# California Turfgrass Culture

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# Coated Fertilizers:

## *General description and applications*

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In the coating process, individual granules of inorganic fertilizers are coated with resinous, polymeric membranes. When such granules are placed in contact with water or moist soil, water passes through the membranes and dissolves some of the fertilizer. .A saturated solution with considerable osmotic pressure develops within each capsule. The coated granules swell and become spherical in shape. Apparently the dissolved fertilizer materials diffuse through the membranes into the outside solution. The rate of diffusion is regulated by the thickness of the membranes and is relatively steady until about two thirds of the fertilizer has been released. The rate of transfer through the membranes is not markedly influenced by steam sterilization of soils or by other conditions occurring in soils, except dryness. The influence of soil conditions on diffusion rates will be the subject of a subsequent article.

Nitrogen (including urea), phosphorus, potassium, and mixed fertilizers can be coated. With some coatings, the minerals have been released over a period exceeding six months. A depletion time of 4 or 5 months is adequate for many crops.

After all the minerals have passed through a membrane, the solution is withdrawn from the capsule, apparently by soil-moisture suction. The membrane shrinks, becomes brittle, and is easily crushed between the fingers The swollen condition distinguishes coated particles which are still functional from those which are exhausted.

### Duration of supply

To illustrate the duration of mineral supply from coated fertilizers, 500 granules of coated 20-10-5 fertilizer were examined after 112 days in soil with a growing crop. Of the lightly coated granules, 37.4 per cent were still swollen; of the medium coated, 49.6 per cent; and of the heavily coated, 58.2 per cent.

The graph shows cumulative quantities of nitrate nitrogen and of potassium released from a 60-centimeter column containing 30 grams of coated 10-10-10 fertilizer uniformly incorporated in 1 kilogram of krilium-treated soil. The column was leached every few days. At the end of 74 days, some 68 per cent of the added nitrate nitrogen and 57 per cent of the added potassium had been recovered. On the graph, the relative linearity of the curve showing the amounts of minerals recovered demonstrates the utility of coating in sustaining the nutrition of a planting during a prolonged period.

### Practical uses

Possible uses for materials with these properties are exciting, but application will be influenced by the cost of the coating process. Probably coated fertilizers will find application first for high-value plantings such as omamentals and turfgrass. They show promise, along with other materials to be reported later in this series, of solving some difficult management problems in California's 100-million-dollar commercial flower and nursery industry.

The occasional rapid deterioration of vigorously growing canned nursery stock after it leaves the hands of the grower has been a problem. Liquid fertilization is now widely used by nursery stock producers in conjunction with highly permeable soil mixes, which have little retentive capacity for several of the fertilizer elements. Thus, while the grower may do an excellent job of producing stock, the retailer may not be equipped to maintain the stock properly, or the consumer may be disappointed with the rapid decline of a vigorous plant, caused by inadequate nutrient supply.

Coated fertilizers are capable of minimizing or eliminating this problem. The philodendrons pictured here were grown in a typical nursery mix and were uniform in size at the time a coated source of nitrogen and potassium was applied. The planton the left received 12 grams of nitrogen as heavily coated urea; the plant in the center received 1.5 grams of nitrogen as lightly coated urea - somewhat more than could be given safely in a single application of a soluble, uncoated source. The plant on the right received no nitrogen. Adequate quantities of other fertilizer elements were supplied to the plants. After fertilization the plants were maintained with only tap water. When the picture was taken, 5 months after the fertilizers were applied, new foliage on the largest plant was highly acceptable, though not quite the dark, glossy green which had been achieved previously.

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**Heavy applications safe**

Relatively large applications of coated fertilizers can be made safely, because the coating separates the fertilizer from the soil solution at the start. However, if the proper amount of deep leaching does not take place, salinity conditions can develop rapidly, as with other soluble fertilizers. Prolonged storage of moist soil containing coated fertilizer is not good practice, because the minerals released during storage may be excessive when a planting is finally made in the soil. In practice, one pound of actual nitrogen from a heavily coated source per cubic yard of soil has given excellent results with potted chrysanthemums and has grown them to maturity without further fertilization. (With granules 1/8 to 3 /16 inch in diameter, the coating would represent 12 to 15 per cent of the total weight.)

