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Spring 1968

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NOTICE

University Of Connecticut

SYMPOSIUM:

Pollutants in the Roadside Environment
To be held at the College of Agriculture Auditorium,
University of Connecticut, February 29, 1968. For further information call or write E. D. Carpenter,
Plant Science Department, University of Connecticut.
Wetting Agents

by STUART DENTON, College of Agriculture
University of Massachusetts

INTRODUCTION

Surfactants, surface active agents, and wetting agents are three names for the same group of materials. The three names are used interchangeably in the literature and in this paper. Surfactants can be divided into three groups (1, 5, 16, 17): nonionic agents, cationic agents, and anionic agents. Cationic agents are little used in agriculture. The fertilizer industry uses the anionic and nonionic groups. Nonionic wetting agents consist of an alkyl and an aryl group of differing molecular weight as an alcohol, an ester, or an ether. Those used in turf management and many used in erosion control and irrigation are of the nonionic types. Anionic wetting agents are also used by the latter two.

Wetting agents act in two ways: first by lowering the surface tension of the water to which they are added; and, secondly to decrease the liquid-solid contact angle (5, 14). Surfactants increase a liquid’s ability to moisten a solid by lowering the interfacial tension as measured by contact angle. These surfactants modify the liquid-solid interface by providing more intimate coupling. This is possible because one part of the molecule — the strongly polar group — is hydrophilic and thus orients toward the liquid phase. The nonpolar hydrophobic group is attracted to the nonaqueous material.

Wetting agents are useful in fertilizer production, herbicidal sprays, erosion control, irrigation, and turf management. This paper discusses these uses in the light of limited research available.

FERTILIZER PRODUCTION and HERBICIDAL SPRAY

In the production of commercial fertilizer, considerable difficulty is caused by the slowness of chemical formulations from ground parent rock, and by the solidifying of the product in storage piles and bags. A 1958 survey (3) of 250 fertilizer manufacturers revealed that of forty-nine who replied thirty-one used wetting agents. The indication among manufacturers, though not unanimous, was that wetting agents reduced blocking of superphosphate in the storage pile. Some also reported that the surfactant reduced blocking of mixed fertilizers both in the pile and in bags. Furthermore, curing time was reduced. No conclusive trend was shown with ammonium nitrate and urea.

Sauchelli (17) attributes the favorable effects of surfactants to their ability to reduce surface tension. One portion of the chemical has an affinity for water while the other portion is repelled by water. The surfactant comes to the surface of the liquid (water) and millions of molecules pierce the surface thus lowering the surface tension.

In the fertilizer industry both anionic and nonionic surfactants are used. As a conditioner in fertilizer production the surfactant acts chemically to promote rapid curing and other benefits. In ordinary fertilizer moisture collects on the surface of component particles where solvent action results in a concentrated solution of the soluble chemicals present. As the temperature gradient drops the solution cools and causes the dissolved materials to “salt” out, as crystals that bind and knit the surrounding solid particles to form a hard set. The affect of the wetting agent is to induce surface moisture to penetrate below the surface so that the surface “salting” out phase with the consequent crystal bonding is prevented.

Surfactants improve superphosphate manufacture by enabling a more efficient use of acid, permitting a higher per cent conversion with the same acid to rock ratio in an equal curing time or a quicker curing time for an equal conversion. A softer and drier superphosphate is produced which is easier to handle and requires less or no blasting. In the same manner there is less adherence to equipment and thus less shut down time for cleaning.

In the manufacture of mixed fertilizer the use of surfactants gives more efficient ammoniation and therefore a higher actual rate of ammoniation though the stoichiometric relationship is not affected. Before surfactants can be used in industry it is necessary to determine the specific factors that lead to the economic use of surfactants and the extent of surfactants contained as surfactants of residues in raw fertilizer. An excess may be harmful.

Rulison (16) presents some more specific ideas on surface active agents of the alkyl aryl sulfonate chemical group. He thinks that the surfactant may change the fertilizer salt crystal shape so they do not interlock so easily. Also there may be a thin film of water or vapor around the crystals; the surfactant could break these water bridges connecting the crystals and keep them small. The resulting product feels and acts drier though moisture analysis reveals the same amount of water.

From an economic point of view it costs fifteen to forty-five cents to treat a ton of fertilizer with one to three pounds of surfactant. The same results can be obtained by using a fluffy material such as vermiculite at a rate of thirty pounds per ton or 100-200 pounds of a bulky material at a cost of fifty cents to one dollar per ton. Also with the smaller amount used per ton, one can get more nutrients per ton.

Beside better storage and drilling of the fertilizer, the materials heat to a slightly higher temperature during processing and therefore give a more complete reaction. Also less solvent liquid is needed due to better liquid-solid contact. Finally a higher rate of ammoniation is attained because more liquid ammonia can be added due to the quick penetration and fixing of the ammonia.

If manufacturers can solve the problem of lumping and setting in storage they can eliminate the need for expensive conversion to granulation. However, in the manufacturing phase it doesn’t appear to have much advantage for fertilizer which has time to cure for the usual eight weeks.

The use of wetting agents in the application of herbicides is not new but this phase has had little scientific analysis. Klingman (5) reports that wetting agents give uniform and complete wetting by contact herbicides. If no wetting agents are used the herbicides may burn pinholes in the leaves. Also lower gallonage may be used with the wetting agent.
Engel (2) tested six different wetting agents with potassium sulfate for crabgrass control and found they all increased the effectiveness of herbicidal treatments. There was a greater kill of crabgrass and increased turf injury.

Summarily, there are five important effects of surface active agents used in spraying operations. First they favor uniform spreading of the spray or uniform wetting of the plant. The spray droplets tend to stick to the plants so there is less bounce off and usually less runoff. Thirdly, chemical sprays are brought into intimate contact with the plant; droplets do not remain suspended on hairs, scales, or other projections. The surfactant may solubilize non-polar plant substances like waxy cuticle, or the lipidoid portion of the cell wall may be solubilized so the plant can absorb the chemical quickly. The solubilized cell wall may permit the cell sap to leak into the intercellular spaces. Finally, surfactants are thought to have many effects on proteins leading to protein precipitation and denaturation as well as inactivation of enzymes, viruses and toxins.

**EROSION CONTROL**

The use of wetting agents to control soil erosion has been little investigated, but the implications of such a use are obvious. On dry, water repellent soils, sudden downpours can wash the soil surface severely without the soil taking up much of the water. Wetting agents can be effective in reducing erosion by allowing more water to penetrate the soil at a faster rate and therefore reduce runoff. Osborn (12) in studies of a burned over chaparal area with a sixty-four per cent slope used a wetting agent known as CS-555; its active ingredient is alkyl-polyoxyethylene alcohol. All the untreated plots were rilled up to four inches while rilling of the treated plots was very minor or none at all. The beneficial effect was not caused by increased aggregation or binding of the soil particles but by modification of the wetting characteristics of the soil.

Furthermore, grass seedings in these plots were affected. On the untreated areas coverages of five, nine, and seven percent were recorded, while the treated areas had coverages of eighteen, twenty-five, and forty-five percent. Two factors enter here: first there was more water for germinating in the treated plots due to less water runoff; and secondly, on the untreated plots much of the seed was washed away. Most of the vegetation on the untreated plots was at the lower end.

Osborn in another study (13) treated a burned off watershed with wetting agents. At the end of a rainy season of thirteen inches of rain, the erosion on the untreated plots was fifteen times greater than on the treated plots. Water runoff was reduced by thirty-two percent and seed loss was prevented. The economic feasibility of such treatments for erosion control on nonwettable soils and the duration of the treatment’s effectiveness is still questionable. Current studies involve incorporating wetting agents into a powder. This would be more practical and cheaper than the liquid now used in helicopter applications.

