatic herbicides with the LC₉₅ for bluegills (dose in ppm which will kill half of the population in 48 hr).

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Use rate (ppm)</th>
<th>48 hr. LC₉₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulfate</td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>Hydrothol 191</td>
<td>0.05-0.2</td>
<td>1</td>
</tr>
<tr>
<td>Aquashot</td>
<td>0.5-3.0</td>
<td>200</td>
</tr>
<tr>
<td>Diquat</td>
<td>0.2-1.5</td>
<td>91</td>
</tr>
<tr>
<td>Aquazine</td>
<td>1.0</td>
<td>118</td>
</tr>
<tr>
<td>Dowpon</td>
<td>1.0</td>
<td>119</td>
</tr>
<tr>
<td>2,4-D ester (liquid)</td>
<td>0.4*</td>
<td>1</td>
</tr>
<tr>
<td>2,4-D amine</td>
<td>0.4*</td>
<td>840</td>
</tr>
</tbody>
</table>

*Calculated for 4 acre-ft.

There is a wide margin of safety with most of the herbicides. Exceptions include Hydrothol (dimethylalkylamine salt of endothall) and the liquid ester formulations of 2,4-D. Hydrothol should be used only as a partial pond treatment, leaving untreated water for fish to escape to. Even with this precaution, localized fish kills can occur.

Liquid 2,4-D esters are particularly effective against shoreline brush species, but the toxicity of these formulations negates their usefulness in the aquatic situation. Exceptions to this are granular 2,4-D esters such as Aquakleen and Weedtrine II.

The margin for safety of the most widely used herbicide, copper sulfate, is not as great as one would wish. Although fish kills following use are rare, they do occur and are probably associated with the kill of microscopic algae which are more difficult for the unfamiliar observer to notice than the conspicuous growth of mat-forming filamentous algae.

**Control with Dyes**

Another method of aquatic weed control which involves a chemical but is actually non-pesticidal in nature is the use of the blue dye Aquashade. It has long been known that shading aquatic plants by use of black plastic or dyes can be an effective control method. Aquashade is particularly useful for ornamental ponds where there is little or no water outflow and where the major weed problem is of the submerged type. It is also effective on algae but only when applied before the algae appear at the surface of the water. It will not control algae which originate in shallow water less than one- to two feet deep; thus, copper sulfate may have to be applied in conjunction with an Aquashade treatment.

The dye should be applied before or just as the weeds appear in late winter or early spring. A second application in mid-summer may be required depending on the residence time of the material. It should not be applied to turbid water since the most rapid removal of the dye, other than from direct water outflow, is through sediment adsorption.

**The Future**

What new developments in aquatic weed control can we look for in the next several years? One certainly will be the introduction of controlled release aquatic herbicides: formulations which can produce long-term control while releasing very small amounts of chemical at any one time. An exciting area of research in aquatics is that of plant growth regulators. These compounds have a tremendous potential for providing the "ideal" aquatic habitat: plant growth sufficient to produce oxygen and provide fish cover but not so great as to impede man's activities. With these and the methods currently at our disposal, we can be optimistic about the future of aquatic weed control.
Is there some restlessness, concern and modest dissatisfaction among the rank and file of golf course superintendents in the Metropolitan New York area? Apparently so, and its is more obvious than we believed. This was illustrated by Jim McGloughlin, Executive Director of the Metropolitan Golf Association, at a recent Superintendents’ meeting where he explained what he feels has set the stage for the “unrest” exhibited by golf course superintendents.

1. **Money Pressure.** Clubs have had to reduce spending as a result of the present economic slow down. Mr. McGloughlin feels that this financial squeeze should be viewed as an “opportunity to excel within boundaries being defined by the lower budgets”. It was also illustrated that some discontent with salaries had been noted. However, it was pointed out that the superintendent generally moves into a higher economic bracket earlier in life than other professions. As a result, a superintendent often “feels that he is under an economic lid”, and doesn’t know here to turn next for advancement. Above all, he cautioned, “keep confident and don’t lose sight of the constructive values of your job”. 