Aside from the field of ornamentals, coated fertilizers will be of interest and probable value wherever leaching losses are high. Coupled with sprinkler irrigation, they may increase the utility of very sandy soils. At the proper rate and coating thickness, fertilizer can safely be placed directly with *or* beneath seeds to give a rapid plant response, which may be of particular importance where the growing season is short.

Foresters have sought a long-lasting fertilizer source which could be used at the time of planting seedlings. Looking at the broader soil resource in relation to population problems, the techniques of controlling and extending nutrient availability from fertilizer materials may be an important tool in more efficient utilization of soils in the tropical regions.

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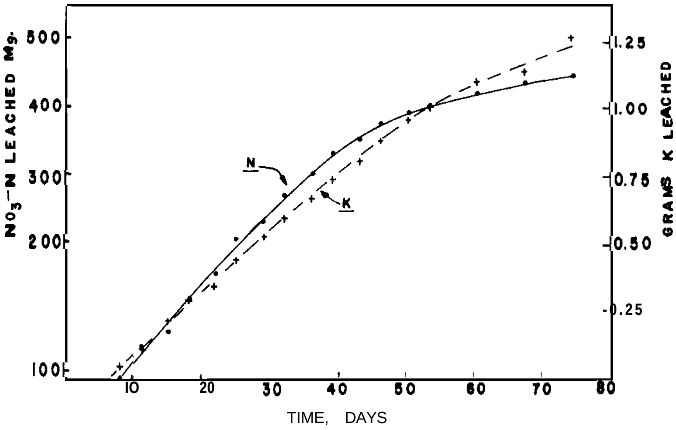
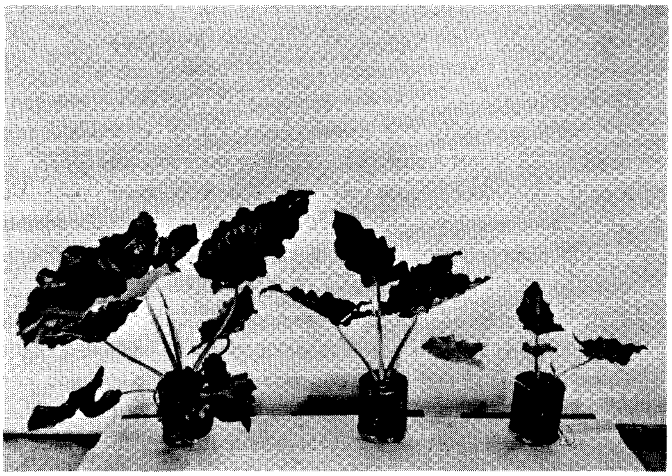



Cumulative removal of nitrate nitrogen and of potassium by repeated leaching from 1 kilogram of krilium-treated Yolo loom into which 644 milligrams of nitrate nitrogen and 2,175 mg of potassium had been incorporated from a coated source.



Philodendron plants, maintained with top water for 5 months following the application of coated nitrogen and potassium sources. The plants were of equal size when fertilizer-was applied. The plant on the left received 12 grams of nitrogen from heavily coated urea, the center plant 1.5 g of nitrogen from lightly coated urea, ond the plant on the right no nitrogen at that time. During the 5 months following fertilizer application, on estimated 8 to 10 feet of water was applied to each plant, with about one half this quantity passing through the container.

*Eugene Marzolf*

Mr. Eugene Marzolf, for many years a leader in the California Turfgrass industry, died October 21, 1961. Mr. Marzolf was a founder of the Southern California Turfgrass Advisory Committee which later became the Southern California Turfgrass Council. He was also a founder of the Athletic and Recreational Turfgrass Association and the Southern California Golf Course Superintendents Association. He was a charter member of the Golf Course Superintendents Association of America and a member of the Hi-Lo Desert Golf Course Superintendents association.

Gene for many years was active in various aspects of golf course work. In 1948 he became a turf consultant at Northrup King Seed Co. and later joined the sales force of Pacific Toro Co. in Los Angeles. At the time of his death he was sales manager for the company.

# WETTING AGENTS

***can increase water infiltration or retard it, depending on soil conditions and water contact angle***

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Wetting agents are being marketed as means of increasing water infiltration of soil. At present no recommendation either for or against their use in irrigation water can be made that will cover every soil condition. However, certain effects of wetting agents on water entry are known, and these indicate conditions under which wetting agents are most likely to be beneficial.