**IRRIGATION**

An analysis of the literature will reveal considerable controversy on the matter of wetting agents aiding water penetration into the soil. Whitcomb (20) found that while some surfactants (Aqua-Gro, All-Wet, Pro-Green, Solar 25 liquid concentrate) reduced the solution surface tension as much as 37.8 dynes/cm (i.e., to about half the normal for water) they did not appreciably alter the infiltration rate of the area wetted by the water applied under many soil and turf conditions. However, since his work was restricted to putting green turf, Whitcomb does concede that wetting agents may improve water infiltration under some hard to wet soil and thatch conditions. Lunt (8) in laboratory and field studies found little if any increase in the water infiltration rate into soils because of a decreased surface tension in the water treated with wetting agents. On a Kern County potato field wetting agents were used in the irrigation basin without causing any apparent change in the rate of water entry into the soil. Deviations of infiltration rates of wetting agent solutions from those of water measured in laboratory tests were not statistically significant.

Peishek (14) reports that the infiltration rate of water will be reduced at a lower surface tension but that it may be increased due to the lower contact angle caused by the wetting agent. The effect a wetting agent has on the infiltration rate, then, is dependent on the liquid-solid contact angle. Also the wetting agent will improve infiltration of some non-wettable materials by wetting more medium and therefore increasing the transmission coefficient. However, the reduced surface tension is important in evaporation. According to Law (5) the action of one nonionic surfactant in evaporation reduction is due to the decreased surface tension at the solid-liquid interface. This reduces capillary flow to the surface layer of the soil causing the formation of a dry diffusion barrier. Spurrier (18) found that a surfactant affected the movement of water in a sand column and thus reduced the amount of water available for evaporation from the exposed surface because capillary movement was reduced. It is possible to incorporate enough surfactant into the soil to affect these physical properties without injuring the plant.

Morgan (10) testing wetting agent treatments used a check and a three parts per million solution for the initial treatment on dry soil. The wetting agent increased the infiltration rate on unamended soil but had no effect on physically amended soil. It caused the peat amended soil to become less compact but had no effect on any other soil materials. The relative beneficial effect of wetting agents depends on the quantity of water applied. Infiltration rates increase with time whereas the beneficial effects of the wetting agents decrease as the time of water application is increased (7).

Mazio (9) observed that a drop of water on any hydrophobic material will tend to form a ball since a sphere is the smallest unit to contain molecules. The action of a wetting agent will lower these cohesive forces thus preventing beading and permitting freer movement through the soil. The wetting agent changes the physical properties of the water, not of the soil. The more organic matter in a soil, the more hydrophobic it is. Experiments show that wetting agents give much faster water penetration through an hydrophobic soil and that the benefits last over several waterings. The surfactant gives faster and deeper water penetration and the treated soils retain moisture longer making more water available to plants. Wetting agents, then, are beneficial in establishing and maintaining a dense turf on heavily used areas. A more vigorous turf is developed by making (Continued on Page 10)
Deflation in Amateur Prize Value

Once upon a time there was a college student who was a very fine golfer—so fine, in fact, that his quarters at college at one stage contained 17 new golf bags and dozens of unopened boxes of new golf balls.

Much of this gear had been won as prizes in tournaments. The rest was believed to have been quietly left as gifts by manufacturers' representatives, whose consciences did not quail at teaching a young man to break amateur rules clandestinely if only the representatives could influence him to play their equipment and thus give it cheap advertising.

Seventeen golf bags! Of course, the young man could use only one at a time. What happened to the others—and to those dozens and dozens of unused golf balls?

Most of them were sold by the young man, and he kept the cash proceeds. Not many years later he did a short left oblique and turned professional. Today he is well known on the pro tour.

Let's consider the prizes he won and sold; for present purposes, let's disregard the reported gifts from manufacturers. The prizes he won were supposed to symbolize the honor of victory—the distinction of being pre-eminent. They were meant to be the modern counterpart of the laurel wreath of ancient Greece.

The young man was playing golf ostensibly as an amateur—for fun, for the love of it. But he cashed in many of his prizes.

The New Rule

Today somewhat similar situations exist in amateur golf. Some players accumulate valuable merchandise prizes. They apparently are preoccupied with winning because of the tangible value of prizes.

Now the time for reaction has arrived—the time for once more holding aloft the very simple but unmistakable ideal of amateurism: "An amateur golfer is one who plays the game solely as a non-remunerative or non-profit-making sport."

And so, on January 1, 1968, the maximum retail value of a permissible merchandise prize for an American amateur golfer will be reduced from $200 to $100. This is one of several changes in the Rules of Amateur Status adopted by the United States Golf Association. British golf authorities have made a comparable reduction, from £50 to £30 retail value.

The 1968 codes of the USGA and the Royal and Ancient Golf Club Club of St. Andrews, Scotland, are similar in basic principles although different in a few minor points. A number of differences were reconciled in meetings last May at Sandwich, England, by committees under the chairmanship of Morrison Waud, Chicago, for the USGA and Gerald H. Micklem, of Sunningdale, England, for the R&A.

The reduced top value does not apply to prizes of only symbolic value, such as metal trophies. The reduction is aimed at merchandise prizes.

There are objectors to the new legislation. One theme is: "In these days of inflation, should not the prize limit be raised rather than lowered?"

The question goes to the heart of the matter. It implies that amateur golf should be worth the winning—that the tangible rewards should be of first concern.

The point is that amateur golf is, and always has been, a game to be played for its own sake, "as a non-remunerative or non-profit-making sport," in the language of the universal Amateur Definition.

That view, admittedly puristic, has always been the ideal in amateur golf. It is an ideal on which the game has flourished. If golf should go down the other road—the road of winning for the sake of tangible rewards—where would it wind up? That is a question which every golf-lover must ask himself.

Other Amendments

In the 1968 code, the rule about sale of golf merchandise by an amateur has been made more explicit. It will be an infringement to receive compensation, because of golf skill or golf reputation, "for selling or promoting the sale of golf merchandise, at either wholesale or retail."

The language of the rule denying amateur status to teachers at educational establishments who accept pay for teaching golf has been spelled out in greater detail. Fundamentally, giving golf instruction for pay is a violation. The following explanatory note has been adopted:

"Golf instruction may be given to students at educational establishments by faculty members who do not teach physical education if golf instruction is given without compensation and is incidental to other duties. Physical education instructors and camp counsellors who give golf instruction as part of their compensated duties are not amateur golfers."

Progress toward identical codes by the USGA and the R&A follows recent announcement of a uniform international code of playing rules. The R&A differences in the amateur regulations are minor and are largely attributable to differences in educational, economic and geographical conditions. The basic R&A variations relate to permissible instruction by teachers of physical education, allowance of expenses for local team events under certain conditions, and forfeiture of amateur status after age 21 for serving regularly as a caddie. In the United States there is no prohibition against caddying.

—Reprinted from The Golf Journal, Vol. XX, No. 5
Mark of the Industry Today
Is Professional Tree Care

Research has helped make a scientific profession of arboriculture. Foresters, entomologists, pathologists, physiologists, arborists and others have contributed to an understanding of tree problems. Their work in the field and laboratory has saved many valuable trees and perpetuated what has now become a national beautification program.

Mechanical care when properly done can speed recovery time for the tree, as well as protect it against insects and diseases during coming months and years. Use of rubber or other soft footwear and ropes are simple practices. But they are extremely important in terms of tree care. Spurs are not nearly so safe as ropes and resulting bark wounds open the tree to disease organisms.

Bleeding at certain times of the year becomes a problem when sapwood is exposed during pruning and cavity work. Maple and birch, which are profuse bleeders, should not be pruned in the spring. Work on other hardwoods and evergreens may be done at any time. Small pruning wounds made between February and May heal most rapidly.

Another precaution in working with trees, especially when moving from site to site, is maintaining sterile tools. Some bacterial, fungus, and virus diseases can be carried by tools. Therefore, use denatured alcohol on all tools after use, or disinfect with bichloride of mercury (very poisonous but may be prepared by mixing 1 part of mercuric chloride to 1000 parts of water), or purchase a commercial disinfectant.

Careful bark tracing promotes rapid healing. Dead or fractured, irregular areas of bark need to be cut back smoothly and cleanly with a sharp knife to live cambium or tight bark. This is true even though the wound is made larger. Cut only soft bark tissues unless wood is decayed. Make the wound lengthwise of the tree, pointed at the top and bottom.