2. **Responsibilities.** Quite often a superintendent will obtain a job at age thirty where his responsibilities will not change appreciably for the rest of his life. Mr. McGloughlin felt that the “superintendent would have to allow his maturity to cope with this situation” while on the other hand considering alternatives such as moving to a different club, off-site consulting, club management, or other competing jobs. Again, he emphasized, “don’t become discouraged”. 

3. **Status Competition.** There is a status problem at many clubs between the manager and the superintendent and most individuals are not sure where they reside in the “pecking order” of their club. Mr. McGloughlin feels that the position of golf course superintendent is the best defined at this time and most consistent. He indicated that the superintendent probably fares far better in the “pecking order” that he feels he does.

4. **Professional Image.** It is natural to want a better image but how should the superintendent go about it? First, “it has to be earned, not wished for around tables”. It was pointed out that the superintendent is seeking professional recognition from a “highly professional society”. As a result, this makes the task more difficult and a greater challenge. Mr. McGloughlin asked that we consider the following to improve professionally:

   1. Develop a greater feel for public relations within our clubs and communities.
   2. Become more involved at meetings by exposing ourselves at all opportunities as being anxious and willing to perform any task.
   3. Dress up to par if we are to be recognized by the professionals we want recognition from.
   4. Do not become complacent.
   5. Play more golf it at all possible. Mr. McGloughlin noted that the corporate world uses the game of golf to a tremendous advantage but the superintendent generally neglects to use the game in this manner. Playing golf is a natural opportunity to communicate with the people we are working for.
   6. And finally, to further compliment our job situation, try to provide education for property maintenance, high school orientation programs and the community environment.

As we all know, our profession has many advantages. Noting that his list was surely incomplete Mr. McGloughlin...
suggested that the superintendents' job situation is healthy because of the following:

1. There are 30,000 golf-related job opportunities.
2. The work is seasonally flexible throughout the country.
3. It is out-of-doors.
4. The job provides access to a club environment.
5. It is challenging, technically, dealing with labor, machinery, and nature.
6. It provides an opportunity to display a variety of talents.
7. The job is needed, appreciated, and respected.
8. It provides opportunities to learn.
9. There are national and local associations capable of providing assistance.
10. The superintendent is most often his own boss.
11. The work can be recognized as it is in front of the people.

But, what lies ahead? What are the trends within our industry? Mr. McGloughlin noted that "from a management point of view, the golf club industry is in its very early crawling stages. It has yet to mature to walking and running stages". This, of course, is referring to the "General Manager Concept" which he felt could open a new horizon for all of us. In his opinion, the club industry will move in this direction and he stated that "there is a need for consistency in professionalism throughout all club programs which could be better given by General Managers than the Committee System".

As of yet, according to Mr. McGloughlin, "we do not have the individuals ready to fill the role of General Manager". But, all of us were urged to prepare to migrate to this role even though the clubhouse manager feels more inclined for the position. It was stressed that "all phases of club management have the same edge toward the role".

This obviously raised questions from the audience. Would the General Manager concept relegate the status of the superintendent to that of a foreman? Would the creation of a fourth executive increase the cost of administrative salaries unreasonably or might the salaries of the present executives be decreased to accommodate the fourth? Could the committee role be abandoned completely or would department heads find themselves caught between two bosses? I guess these questions and many others will only be answered with the passage of time. At present, it is important to prepare ourselves as best we can to accept new responsibilities as they are presented. Our profession will continuously upgrade itself through education and experience. Finally, and perhaps most important of all, all phases of club management must strive to cooperate to provide the best possible environment for our club members.
"Four Seasons Ground Maintenance"

Horace Ames
St. Vincent Hospital
Worcester, MA

St. Vincent Hospital is located in the heart of Massachusetts atop one of Worcester’s seven hills. Founded in 1893 by the Sisters of Providence in an old farm house, it has now grown to its present status as the third largest health care center in New England.