When a liquid comes into contact with a solid, it forms a contact angle with the solid. The, contact angle depends on the properties of the solution and the solid. On a hydrophobic (water-resistant) surface, such as wax, a drop of water "balls" up to form a large contact angle (Diagram A.) On a hydrophilic (water-receiving) surface, such as glass, a small contact angle is formed, and the water spreads (Diagram B).

If a wetting agent is added to the water to reduce its surface tension, and the water comes into contact with a hydrophobic surface, the solution forms a lower contact angle, thereby wetting more of the surface (Diagram C).

How do surface tension and contact angle affect water infiltration rates? Water enters a soil primarily as a result of capillary and gravitational forces. Capillary force is the more important during the initial period of infiltration. Modification of surface tension has little effect on gravitational force, but it does affect capillary force. Decreasing surface tension decreases capillary force, but at the same time the accompanying decrease in the contact angle increases the force. The addition of a wetting agent, therefore, on the one hand reduces capillary force, and on the other, increases it. What must be determined is which effect predominates, the beneficial or the detrimental.

If the surface to be wet is not water-resistant, addition of a wetting agent will be of little benefit

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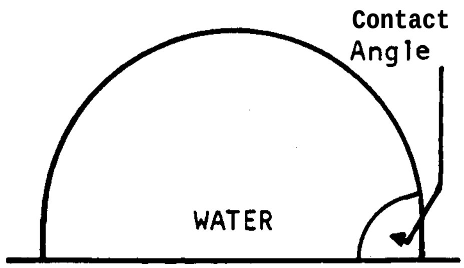


HYDROPHOBIC SURFACE

A


HYDROPHILIC SURFACE

B


HYDROPHOBIC SURFACE

C

because the already low contact angle cannot be lowered much more. If the surface to be wet is hydrophobic, however, the contact angle can be considerably modified by a wetting agent, possibly to the point of over-coming the bad feature of reduced surface tension. In other words, the effectiveness of a wetting agent depends on the nature of the solid that is to be wet.

Another problem concerning wetting agents is their residual effect. When a hydrophobic surface has been wet with water plus a wetting agent, and the water has evaporated, what happens when the surface is wet again, with plain water? Three possibilities exist: (I) the surface would remain the same, and water would wet it as shown in diagram A; (2) the surface would have been made hydrophilic, the water would retain its high surface tension and wet the surface as in diagram B; (3) the wetting agent would redissolve in the added water to produce essentially the same condition as when it was originally applied in water.

An experiment *was* set up to show the importance of the contact angle and to learn more about the residual effect. White quartz sand was washed to remove silt and and clay. Chaparral litter was extracted with ammonium hydroxide, and the extract was poured over two batches of sand. (The litter extract had previously been found to make the sand more hydrophobic.) Each batch of sand was sieved into various sizes. The 30- to 60- mesh fraction was packed into glass columns, and the time required for infiltration of 50 ml of solution was measured. (The glass tubes were treated with paraffin dis-wolved in xylene so that they would not be more wettable than the sand). Tap water and three commercial wetting agents (diluted to concentrations recommended on the containers) were used in the checks. After the initial run, the sand was removed, allowed to dry, and repacked in the tubes. Water was then rerun through the tubes as a check on the residual effect of the wetting agents. (Sand was used rather than soil because wetting and drying did not alter the structure, and the original packing could be reproduced.) The table shows relative infiltration times.

On the untreated sand, wetting agents were detrimental to infiltration both on the initial run and the rerun. The rerunpattern suggests that the wetting agent dissolves in water to create a situation similar to the initial solution. The decreased infiltration on the untreated sand was probably a result of reduced surface tension, which was not overcome by a more favorable contact angle since water wets sand at a fairly low angle.

On the treated sand, the wetting agents increased infiltration, especially on sand treated to be least wettable. In these cases, the decreased surface tension effect was surpassed by the creation of a more favorable contact angle. The rerun on treated sand resulted in even better infiltration than the original. This indicates that if some of the wetting agent did dissolve in the added water, the surface tension was not reduced *to* that of the original solution, and. the wetting agent had a favorable effect on the surface, reducing the contact angle.