For freshly bruised trunk

1. Prevent or mend a split crotch by a cable installed 2/3 of the distance from crotch to top of branches.
2. Old stub decay needs to be cut off flush to tree, cavity filled, and treated.
3. Stub cleaned and treated as a new wound. Paint exposed bark edges with orange shellac and apply wound dressing.
4. Any branch more than 1 inch in diameter needs to be pruned in 3 cuts as lettered, making the center cut first. This prevents damage by peeling of bark.
5. Stripped bark results from one-cut pruning or from wind damage. Tree health is aided by keeping bark wounds small and using the 3-cut system in No. 4.
6. Reinforce weak or split crotches with screw rods. Counter sink nuts. Bark trace holes and treat.
7. Perfectly healing pruning wound should appear as in drawing.
8. When limb is removed and only slight decay follows, clean wound and dress, but do not fill.
9. Common bark injury or bruise is common. Treat as shown in No. 10.
10. Treat bruise or bark injury by cutting torn bark back to solid bark to form a larger wound, painted at top and bottom. Shellac bark edge and paint wood.
11. Large cavity here is properly filled in sections. But before doing cavity work, decide if work is worthwhile. Old, slow growing trees are seldom worth effort. Good rolls of callus growth around large cavities are strong, and removal weakens tree. Best treatment may be to brace cavity area and fertilize tree.
areas, an alternate method is worth trying. Tack the loose bark back onto the trunk and shade the damaged bark area with a burlap shield. Install this shield a few inches from the trunk to allow for air circulation. This sometimes keeps the cambium cells alive to produce callus growth and reduces the size of the wound. When it doesn’t work, bark trace and treat.

**Judicious Pruning Insures Future Shape**

Pruning is done for a variety of good reasons. But it needs to be planned carefully to maintain the shape of the trees. Even when trees are interfering with overhead wires, judicious pruning and planning for future growth can usually be done to maintain the shape and prevent interference with the wires.

When pruning branches one inch or more in diameter, make three cuts (see illustration). This prevents peeling of bark as the limb falls. Final cuts need to be smooth. Avoid loose bark and be sure they are flush with remaining branches or trunk. This promotes rapid healing. Always start pruning at the top of the tree and work downward. Remove all dead, dying, diseased, and interfering branches. Treat larger wounds with a wound dressing. Renew this at least once or twice a year because of checking or weathering.

In treating solid, surface wounds, all exposed wood resulting from bark tracing, pruning, and cavity work should be treated with a wound dressing. Best procedure seems to be to paint the exposed bark edges with orange shellac followed by an application of an asphalt base paint over the entire wound once the surface is dry. Such dressings as asphalt varnish, fibrated asphalt roofing paints, and water-asphalt emulsions have merit. Water-asphalt emulsion can be applied to both wet and dry surfaces at temperatures above 32 F. Do not use asphalt preparations which contain carbolineum, creosote, gasoline, or similar materials. Mixtures such as 10-2-2 of lanolin, rosin, and crude pine gum; shellac coated with plastic asphaltum; and Bordeaux paint are examples of other cambium and wound dressings. Asphalt applications need to be thin to moderately thick to prevent blistering. Reapply at least once yearly, after carefully removing old, peeled coatings. Cover only exposed wood, and not the callus roll.

Wounds less than one inch in diameter on hardwood trees need not be painted. Small wounds on evergreen trees can be ignored or protected by smearing the wound with the resins exuding from the cut. Large wounds on evergreens need to have the exuding resin smeared after asphalt paint is applied.

Avoid use of regular house paint. Those containing oil are sometimes used by amateurs, but their value is doubtful. Oil paints or other oil preparations will kill back bark on sugar maples. If applied completely around the trunk, young sugar maples will usually be killed. The same may occur on beech, butternut, and exotic maples.

Cables should consist of galvanized material strong enough to stand expected stress. For example, 7-strand 1/4-inch and 5/16-inch cables are rated at 500 and 1000 pounds of stress. Thimbles, lags, or eye bolts need to be coated with a rust-resistant material. If the rust coating is damaged during installation, apply a protective coating. Lag screw hooks may open under stress, so are not reliable. Thimbles are used in each eye splice to prevent parting of the cable where it passes through the eyebolts.

Screw rods with nuts and washers are needed for bracing through and near weak crotches. These need to extend completely through involved limbs. At least 2 are needed for large limbs. Bore holes for screw rods with lag threads 1/16 inch smaller than the rod. Countersunk washers and nuts at both ends increase holding power. For bolt rods with machine threads, bore holes the same diameter as the rod. Bolt rods are best for soft or weak wood, or where there is less than 3 or 4 inches of sound wood at each end.

Washers and nuts should be countersunk, the cuts pointed above and below, and all cuts and bolts then treated. Once washers and nuts are in place, exposed parts of wood, bolts and nuts need to be waterproofed.

When installing cables, make them just taut. Inspect occasionally for breakage of cable strands and remedy any slack or replace as needed.

—Reprinted from Weeds Trees and Turf, May, 1967
Stockbridge Graduate Appointed Head Of Winged Foot

Edward C. Horton, a 1967 graduate of the University of Massachusetts two-year course in "Turf Management", was recently appointed Superintendent of Courses at Winged Foot Golf Club in Mamaroneck, New York.

"Ted" graduated from high school and attended college in his native Montreal, Canada, and spent several summers working on the grounds crew of Summerlea Golf and Country Club which, at that time, was under the able supervision of Construction Superintendent Mr. James Norman. Having become interested in Turf Management as a career, he spent eight months during 1965 working as a "groundsman" at Sunset Golf and Country Club in Saint Petersburg, Florida.

After being accepted at the University of Massachusetts for the 1965 fall semester, "Ted" studied under Dr. Joseph Troll, and proved himself an able student. He maintained a 4.00 average throughout his two years at school, and received the "Wall Street Farmers' Scholarship" and a "Golf Course Superintendents' Association of America" Scholarship. He was appointed to "Lear", Stockbridge's Honor Society, and was elected by his classmates as "Student of the Year". An active member of the "Turf Club", "Ted" was editor of the Massachusetts Turf and Lawn Council Turf Bulletin and co-editor of the Turf-Conference Proceedings, Turf Clippings.

During his Placement Training in the summer of 1966, "Ted" worked at Winged Foot Golf Club where he was exposed to the outstanding management policies practiced by Sherwood A. Moore. Following graduation in June of 1967, "Ted" had the opportunity to return to Winged Foot as assistant to Mr. Moore. A member of the Golf Course Superintendents' Association of Metropolitan New York, "Ted" feels that this area has many outstanding golf courses and as a result offered unlimited opportunities.

His opportunity came during the fall of 1967 when Mr. Moore resigned from Winged Foot Golf Course to become the Golf Course Superintendent and Property Manager of Woodway Golf and Country Club in Connecticut. "Ted" was selected as Mr. Moore's successor, and as a result became one of the younger Golf Course Superintendents of thirty-six holes in the Northeast.

"Ted" and his wife Nancy are presently living in Harrison, New York.

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Soil Testing Doubles In 10 Years

Soil testing in the United States has more than doubled in the last 10 years. Over 3.8 million samples are analyzed each year to determine their fertility status. Farmers, gardeners, horticulturists, nurserymen, and home owners are trying to find a way to produce a more profitable, higher-yielding, better-looking, or superior-quality crop. Soil testing must be a help or these people wouldn’t continue investing $1.5 million a year in the service, plus the cost of taking the samples and delivering them to the laboratory. When you think of it as part of a consultant’s fee for a prescription, recommended treatment, or even a status report, it is ridiculously low to be in keeping with the times.

Service Improving

People using soil tests no doubt purchase the lion’s share of about two billion dollars worth of fertilizer, liming materials and other soil amendments sold in this country. They are looking for service, and that service is improving year by year. Today’s soil testing laboratory is clean, attractive, and efficient, with quality control built into the operation. Expensive equipment, geared to speedy results make precision measurements a routine matter. Refinements are continuing, both in the laboratory and in reporting of results. Practically every laboratory today is prepared to make measurements such as micronutrients, soluble salts, exchange capacity, sodium, and several others, in addition to the regular determinations of pH, phosphorus, and potassium.

Cost Nominal

The average cost of testing soils in a state or county laboratory operated by government employees is $1.51 per sample. Cost in the commercial laboratory is estimated to be about $3.53 per sample. These two figures are not necessarily comparable. Some of the commercial laboratories determine more nutrients than the routine tests made in most government laboratories.