Being a groundskeeper in New England is a challenge in itself having to deal with the four seasons. The winter months (mid December through mid March) pose as one of our major challenges. Snow storms no matter how large, keep us busy plowing and sanding around the clock. We start plowing at two inches and being a health care institution with peoples safety at stake, we plow steady until the storm is over. Our main concerns are: (1) keeping the ambulance entrances clear, (2) the sidewalks and doorways de-iced and (3) the parking lots plowed and sanded throughout the duration of the storm. Around the clock employee shifts make it very difficult to keep the seven large parking lots empty so that we can plow them.

It certainly is a relief when spring brings a complete thaw and along come the green grass and the flowers we planted last fall . . . crocuses, daffodils, tulips and others. Broken shrubs, trees, branches, turf problems and grass areas where heavy snow has been stored during the winter all need our attention.

We start pruning in late March or as soon as weather permits. The damaged grass areas are repaired and treated. Top-dressing is done in early spring using a mixture of Kentucky Blue, Red Rescue and Perennial Ryegrass. The lawns are that-ched and a 10-6-4, 40% natural organic fertilizer is applied. Lime is applied as soil testing requires, usually every two years.

We prepare our flower beds using a mixture of peat, bone meal, and electra turned into the soil with hand tools. The small ornamental trees are edged and fed with the same 10-6-4 used on the lawn.

Roses planted in the area called the “front island” are carefully pruned and fed. We also supply a systemic insect repellent.

For insect control we use a product called Dursban (for insects such as chinch bugs, japanese beetles, etc.), Tupersan pre-emergence crab grass control and Weedone for various other weeds. We have found that maintaining a good turf is the best weed control.

Early summer we start our hedge trimming. A spreading yew hedge encompasses the entire main hospital. There are also several upright yews and hemlocks around the main entrance and front island. These are all trimmed with hand clippers and it takes about two weeks. A privet hedge surround our nursing school and a variety of flowering and non-flowering shrubs are around the building. The privet hedge is trimmed every two weeks and the yew hedge in late June or early July, then touched up in September.

We plant our annuals in late May after the danger of frost is gone. Two men are assigned to maintain the garden areas all summer, pruning and grooming daily and weeding weekly.

Lawns are moved twice a week during the early summer and once a week during the dry part of late summer. We had a very wet spring this year so a summer feeding of Milorganite 6-2-0 was used on all grass areas.

The cold Autumn months allows us an opportunity to restore and maintain equipment. A preventative maintenance program initiated ten years ago enables us to keep a close watch on our equipment. When anything goes wrong we repair it immediately, doing 90% of all our own work. Our equipment consists of two four wheel drive 1 ton trucks with 8’ plows, one CJ5 Jeep with plow, front end loader, small bulldozer, sander, parking lot sweeper and two snow blowers. Turf equipment consist of one 12 horsepower garden tractor with attachments, four 26” self propelled mowers, 3 push mowers, two edging machines and a large vacuum cleaner.

In addition to other duties we have a large in-ground pool, donated to the Sisters of Providence by a patient, to maintain.

Throughout the seasons, as manager of the Groundskeeping Department, I work beside the men on my crew, teaching them the methods I have learned through experience over the years. I give each man his own area of hospital grounds to develop, this way he can take personal pride in his accomplishments and feel a sense of responsibility. They also feel a sense of competition with other crew members. In these ways, all of us find our own means to express the four seasons ground maintenance at the St. Vincent Hospital.

The following was offered by one of the members of my grounds crews as his view of a groundskeeper’s job.

“A groundskeeper gives, he does not keep; and by this giving, he allows nature an opportunity to give in return . . . to express. He approaches his job with the same exuberance that is personified in the natural beauty of this four season climate and in the spirit of growth and progress of the institution.

“’The groundskeeper persuades, he does not force . . . he suggests, rather than commands. He fuses the abstract and concrete aspects of growth and change into a smooth expression of spirit and beauty without sacrificing their innate vivacity.’”
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