These results show that much depends upon the contact angle between the soil and water, and that wetting agents are most likely to be beneficial when the surface is hydrophobic. Further studies of contact angles existing under natural conditions should indicate whether wide-spread use of wetting agents to promote better infiltration of irrigation water would be practical

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RELATIVE TIME REQUIRED FOR 50 MILLIMETERS OF SOLUTION TO INFILTRATE SAND COLUMNS

| Solution | Untreated sand | | Treated sand No. 1* | | Treated sand No. 2† | |
|---|---|---|---|---|---|---|
| | Initial time | Water re-run | Initial time | Water-re-run | Initial time | Water re-run |
| Water | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Product A | 1.2 | 1.3 | 0.7 | 0.6 | 0.8 | 0.5 |
| Product B | 1.3 | 1.3 | 0.7 | 0.6 | 0.8 | 0.6 |
| Product C | 1.3 | 1.3 | — | — | 0.8 | 0.6 |

• Time for water entry 3.1 times that in untreated sand.
† Time for water entry 1.8 times that in untreated sand.

ABSTRACT OF MOTION PICTURE –

# "WATER MOVEMENT IN SOILS"

MADE AT WASHINGTON STATE UNIVERSITY

By W. H. Gardner and J. C. Hatch in 1959

Water moves in an unsaturated soil in all directions indicating that gravity is not the only factor affecting its movement. The dominant force causing water to move in a medium or fine textured soil is soil suction. This is the attraction of fine soil particles for water. As soil approaches saturation, gravity's role in water movement becomes more important.

In a sandy soil, gravity is a more important factor in water movement. Coarse particles neither have as great an attraction for water nor do they permit as great a movement of water films as do fine particles. If water is supplied directly to a layer of coarse sand which is exposed at the surface, water will enter it readily through the large pores. Water moves through these large pores by the force of gravity and is not dependent upon soil suction.

If a sandy layer occurs within a loamy soil, water will not move into this layer until the soil above the sand layer is saturated. Such a situation occurs when a layer of coarse sand or gravel is placed in a soil. Often this is done when planting or building a putting green. Soils with a sand layer buried within them also are more difficult to leach because of this restriction of water movement.

If a clay layer exists within a sand, the water will be less restricted in its movement into the clay layer from the overlying sand than in its movement out of this clay layer to the sand under it. Water tables normally do not build up over a silt lens because of the inability of the silt to absorb water but rather because the water movement to the layer beneath it is restricted. As saturation builds up above a sandy layer, eventually the water will move into the sand. When it does it will move through the sand and into the soil beneath it.

The question is frequently asked - Would water move differently if the sand layer under a loam soil were slightly moistened, that is, moist enough to support plant growth. Again, it has been found that water will not move down through the soil into moist sand any more readily than if the sand layer is dry.

In comparing the rate of water entry and movement through a uniform sandy soil with loam or clay loam soil, water moves into the sandy soil at a faster rate than it does into the clay loam soil because of the difference in pore size. Despite this fact, the net usable water, once the soil is wet, in the clay loam soil is greater than in the sandy loam soil. This means a clay loam soil should need to be wetted less frequently than a sandy loam soil. Water normally will need to be applied to the clay loam soil at a slower rate for good absorption than to a sandy loam soil.

It is important to understand the relationship of water movement to the movement of fertilizer materials which may be in the soil. Fertilizer materials applied to the soil will not necessarily move uniformly down through the soil but will be carried in several directions with the the moving water. Therefore, in areas where two wetting fronts come together, as when furrow irrigation is practiced, one can get a concentration of fertilizer or other salts on the beds or ridges between furrows. This suggests an advantage of using sprinkler irrigation where water is applied more uniformly. There is little opportunity for salt accumulation due to "subbing". Fortunately, most areas of turf are sprinkler irrigated.

Water movement into soils is affected by tillage. An important practice is the inclusion or incorporation into the soil of organic' matter, such as manures, peat moss or wood shavings. They should be thoroughly mixed into the soil to increase water movement into the soil. Organic matter, such as manures, can aid in stabilizing the structure of a soil to improve water penetration. However, if they are incorporated into the soil in a horizontal layer not open to the free water surface above, i.e. buried, they will restrict the movement of water in the same manner as a sand layer. Channels left in soil by earth-worms or other burrowing animals if not open to the free water surface above will not aid the movement of water but will act as if they were filled with sand. If vertical mulching is used and the layer of organic matter continues up to the surface, that is open to free water, water will readily move into this area. However, if these channels become sealed at the soil surface, the water movement into them will be restricted.

In summary, unsaturated flow of water in soil and other porous materials takes place because of the attrac- of fine soil particles for water and of water molecules for each other. How readily the water moves depends upon the nature of the pores and the particle site in the system.