One change in keeping with the times is the increase in cost for testing. It appears to have advanced about 51 per cent in the last 10 years. In turn, however, the average lapse of time between arrival of the sample in the laboratory and release of the test report has been cut on the average of 36 per cent, or from 14 days down to nine.

Operations in a few states have become so modernized that a computer writes the fertilizer recommendations. Where large numbers of samples must be handled in a hurry, this appears to be the most efficient procedure.

One of the big problems in all soil testing laboratories is the seasonality of the work. Invariably the farmer puts off soil testing until he thinks about buying fertilizer or lime and he seems to put this task off just a little later each year. While most agronomists recommend fall soil sampling, a few contend it’s better to wait until spring to take samples because the availability of nutrients in some soils appears to build up over the winter months. How important is this anyway? If a soil is low in nutrients in the fall, and it builds up to a medium level over the winter, maybe we are kidding ourselves on what that soil will be able to deliver to the plant next summer.

We need to continue to drive for a systematic procedure of soil testing. It should be on the whole farm basis, field by field and soil by soil within the field. This way soil testing will return a handsome profit to more and more farmers.

Standardization Moving Ahead

When soil testing was first getting started some 30 years ago, and for a long time thereafter, it seemed that everyone wanted to develop his own pet procedure. In more recent years, however, there has been a shake-down until it looks as though standardization within well-defined regions is about to get established. Several states are now using the same testing procedure, and recommendations are being formulated to work across state lines.

Increase Coming

Leaders in 42 laboratories expect soil testing to increase in the next five years. Of these, nine expect the increase to be 10 per cent or less, while 31 look for an increase of 10 to 25 per cent. Only five expect an increase of more than 25 per cent. Leaders in nine other laboratories think the volume of soil testing will remain about the same.

It was surprising to me that less than half of the states (40 per cent) include fertilizer recommendations with soil test results.

In addition to a soil testing service, 19 states now provide a plant analysis service. Last year, 112,715 plant analyses were made for farmers in these states, exclusive of those made in private commercial laboratories.

Today, farmers want to know how to maximize their profits. Soil testing is a tool they rely upon, and although it is good, it can be improved through more field trials, involving top-level management and inputs, geared to modern farming. Here is a good opportunity for extension and research people to do some cooperative work that will advance agriculture through its next step.
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(Continued from Page 4)

the water more readily available and the more vigorous turf can withstand heat and drought longer, thus reducing wilt and decay.

A surfactant known as PR-51 is now being developed and tested by the Research and Development Department of the Atlantic Refining Company (11). The flaky light-colored solid, derived from petroleum, is applied at the rate of fifteen to fifty pounds per acre. It is carried into the soil pores by water and moves to the soil-water surfaces where it speeds up water movement. This is particularly important in small sized pores where water ordinarily moves slowly if at all. The increased ease of water movement in the soil makes more water available for plant growth, especially in the finer textured soils like loams and silty loams that retain large amounts of water even at the wilting point.

Every product that lowers the surface tension of water is not considered a good wetting agent unless it provides a residual affect whereby the soil condition is modified to improve the uptake of pure water on subsequent irrigations (14). Good wetting agents will redissolve in water and provide intake behavior very similar to that observed when the wetting agent solution was used (14, 7). A wetting agent may be good for as few as two additional irrigations (14) up to a full year or more depending on the soil; heavier soils with less rainfall will leach the material more slowly (11).

Wetting agents are best applied to bare soil or seedbeds since too high a concentration may cause temporary stunting and burning. By improving soil drainage wetting agents make earlier spring plowing possible, particularly in wet, heavy types of soil. Also faster seed germination can be expected since the drier topsoil warms up more rapidly; in addition water with a surfactant adsorbs through the waxy seed coat faster (11).

Ivarson (4) studied the persistence and biological effects of three surfactants; a nonionic compound called Tween 80 (Polyoxyethylene sorbitan monoleate); a cationic compound Ceepryn (Cetyl-pyriddinium chloride); and an anionic compound Nacconol NRSF (alkyl aryl sulfonate). The Tween 80 decomposed rapidly in the soil; the Ceepryn decomposed following an initial lag period; while the Nacconol NRSF resisted decomposition entirely. Tween 80 had little or no undesirable biological effects in the soil. The Ceepryn at very high levels reduced the total number of microorganisms in the soil and inhibited nitrification. The Nacconal NRSF was even more detrimental. The potential toxicity of ionic surface active agents is reduced as a result of adsorption by the colloidal fraction of the soil. Cationic compounds are adsorbed to a greater extent than anionic compounds.

TURF MANAGEMENT

Several aspects of turf management lend themselves to the use of surfactants. The first of these is the problem of thatch, which when dried out, seriously retards water intake. The unique nature and use of a turf crop as opposed to field crops would benefit from anything that would overcome the adverse effects of soil compaction, frequent watering, and constant traffic.

Little work has been done on the thatch problem (14, 9). One wetting agent solution took less than a minute to penetrate 2.5 cm of thatch while water alone took fourteen minutes. It took ten min-
utes for 100 ml. of solution to penetrate this thatch and took fifty-six minutes for the same amount of pure water to penetrate. The residual effect of the wetting agent lasted for at least the three following waterings. In subsequent tests the water penetrated faster than in the first trial. This may be a consequence of the core being more moist from the original run. Furthermore, the wetting agent solution went through the entire core of thatch while the pure water came through only certain portions of the core leaving much of it dry.

Wetting agents will allow faster and deeper soil penetration of available water. During long watering this is especially beneficial to grass as it does not limit the oxygen supply in the soil as it will if the water is slow to penetrate. Also infrequent large watering is better than more smaller waterings. Surfactants have no effect on soil structure per se (11). They are not soil conditioners and have little or no benefit on soil devoid of pores. Compacted subsoils and heavy clay topsoil must have pores made either by mucking or liming acid soil or similar treatment. Smart (19) found that the soil wetting agent Aqua-Gro made golf greens look greener. Applied at the rate of one-half quart to fifty gallons of water the surfactant induced soft greens which were not soggy but springy and turgid. The problem of wilt became more acute because fertilizer was breaking down too fast. This was cured by going on to a low nitrogen program. A final application schedule of one quart per green in early spring and in September supplemented with one-half quart every month in the playing season seemed to hold the greens in good condition.

Wetting agents have been found to be detrimental to some grasses if used in excess. Morgan (10) found that the wetting agents he used had no effect on top growth. Whitcomb (20) tested four different wetting agents which reduced the surface tension from 72.8 dynes/cm (that of pure water) to as low as 35.0 dynes/cm. After three weeks those plants exposed to the lowest surface tension had yellow foliage. Subsequently all treated cultures showed increasing amounts of injury. The foliage revealed increased calcium and zinc with increased concentration related to some alteration in the physiology of the turf.

Roberts (15) reports the problem from the standpoint of moisture stress. The sum of the soil moisture tension and the osmotic pressure of the soil solution is the total soil moisture stress. This is used as a measure of the total amount of work a plant must do to absorb a unit amount of water from the soil. In a plant under a moisture stress cell enlargement stops with a loss of turgidity and cell wall thickness increases due to cutinization and lignification. The stomates close prematurely as starch is converted to sugar. Photosynthesis is reduced and respiration is increased. Leaf area is reduced while the thickness increases. The root-shoot ratio increases and there are changes in mineral metabolism, especially of nitrogen. Extreme stress will lead to rapid senescence of the leaves.

While the nonionic organic wetting agent investigated had a negligible effect on the osmotic pressures as measured, some adverse effects were noted. The plant foliage was lighter green and slightly wilted in appearance. As temperature increased, growth decreased and turf stands became thin. Additions of

(Continued on Page 14)
1968 University Of Mass. Annual Fine Turf Conference

This is your first call for the 1968 Turf Conference. The dates this year are March 6, 7, and 8 and it will be held at the White House Inn, Chicopee, Mass. (Exit 6 — Mass. Turnpike) due to extensive construction work at the University Student Union building. Next year, however, the conference will be back on campus with wonderfully new and adequate facilities.