**Prepared by –**

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# Observations on Golf Turf in Scotland and Ireland

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Between 35 and 40 golf courses in Scotland and Ireland were visited by the author during June and July of 1961. Wherever possible, detailed information on turf culture was secured from greenskeepers, golf professionals, the club secretary, or members. Turf and course management varied greatly, determined by the location of the course, soil type, funds available, the amount of play, and the knowledge, skill, and desires of the management.

Green fees varied from 60 cents to $3 per day. Dues for playing members ranged from $15 to $30 per year. Maintenance personnel varied from two men and 200 sheep for the 18 hole course at the Ennis Golf Club (Ireland) to 12 men for 45 holes at the Gleneagles course in Scotland.

The play was rapid; perhaps more so in Scotland than in southern Ireland. Col. B. Evans-Lombe, secretary of the Honorable Company of Edinburgh Golfers at Muirfield, laughingly said the Scots dislike to be away from their whiskey more than 2 1/2 hours to play a game of golf. The Belvoir Park Golf Club in Belfast has wide fairways with the rough clipped to three or four inches, to speed the play of their 700 playing members. Players apparently do not expect or demand lush grass on fairways and greens, or soft greens where the ball will "bite."

**Management is Consistent**

Management of most golf clubs, including the courses, is in the hands of the secretary. He is, for practical purposes, the general manager. He may or may not be advised by a greens committee; he may or may not know turf culture; he may delegate few or many management decisions to the greenskeeper. There appears to be considerable permanence in the job of secretary, hence consistent management. Long term programs on weed control, fertilization, aerification, and training of personnel, can be adopted with reasonable assurance of satisfactory completion.

**Seaside vs. Inland Soils**

The courses are generally described as "seaside" or "inland." The difference is in the soil type, more than in the location. Inland courses were played that were nearer the sea than some of the seaside courses.

Soils on the seaside courses are dune, or blow sand. They are deep, uniform, well-drained, apparently low in organic matter, and of low water-holding capacity. After continuous play for many years, soil compaction does not seem to be a problem with these soils. Soils of inland courses are variable, but are usually heavier, of higher water-holding capacity, and in some cases have poor natural drainage compared to the soils of the seaside courses.

**Growing Conditions are Good**

Temperatures are well suited to cool season grasses such as Bent, Chewings fescue, or Red fescue. Rainfall is from 35 to 50 inches annually, of low intensity, and rather well-distributed through the year. Humidity is usually high, compared to Southern California, and favorable except for periods during late summer when warm rains coupled with very high humidity may occur. Occasionally during the summer, dry winds off the continent to the east combined with two or three weeks drought may severely dry out and burn the grass.

Irrigation isn't practiced on those fairways observed. The greens on many of the seaside courses are irrigated. Portable pumps are often used to pump water from seepage holes or pits dug into the sand as close to the greens as practical. A few inland courses may irrigate greens during periods of prolonged drought.

**Sentgrass Greens**

No new greens or mother nurseries were seen at any of the courses. Dr. Jackson, Sports Turf Research Institute at St. Ives in Bingley, England, recommends that if new greens or mother nurseries are to be established on the British Isles, seven parts of Chewings fescue to three parts of Bentgrass seed be used. He says the fescue gives a quick cover and acts as a nurse-crop. The Bent provides longevity. Bentgrass greens over 100 years old were seen in excellent condition at Old Prestwick, Scotland.

Dr. Jackson states that the Research Institute is testing the stolon Bents, but is not recommending them for Britain at this time. Under their conditions, he has found them to be more coarse and no more resistant to Fusarium than the well-adapted New Zealand Brown Top Bent. Most of the greens observed appear to consist largely of fescue, either Chewings or Red, New Zealand and Brown Top Bentgrass, and lesser amounts of weeds such as poa annua, annual clover, moss, andoccasionally Yorkshire fog.

Plugs were taken with an Oakfield soil tube from greens at Gleneagles, Muirfield, Prestwick, Royal County Down, Royal Portrush, Portmarnock, Royal Dublin, and others. In many cases the roots extended past the end of the 12-inch plug taken on the sand greens of the seaside courses. In no case was turf found that was not rooted down at least five inches. Turf on the loam soils of inland courses tended to have less extensive root systems than on seaside greens.

The explanation for the very deep and extensive rooting systems of closely cut greens truf appeared to be related to well-adapted grasses growing under favorable environmental conditions. Irrigation, fertilization and other cultural practices are also undoubtedly contributing factors.