IMPORTANT NOTE: DUE TO THIS CHANGE IN LOCATION AND FACILITIES IT IS IMPERATIVE THAT YOU REQUEST A BANQUET RESERVATION WITH YOUR PRE-REGISTRATION FORM. ONLY A VERY, VERY FEW TICKETS WILL BE AVAILABLE FOR THOSE WHO FAIL TO DO SO. ALSO — DO NOT SEND PAYMENT WITH YOUR PRE-REGISTRATION, OR RESERVATION. IT WILL BE ACCEPTED WHEN YOU PICK UP YOUR CONFERENCE PASS AND/OR BANQUET TICKET.

If you should require any further information regarding registration, room reservation, or meals, write:
   Dr. Joseph Troll, Chairman
   Annual Fine Turf Conference
   Stockbridge Hall
   University of Massachusetts
   Amherst, Massachusetts 01007

This conference is open to any and all interested in fine turf culture. It is being presented and sponsored under the cooperative efforts of The Massachusetts Turf and Lawn Grass Council, the New England Golf Course Superintendents Association, and the Massachusetts Cooperative Extension Service. As usual, Dr. Troll has worked long and hard to compose the outstanding program outlined below. His efforts are certain to benefit all attending this conference and he looks forward to another record turnout.

WEDNESDAY, MARCH 6
   — Morning —

11:00 - 1:00  Registration — Lobby

   — Afternoon —
   GENERAL SESSION — Pioneer Room
   Chairman: Mr. Anthony Caranci, President
   Golf Course Superintendents Association
   Rhode Island

1:00  Welcome
   — Fred P. Jeffrey, Associate Dean, College of Agriculture, University of Massachusetts

1:15  1967 Turf Problems
   — Mr. Alexander M. Radko, Eastern Director, USGA, Green Section, New Jersey

2:00  Remedies for 1967 Turf Problems
   — Mr. Lee Record, Agronomist, USGA, Green Section, New Jersey

2:45  Break

3:00  Southern Turfgrass Production and Problems
   — Dr. Ralph W. White, Jr., Agronomist — Turf, Southern Turf Nurseries, Georgia

3:45  Canadian Turfgrass Production and Problems
   — Mr. David Moote, Superintendent, Rosedale Golf Club, Canada

4:45  Massachusetts Turf and Lawn Grass Council
   — Business Meeting

   — Evening —

7:30  Films on Sports — Pioneer Room

THURSDAY, MARCH 7
   — Morning —

   GENERAL SESSION — Pioneer Room
   “Current Turf Research and Development at Home and Abroad”
   Chairman: Mr. Anthony Caranci

9:30  Turf Research Abroad
   — Dr. C. R. Skogley, University of Rhode Island

10:15  Turf Research at Home
   — Dr. Victor S. Youngner, University of California
11:00 Commercial Turf Research  
   — Mr. James A. Simmons, O. M. Scott, Ohio  
11:45 Lunch  

**AFTERNOON SESSIONS** — Those not interested in golf course maintenance can attend the Alternate Session on general turf management.

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**AFTERNOON**  
**GOLF COURSE SESSION** — Pioneer Room  
"Costs and Labor Management"  
Chairman: Mr. Anthony Caranci  

1:30 Reducing Costs in Turfgrass Management  
   — Mr. Tom Mascaro, West Point Products, Pennsylvania  
2:15 Labor Management — Superintendent’s Viewpoint  
   — Mr. Sherwood Moore, Superintendent, Woodbury Country Club, Connecticut  
3:00 Break  
3:15 The Reluctant Human  
   — Professor John W. Denison, University of Massachusetts  
4:00 The Problem Drinker — A Management Responsibility  
   — Mr. G. E. Osburn, Hercules Company, Delaware  

**THURSDAY, MARCH 7**  
— Afternoon —  
**ALTERNATE SESSION** — Springfield Room  
Chairman: Mr. George Moore, President  
Massachusetts Turf and Lawn Grass Council, Massachusetts  

1:30 Seed Production  
   — Mr. Robert J. Peterson, E. F. Burlingham & Sons, Oregon  
2:15 Maintenance of Cemetery Turf on High and Low Budgets  
   — Mr. Stanley Sosienski, All Saints’ Cemetery, Connecticut  
3:00 Break  
3:15 Steps in Lawn Construction  
   — Professor John M. Zak, University of Massachusetts  
3:45 Review of New Chemicals for Weed Control in Turfgrass  
   — Mr. Alvin A. Baber, Dupont Company, Pennsylvania  

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**Evening** —  
Chairman: Dr. Joseph Troll, University of Massachusetts  
7:30 Banquet — Pioneer Room  
Speaker  
   — Mr. Irv Wermont, “Humor: The Greatest Medicine in the World”

**FRIDAY, MARCH 8**  
— Morning —  
**GOLF COURSE SESSION** — Pioneer Room  
"Design, Construction and Renovation"  
Chairman: Mr. Geoffrey Cornish, Golf Course Architect, Massachusetts  

9:30 Contemporary Design Standards  
   — Mr. Geoffrey Cornish, Golf Course Architect  
10:00 Construction — Superintendent’s Viewpoint  
   — Mr. Robert Grant, Superintendent, Brae Burn Country Club, Massachusetts  
10:30 Construction — Contractor’s Viewpoint  
   — Mr. David Canavan, Moore Golf, Inc., Virginia  
11:00 Renovation  
   — Mr. Paul E. Weiss, Superintendent, Concord Country Club, Pennsylvania  
11:30 Questions and Answers
the surfactant to reduce surface tensions from the, normal of 72.8 dynes/cm to 46.4 dynes/cm caused reduced dry weight yields at harvest. Reduction of surface tension to 35.8 dynes/cm caused larger decreases.

Spurrier (18) found little adverse results from surfactants that are used in fertilizer manufacture to improve the blending of materials and to speed the manufacturing process. Santomerase No. 1 is forty percent active anionic alkylaryl sulfonate and sixty percent sodium sulfate. The active ingredient is a sodium salt of dodecyl benzene sulfonic acid. This did not influence the dry matter weight or protein content of Kentucky Bluegrass. The nitrogen and surfactant interaction was found to be insignificant. Experimental plots receiving higher rates of nitrogen in the fall with the surfactant had less burn damage than plots of the same nitrogen application without the surfactant. Applications of surfactant at one, ten, and one-hundred parts per million had no significant effect on the herbage of Sudangrass and red clover. But at 1,000 parts per million both species showed a highly significant reduction in herbage yield.

At 10,000 parts per million surfactants inhibited seed germination. Clover seed was affected more than grass seed. The rate of water absorption into seeds of wheat and soybean seeds was not increased by the addition of a surfactant to the solution the seeds were soaked in. High concentration of surfactants caused a slightly depressing effect on the total amounts of water absorbed into wheat and soybean seeds. Up to a concentration of 100 parts per million there was no difference.

Spurrier thus concludes that there is no evidence that Santomerase No. 1 has any deleterious effects at the rate used in processing commercial fertilizer—about three pounds per ton of fertilizer. The possibility of undiscovered residual effects remains to be researched.

CONCLUSION

At this stage, one can conclude little with certainty about surfactants. They certainly have a great potential and are useful at the present. However, more research needs to be done at the chemistry level to find out, for instance, just what the wetting agent-fertilizer interactions are for different agents and fertilizers. Much needs to be done on the economic feasibility for erosion control. Knowledge is needed as to residual effects of surfactants used for irrigation and turf management, especially over long term use. Finally, much needs to be done to determine the nature of any adverse effects of any wetting agents on plant growth.

Surface active agents definitely have a place, though, in modern agriculture in fertilizer manufacture, herbicidal applications, and irrigation and its related fields.

BIBLIOGRAPHY


Let me but do my work from day to day, In field or forest, at the desk or loom, In roaring market-place or tranquil room; Let me but find it in my heart to say, When vagrant wishes beckon me astray, "This is my work, my blessing, not my doom; Of all who live I am the one by whom This work can best be done in the right way."

—Henry Van Dyke

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FIGURE 1
Generalized scheme illustrating the carrier concept of nutrient ion transport through an impermeable cell membrane.

REQUIREMENTS:
1. Carrier, C, is specific for certain ions or groups of ions.
2. C is an energized state of C. C will bind an ion, C will not (or with low affinity).
3. C → C process occurs preferentially at inner surface of membrane.
4. C → C process requires energy.

PLANT NUTRITION studies generally center around three questions:

... What nutrients are needed and in what amounts?
... What are the functions of nutrients in plants?
... How do plants selectively accumulate nutrient ions from the soil?

The last question is the most difficult. A plant is not a factory where the type of production can be adjusted to the raw materials available. Instead, plant cells, the basic production units within plants, are organized collections of specific chemical compounds. Cell division and enlargement, which constitute growth, require synthesis of these compounds. These compounds, in turn, call for nutrient elements in proper proportions. If there is an imbalance, or an inadequacy of any nutrient, growth is restricted. Use of other nutrients consequently will be curtailed and they may accumulate at some point, or be diverted to other metabolic products. In turn, variations in chemical composition of plants can result.

The farmer is allowed far wider latitude in applying plant nutrients for crop growth than one would estimate in view of the specific needs and balances of normal plant cells. This allowance is largely provided because plant roots selectively absorb nutrients from soil.

For example, most plants (except halophytes) absorb potassium in preference to sodium, a very similar nutrient ion which they do not need, but which is present in all soils. Actually, needs of plants can be partially satisfied with ions selectively accumulated from a poorly balanced soil supply.
Growth will not be optimal, but the plant will survive.

The few hundred pounds of nutrients per acre concentrated in crops are initially spread through millions of pounds of soil to depths of one to several feet. Accumulation of these nutrients from the very dilute soil solution is impossible without energy provided by aerobic respiration.

Furthermore, the soil must be moist, warm and well aerated for active nutrient absorption. For example, potassium deficiency has been observed in crops growing on compact or poorly drained soils even when abundant potassium is present. These soil conditions restrict gas exchange, reduce root respiration due to insufficient oxygen, and, consequently, roots are unable to absorb sufficient potassium.

**Role of Nutrient Carriers**

Cell membranes are the primary sites for nutrient ion absorption by roots. It is here that energy derived from respiration is applied to the transport of selected ions into the root.

A properly functioning membrane does not permit free diffusion of nutrient ions in or out of roots. Consequently, the so-called "carrier" concept of nutrient ion transport has arisen. Figure 1 gives a generalized schematic illustration of how a nutrient ion is transported by a carrier, "C", across a cell membrane.

The requirement for energy lies in the fact that the carrier effectively binds the ion only in an energized state, designated \( \sim C \). In other words, it takes energy to transform \( C \) to \( \sim C \). (The "squiggle" is a symbol indicating a high-energy state, usually a covalent bond with a high-standard free energy of hydrolysis.)

Somehow, \( \sim C \) can bind and release ions at inner and outer surfaces of membranes. In this way, it acts as a bridge for ion transport. For net nutrient ion absorption to occur, however, \( \sim C \) must be transformed to \( C \) at the inner side of the membrane, releasing the ion. To complete the transport cycle, \( C \) must be reactivated, using energy generated by respiration.

According to the carrier concept, the rate of net transport of a nutrient into a root depends on three conditions:

- Concentration of carrier (generally considered constant),
- concentration of the ion outside, and
- rate at which respiration provides energy.

The carrier system has been compared to a conveyor belt where the rate of transport depends on:

- width of the belt (carrier concentration),
- rate of loading (external concentration), and
- rate of turning (respiration rate).

There is good evidence that aerobic respiration provides the energy. Little is known about the action of carriers, however, for no one knows what the carriers are. Evidence points to carriers as being integral parts of cell membranes, possibly lipoproteins. Their removal destroys the membrane, and hence the system in which they can be recognized.

**Transport Rate Varies**

Studies on rate of transport as affected by external nutrient ion concentration show curves like those in Figure 2. Transport increases, up to certain levels for each carrier, as the external ion concentration increases. At high external concentrations all the activated carrier is occupied by ions and the maximum rate of transport is obtained.

The transport system is amazingly effective at low concentrations, which is fortunate for the farmer who finds it impractical to side-dress growing crops in mid-season. In fact, there may be two or more carrier systems for an ion such as potassium, one having a high affinity for the nutrient and dominating when the concentration falls very low, thus enabling the plant to survive.

Nutrient uptake does not continue indefinitely. Cells reach a saturation level and then show no further gain. The level is approximately the same whether the nutrient ion is accumulated rapidly from high external concentrations or slowly from low concentrations.

Work of Jackson and Stief has shown that this is a dynamic equilibrium. For example, when at equilibrium, the outward transport of an ion such as potassium is equal to the input. The nutrient ion concentration in the cell is thus held at a given level.

The "output" is not a simple leakage, as it does not occur with live roots in pure water. No firm explanation can be given, but if the carrier concept is sound, then \( C \) may carry ions out, with a very low binding affinity. Only when the internal concentration is very high can \( C \) be saturated, and thus produce an outflux equal to the influx.

Carriers are not completely ion specific. Potassium carriers, for example, are equally effective with rubidium, an element similar in size and charge. Rubidium does not substitute for potassium in metabolic functions, however, and it is fortunate that only traces of rubidium occur in the soil.

Yet, as has been said, potassium can be recognized. Figure 2. An illustration of rate of nutrient in transport into roots as related to its external concentration. The rate of transport is a function of how \( \sim C \) is occupied by an ion (\( \sim C^{-} \)). "Luxury consumption" may occur with saturation of low affinity carriers.

**Calcium Has Key Roles**

It turns out that calcium is essential for the discrimination in this case. As shown in Table 1, addition of calcium increased the ratio of potassium to sodium in excised barley and corn roots.

Actually, calcium does much more than this. It is essential to prevent the membranes from becoming "leaky" and is essential for the formation and maintenance of membranes. It also...
improves the accumulation rate of other ions especially at low pH.

Just how calcium performs these roles is unknown. There is some evidence that calcium increases the affinity of potassium for its carrier, and that it improves phosphate absorption. Calcium probably affects the potassium-sodium discrimination by reacting with the carriers in some way, thereby increasing the preference for potassium. The effect of calcium on phosphorus uptake is beginning to be understood. In terms of the carrier concept, calcium activates discharge of C, releasing phosphate into the cell.

Transport to Top Essential

In a fertile, moist, warm, welldrained soil, root surfaces are bathed in a nutrient-rich soil solution. The root cells are probably near saturation at all times under these conditions. Hence, continued nutrient absorption is dependent upon transfer of the nutrient ions to above-ground plant parts.

Figure 3 illustrates what is thought to occur in this case. Perforations in cell walls (plasmodesmata) allow the cytoplasm of living root cells to be connected. This unit of connected cytoplasm is called a symplast, and it provides a continuous cytoplasmic pathway for a nutrient ion to the xylem, the upward conducting tissue of plants. Once deposited in the xylem, ions are swept upward by the transpiration stream. Later, they are actively accumulated from the xylem by the leaf and stem cells.

Thus, there are two basic systems of transport in the root, one into the vacuoles and one into the xylem. Little is known as to what regulates the amount transported by each system. During daylight, transport to the xylem dominates. The reverse is true at night.

One point in ion transport is sometimes not appreciated. Too often we think in terms of nutrient uptake as limiting growth, a situation which is particularly evident when an ion such as nitrate falls to a low level in the soil. However, with modern fertility practices, the opposite condition must often prevail where slow growth limits nutrient uptake.

Mechanisms of ion transport into roots and into shoots are sufficiently rapid so that cells are usually near optimal saturation with needed elements. Only by additional growth is "space" made for additional ion uptake. Factors limiting nutrient uptake in this case can be traced to processes such as photosynthesis, translocation of photosynthetic products to the roots (low when plants are fruiting) and tissue hydration.

Fungi May Help

The concentration of soluble phosphorus in the soil solution is always low except close to sites of applied fertilizer. Microbial activity and reactions with other nutrients, clay and organic matter, rapidly convert soluble phosphorus to less available forms. Even in nutrient solutions where soluble phosphorus is high, troubles can arise if pH and ion balance are not carefully controlled. The situation in the soil is often much less favorable.

However, crops continue to obtain soil phosphorus under conditions very unfavorable for phosphorus solubility and uptake. This seems to be due to the infection of roots with mycorrhizal fungi. The infection is symbiotic (mutually helpful), not pathogenic. Plant roots are hosts to the fungi, and, in turn, the fungi contribute in some fashion either to making phosphate available or to its transport from low concentrations. Detailed physiological studies are badly needed here, for the efficiency of phosphate fertilization is at stake.