**Turfgrass is Adapted**

Much of the research on turf grass varieties for the British Isles is being carried on by the Sports Turf Research Institute, Mr. R. B. Dawson, director. They have found no grass varieties better adapted for their greens and fairways than those that have been in common use for over 100 years. This is not surprising when the great amount of natural selection that has taken place is considered.

Red fescue and Chewings fescue are the most common grasses in the rough and on the fairways. Mr. Chewing made a selection from the native Red fescue, and it still carries his name. Greenskeepers, like Mr. Temple at Portmarnock, are still making selections. He has been greenskeeper there for 22 years. He gathers Red fescue seed by hand from the rough during the summer. This seed is used to reseed divot holes and other breaks in the fairway sod. This assures him of having seed from well-adapted grass for his use.

The fine creeping Bentgrasses are also native to cool season areas. Using seed with some degree of genetic purity, it is very easy to see segregation of type in California greens only 15 or 20 years old. Think of the natural selection that must have taken place on the hundred-year-old greens at Prestwick, or those at Muirfield that were planted in 1893! Natural selection, "survival of the fittest," has provided them with well-adapted turf for their greens. Will California greenskeepers wait 70 or 100 years? They will probably prefer to depend upon research and field testing to get the answer sooner.

**Pest, Disease Control**

The major pest control problems apparently are the control of "leather jackets" in the fairways and greens, and earthworms in the greens. Greenskeepers watch and when birds start to damage the turf going after the leather jacket they treat with arsenicals, DDT, BHC or Aldrex. The Sports Turf Research Institute recommends treatment of greens each spring, but admit that most greenskeepers do not follow this practice as a general rule.

Fusarium is known here as a cool weather disease, but it gives the Scottish and Irish greenskeepers more concern in late summer or fall. It is usually associated there with warm, wet weather and lush growth on the greens. Vertisan, merfil, or calomel are the most common fungicides used. Greenskeepers try to avoid trouble by curtailing irrigation (if practiced) and fertilization during the summer months. This is to "harden up" the grass before going into the late summer and fall danger period. The Sports Turf Research Institute suggests regular, preventive fungicide treatments in areas with a bad history.

Fumigation of top-dressing material, or compost, as it is called, and/or new turf areas isn't recommended or done. This is due to lack of materials, need, or knowledge of how to perform the operation.

**Verticutting, Aerifying**

Verticutting (as we know it) isn't practiced on greens turf - Some greenskeepers accomplish much the same result by lightly *scarifying, raking or brushing. Verticutting, or some similar practice, is needed on many courses as an aid in controlling weeds, turfgrass runners, and thatch.

Aerifying is usually done by hand, from four to six inches deep, with hollow tined forks. Some courses use motorized slit-tine equipment. Aerifying is usually practiced in the fall, followed by a top dressing. Greens may be aerified from once a year to once in three or four years.

**Cut to Two Pennies**

Mowing of fairways is done as needed or as time is available. Gang mowers pulled by light tractors appear to be in universal use. Cut varies from 1/2 to 1 or 1 1/4 inches in height, depending upon the season, the location and the greenskeeper. Fairways on the seaside courses generally are cut to 1/2 or 5/8 of an inch. Inland course fairways are not as closely cut.

Greens are mowed three to five times per week in the summer, depending upon growth and availability of labor. Height of cut of the mower is very frequently calibrated by use of the large British pennies. Greenskeepers commonly say that their greens are cut to two pennies, three pennies, etc. Since the pennies are about 1/16 of an inch in thickness, a "three pennies cut" would be about 3/16 inch. The height of cut will vary from 1/8 of an inch to 1/2 inch; the longer cut being more common in the fall and winter.

Hand greens mowers are the most common, but many use power mowers, or "overgreens." The overgreen is a small tractor to which three hand mower units can be attached. The three-unit overgreens are more commonly used on the courses with the larger greens. Some greenskeepers alternate between the hand and the overgreen mowers. Many greenskeepers have a definite prejudice against mechanized equipment, due to the compaction that results from the additional weight. They also prefer the hand-mowers, as there is less danger of scalping the turf on the high spots.

**Divots a Problem**

The grasses found in the fairway turf are not vigorous sod-formers. Divot holes can become a serious problem, as in dry weather the replaced divots die. The holes are filled by hand with sand and then seeded. Or they may be filled with a mixture of sand and seed. Some greenskeepers dampen this seed-sand misture and allow the seed to swell before using it.