Summary

The transfer of nutrient ions from the soil into the root and throughout the plant is an active metabolic process controlled by cellular membranes. We know that calcium is essential for the growth and proper function of these membranes.

Cyclic processes involving membrane constituents called "carriers" are believed responsible for ion transport. In one phase of the cycle carriers bind the ions at the outer membrane surface. In another, carriers release ions at the inner membrane surface, inside the cell. Carriers show a good deal of ion specificity.

Aerobic respiration provides the energy necessary for the cycle. Processes in various membranes which connect the cytoplasm of one cell to another are probably responsible for rapid ion transport across the root into the xylem. When cells are saturated with nutrient ions, the inward transport continues, but is offset by an outward flux which is not understood. When this occurs, further ion uptake is dependent upon growth rate.

References


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INTRODUCTION
With the rapid increase in the popularity of golf there has been a large problem in trying to maintain good golf greens. To help maintain good putting greens which will not compact, soil amendments must be used. Exactly which amendments will be used is mostly dependent upon their availability, plus the personal preference of the superintendent.

To better understand the use of the various soil amendments, we should first understand why we use them and what purpose they should serve. The various soil amendments might have various properties which would be beneficial to certain areas or situations. Some of the more common turf problems are poor drainage, poor root growth, poor aeration, and disease.

Poor drainage is usually a result of compacted soil or improper green construction and design. Gradual compaction will usually develop due to the heavy traffic of golfers and machinery. If compaction is more rapid, then the problem is mostly due to a poor soil mix, plus the heavy traffic. Aeration and topdressing are two means of relieving this problem. Various grades of sand have been used for many years in the past as topdressing. The sand is gradually incorporated into the top 2-4 inches of soil by aeration, work of earthworms, and also thawing and freezing action. This helps to make a more coarse soil mix with greater porosity. This will greatly improve the soil drainage.

Poor aeration is a second problem. This is also a result of compaction. The roots need oxygen which is usually the limiting factor in compacted soils. Aeration and topdressing can be used to relieve this problem. This allows for a free exchange of gases in the soil which is so necessary for good root growth.

Shallow root growth is closely associated with this. Shallow root growth results from a lack of oxygen at the deeper levels of the root zone. Therefore, the root growth will be shallow and close to the surface. This is not good for a variety of reasons. There will be a more frequent need for watering due to evaporation from the upper surface of the soil. Poor root growth is also responsible for poor plant growth. If the roots are not developing properly, there will be a reduced quality in the turf.

Disease is a fourth problem which is prevalent in golf greens. Disease is most common under conditions of high moisture or stagnant conditions. Grass is most susceptible to disease when it is not growing properly. Poor drainage, poor aeration, and disease can therefore lead to disease problems. By the use of soil amendments, these problems can be relieved to some extent. The soil amendments to be mentioned in this paper will be calcined clay, sand, perlite, vermiculite, and peat.

CALCINED CLAY
Calcined clay is a granular clay which is composed of hard, inorganic mineral granules about one-eighth of an inch wide. The calcined clay can absorb water in great amounts and gradually release it to the soil medium as it is needed. It also helps to maintain a loose, friable, porous system in the soil without compaction.

Calcined clay is made by heating montmorillonite clay at temperatures of 1,500 degrees Fahrenheit and above for a prescribed length of time. This removes the OH ions that are a part of the expanded clay lattice. This reduces the tendency of the granules to expand and contract under moisture changes and also lowers the solubility of the granules in water. The calcining, or heating process makes the clay granules hard and pebble-like, having many capillary pore spaces. After calcining, these granules are sent through a series of screens which sort out the product to a uniform size.

Because of the heating process, the calcined clay is sterile and completely free from weed seed and disease. It is completely free from any harmful materials. The granules are uniform in size, dry, and non-sticky even when wet. The granules do not cake or stick to machinery or equipment during use or green construction. It wets easily and becomes firm upon wetting. It actually saves watering time and reduces erosion from water runoff.

Calcined clay is now used as a topdressing in place of sand in some instances. It is used to help increase the water holding capacity of the soil, plus increase the soil porosity, which is so important in maintaining a good golf green. Topdressing dilutes the surface soil with the calcined clay, therefore creating a more porous soil with better drainage qualities. Light applications are worked into the soil using the accumulated thatch as organic matter. This helps to maintain a smooth surface and increase the porosity at the same time helping to control thatch. Power spikes or aerifiers of any type used before the application of calcined clays will definitely increase the rate at which they are incorporated into the soil.

When calcined clay is applied solely as a topdressing, it still works its way into the soil. Freezing, thawing, golf spikes, earthworms, plus other soil actions all help to incorporate the topdressing into the lower depths of the green. It has been found at depths of two inches after a two to four year period.

One of the best advantages of topdressing is the beneficial effect it has on the reduction of thatch. Thatch is a result of the lateral development of bent roots and the accumulation of dead plant parts. As the thatch accumulates it can act as a barrier to water, air, and fertilizer into the soil. It can be reduced by vertical-cutting machines, but the alternate approach is topdressing. The topdressing dilutes the thatch which accelerates the decaying process, thereby improving the soil fertility through the nutritional release. It also dilutes the thatch, making channels for air and water to enter the soil.

Topdressing with calcined clay can also be used to help decrease the frequency of turf disease. Because of the top layer being so porous, it is also drier. The excess water is easily evaporated. Normally, the thatch is thick and moist, allowing for abundant fungus growth.

Layering in calcined clays does not seem to be as much of a problem as it may be with other soil amendments. Because of its porosity and water-
SOIL AMENDMENTS . . (Continued from Page 19) holding capacity, it does not act as a barrier to root growth, air or water. (6)

The recommended rate for application is fifty pounds per 250 square feet of grass, or 1,000 pounds per 5,000 square feet of green. This figures out to be about a seven percent addition to the top one inch of soil, which is the crucial layer. This will contribute greatly to the texture of the (2) top inch. Applications can be added up to five times a year until a good percent of calcined clay has been added. However, too much calcined clay could alter the putting surface. In experiments by Smalley et al. (4) using the calcined clay, they reported a decreased yield in bermudagrass clippings. This was attributed to excessive aeration and therefore a reduction in the available supply.

Topdressings of calcined clay can be added after aerifying the soil with small spoons. The clay can then be washed into the vertical holes left by the aerifier. This leaves the vertical shafts open to air and water, whereas normally these shafts soon fill in. (2)

The exact concentrations desirable in the soil is a subject for debate, however the lighter the soil, the less calcined clay is needed. Sixty percent is recommended for heavy soils and fifteen percent is recommended for the lighter soils. (2)

SAND

Sand is also an amendment which has been used with good success. Swartz and Kardos (5) used various types of soil mixes containing different percents of sand. They found that the various mixes reacted differently to compaction when related to percolation rates and aeration porosity. Mixes with less than fifty percent sand resulted in poor aeration and percolation rates under similar rates of compaction. Better aeration and percolation rates were maintained using seventy percent sand under the same conditions of compaction. However, mixes containing seventy percent sand were considerably lower in percent available moisture than were the mixes containing thirty to fifty percent sand. This would indicate that special water management practices would have to be undertaken and more frequent watering in these soil mixes containing the higher percentages of sand.

It was also reported by Swartz and Kardos (5) that under conditions of maximum compaction, soil percolation rates in the low sand mixes did not exceed 1.5 inches per hour. However, in six out of the eight soil mixes using seventy percent sand, the percolation rates exceeding 1.5 inches per hour were obtained.

Sand used for topdressing is divided into various classes such as coarse, medium and fine. Coarse sand varies from one-eighth of an inch to one twentieth of an inch in diameter. Medium sand is one twenty-fifth to one-fiftieth of an inch in diameter, and fine sand is one-fiftieth to .001 of an inch in diameter. (2)

Both sand and gravel can be expected to improve the soil drainage and porosity, but they hold very little water. A low cation exchange capacity is also a problem when working with sand. Because of this, greens which are amended with sand must be watered carefully and fertilized regularly. In comparison to other soil amendments, sand is also very heavy. Sand weighs about 100 pounds per cubic foot, whereas something like calcined clay weighs only about thirty pounds per cubic foot. This is an obvious advantage when concerned with handling and storage. (2)

Occasionally there is concern about the layer effects of sand. Topdressing with sand is apt to form layers. This sand layer then might be different in its capillary action from the soil above and below it. This in itself can be harmful, affecting the transfer of air and water to the roots. This problem can be overcome though by aeration. Aeration can be done before topdressing allowing for a more rapid incorporation into the soil. (2, 4)

PEAT

Peat is often used on greens to improve the water holding capacity of that green. Peat has a good cation exchange capacity along with its capacity to hold water. Because of its cation exchange capacity, it can be a source of nutrient for the turf. It is most effective on sandy soils to help improve the water holding capacity and also to reduce the rate of leaching. (1, 2, 5)

Peat, which is about 95 percent organic matter, is sometimes hard to mix uniformly in the soil and it is very difficult to wet when it is dry. These are some of its undesirable characteristics, but it is still one of the components in the standard soil mixes when building greens. It helps to give the sand a better texture, plus it reduces evaporation rates, making more of the soil water available to the turf. (2)

PERLITE

Perlite is another of the materials used for a soil amendment. Perlite is a gray-white volcanic material which is mined from lava flows. It is crushed, screened and then heated in furnaces where the small particles explode into sponge-like kernels. It is extremely porous and light, only weighing six to eight pounds per cubic foot. (1)
Because it is heated, it is a completely sterile soil amendment. There is no fear of weed seed or disease being transported by the perlite. It is used in the soils to help improve the water-holding capacity or to lighten the heavier soils. It helps to increase aeration and soil porosity, thereby improving the root growth of the turf. Perlite can be applied in soil mixtures or as a topdressing. It is best applied after aeration where it can be washed into the channels left by the spoons. This way the perlite can help to keep these vertical shafts open to air and water. (2)

However, it does have its drawbacks. It is fragile and is easily crushed. When it is crushed to a fine dusty state, it is no longer of any value as a soil amendment.

VERMICULITE

Vermiculite is a micaceous mineral which has been heated to temperatures of 2,000 degrees Fahrenheit and above. The heat causes the water trapped between the microscopic layers of mica to change to steam expanding the mica layers. This makes a very porous sponge-like mica capable of taking in great amounts of water. Like perlite, it is also sterile and free from disease and weed seed. (1)

It is very light, weighing only six to eight pounds per cubic foot and having a neutral reaction in water. One cubic foot of vermiculite is capable of absorbing as much as three to four gallons of water. Like sand, vermiculite comes in four different grades, number one being the larger size. (1)

Smalley et al. (4) reported that vermiculite improved growth and quality of Tifgreen bermudagrass on a loamy fine sand. Vermiculite was said to have been more beneficial in improving grass quality in the summer months than it was during the winter months. It was mixed at a rate of ten percent. Rates greater than ten percent did not show any better results except in one instance of a drought.

Vermiculite in greens can cause problems though. It is not very strong structurally and can be easily compacted. It loses its structure and the fine layers separate and slide apart. The water retention capacity is lost, plus the fine mica sheets can act as a barrier to water applied to the green. (1, 2)

CONCLUSION

Soil amendments are used to modify the soil properties or conditions. By adding the various amendments soil compaction is reduced, thus making for better aeration, precolation, and water-holding capacities. The amendments can be added to the soil in a mixture at the time of green construction, or later as a topdressing. However, peat would not be used as a topdressing, but as a basic soil mix.

Of the topdressings mentioned, calcined clay and sand seemed to be the best. Neither vermiculite nor perlite can withstand compaction. Both break down physically using their desirable structure and making them useless. Calcined clay seems to be better than sand in that it has better water retention properties and due to its cation exchange capacity it can serve as a source of nutrient supply. Sand has a low water retention capacity and a low cation exchange capacity.

REFERENCES


Anyone who hopes to achieve success, even the average, must know more, or at least as much, about some one thing as any other one, and not only know, but know how to do — and how to utilize his experience and knowledge for the benefit of others.

—Theodore N. Vail
NEW BLUEGRASSES GETTING ATTENTION

Kentucky Bluegrass is perhaps the best of all sod forming grasses, according to “Better Turf & Garden”. It is attractively soft and of elegant color and texture, easily mowed, hardy and strongly recuperative. Some of the fine new varieties include Aboretum, Delta, Fylking, Merion, Newport, Park, Prato, and Windsor.

Fine or Red Fescues are very attractive, hardy, erect-growing species similar to bluegrass, but generally have finer texture and slightly stiffer leaves. Their seeds germinate quickly and are competitive with weeds. Fine fescue lasts on infertile soil with minimum care and is well-suited for dry shade. Select varieties include Chewings, Highlight, Illahee, Pennlawn, and Rainer.

Bentgrass — these luxury grasses provide a dense turf that deserves more careful attention than bluegrass and fescue require, reports “BT&G”. They need to be mowed often and relatively close, and because they tend to thatch, they need occasional thinning. Bents adapt to moist climates and benefit from regular feeding and disease control. The best lawn varieties from seed are Astoria, Highland, and Penncross.

Having one or more fine fescues in a seed blend gives you a candidate grass suitable for difficult spots under trees. The fescue is compatible with bluegrass and will probably take over in favorable locations — a balance that gives good cover in spite of conditions affecting the lawn.

SEX ATTRACTANT FOR FALL ARMYWORM

A sex attractant that may lure the fall armyworm to its death has been produced artificially by ARS chemists and entomologists at Tifton, Ga., and Beltsville, Md. The fall armyworm attacks a wide range of crops including corn, cotton, peanuts, cabbage, alfalfa, grasses and other cultivated and wild plants.

Each insect species produces an attractant that affects only its own kind. Biochemist A. A. Sekula and entomologist A. N. Sparks (Tifton) first isolated, identified, and synthesized the armyworm’s sex attractant, Cis-9-tetradecen-1-ol acetate, a compound resembling many that occur naturally in certain edible fats and oils.

Chemist J. D. Warthen, Jr. (Beltsville) developed a less expensive 3-day, four-step process soon after the Tifton scientists produced the synthetic lure. A medicine dropper barely wet with the synthetic lure affected male moths the same as a female giving off the natural lure. The males exhibited their typical mating behavior when the bulb of the dropper was squeezed to force out lure-laden air around them. They did not respond to the attractant beyond distances of a few feet.

One way the attractant might be used against the fall armyworm would be to spread it across fields in pellets; the odor given off would mask the female’s natural lure. Confused males would be attracted to the pellets instead of the females, reducing future generations of the pests since the mateless females would lay infertile eggs.

Scientists caution that synthetic sex attractants have not yet been proven as adequate controls for this or any other insect. Field tests are necessary to fully gauge the lure’s limitations and potentials.

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NEW VARIETY OF BLUEGRASS
NOW AVAILABLE

A limited quantity of certified seed of Kenblue, a new Kentucky bluegrass, is now available according to Dr. Robert Buckner, agronomist with the USDA's Agricultural Research Service, attached to the University of Kentucky Agricultural Experiment Station Agronomy Department.

Kenblue was developed in 1966 and officially released July 31, 1967 by the University and the USDA-ARS.

It is more insect- and disease-resistant than other named varieties of bluegrass and its adaptability to Kentucky conditions is much higher.

That's because Kenblue was developed from seed taken from twelve farms in seven Central Kentucky Counties where bluegrass is normally grown for seed purposes. In each case, fields had been in seed production a minimum of eight years and maximum of fifteen years, Dr. Buckner said.

The selected seed was blended by the agronomists, and a portion of it held by the University to produce certified seed. A smaller amount was kept by the UK breeders to be sown at the UK farm in Lexington and maintained as a permanent breeders' block.

Native Kentucky bluegrass has never been certified as a variety before, because seed sources were never definitely known. But the new system used last year (selected from the twelve farms and careful blending) makes the seed source known now. “All Kenblue certified seed of the future will trace back to our breeders' seed stock,” Dr. Buckner said.

The certified seed now being offered (approximately 25,000 pounds) is being sold by or through regular retail seed outlets.

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For more information write:
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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.

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