**A Good Starving**

"A good starving does no harm," was the way Mr. McLaren, greenskeeper at Gleneagles, describes his fertilization program. The same philosophy was expressed by other greenskeepers in both Scotland and Ireland.

The fairways on most courses are not fertilized. Portmarnock does use three pounds per 1000 square feet of ammonium sulfate and super-phosphate per year. Royal County Down, in Newcastle, applies nitro-chalk every three or four years. Old Prestwick applies 400 pounds per acre of 7-15-7 this year, but the last previous fertilization was seven years ago, when basic slag was applied.

D. J. Allott, turf advisor for Fison's Fertilizers, Ltd. of Great Britain, states that their recommendations are designed to secure steady growth on the green, or maximum growth consistent with disease control, particularly Fusarium. His general recommendation is 2.3 to 2.9 pounds of nitrogen per 1000 square feet per year. NPK is applied twice a year, with the nitrogen and phosphate from both organic and inorganic sources. This is supplemented with nitrogen from ammonium sulfate as needed. Iron sulfate is used when needed, but no foliar applications of iron are used.

The Sports Turf Research Institute recommends that, to discourage poa annua, phosphate be used only as indicated by soil tests. They suggest ten to thirteen pounds of ammonium sulfate, plus seven to nine pounds hoof and horn per 1000 square feet per year in two or three equal applications, with iron sulfate as indicated for greens.

Most greenskeepers apparently consider these recommendations to be the maximum that should be applied, and maintain their greens at a considerably lower fertility level.

In the late fall most greens are aerified or spiked, and then top-dressed with a compost. This compost consists of a mixture of hoof and horn; potash, superphosphate, with only enough sand to make it easy to handle and spread. Sometimes loam and manure and/or fine peat are added. In early spring a top-dressing of hoof and horn, ammonium sulfate, super-phosphate and sand is used. Fish meal or blood meal may be substituted for the hoof and horn, or added to the compost. Iron sulfate is often included.

During the spring and early summer, ammonium sulfate may be used as needed. Fertilizers are generally not applied during summer and fall, in order to harden the turf and prevent lush growth.

#### They Have Their Problems Too

It would be unjust to leave the impression that the Scot and Irish greenskeepers don't have problems; they definitely do.

The fine sand of the seaside courses has many advantages, but also some disadvantages. When the soils are dry, plugs cut for the cups frequently die when transferred to the old cup hole. Roots on the side and bottom of the plugs are cut, then loose dry sand may fall from the remaining roots and even a bucket of water won't keep the plug from drying. The same problem has been experienced with turf plugs from sand greens in California, if the plug was not carefully handled and watered down after being transferred.

The tees in most cases are small and not watered. The sand of the seaside courses lacks cohesiveness so the traffic frequently breaks through the thin sod. Paths mowed through the rough from greens to tees and from tees to fairways concentrate traffic. Breaks occur in the sod and the wind whips out the sand, leaving a bad pocket. This increases rapidly in size if not taken care of quickly. Mr. A. Costello, secretary at Royal Dublin, has done an outstanding job of handling this problem. They have enlarged their tees, put in alternate tees and paths, and done a good job of traffic control.

The inland courses don't have wind erosion to contend with, but they do have drainage problems. Many need additional tile drains.

Many inland courses have sheep that keep down the rough and provide a revenue for the club. This suits the dues paying member fine, but he's not so happy when sheep urine kills spots of turf on the green.

The turf, players, and greenskeepers suffer on many seaside courses from lack of control of trespassers, picnickers and litterbugs. St. Andrews employs stewards to patrol their courses, but they were not seen elsewhere. Fences quickly rust or are torn down.

#### Conclusions

Climatic factors, the availability of well-adapted turfgrass varieties, and the soil (at least on the seaside courses), give a real advantage to the producer of fine turfgrass in Scotland and Ireland over the California producer. Nevertheless, some of their policies and management practices might well be given serious consideration by those in California interested in the production of fine sports turf.

Continuity of management assures systematic care and relative freedom from pressure from players. The greenskeeper is responsible to only one individual, the secretary. Long-term management programs can be adopted with some degree of confidence that it will be possible to carry them out to a satisfactory conclusion.

Management decisions are based on turf needs that are consistent with reasonable playing conditions; not upon the whims of the players. The golf course is accepted as a challenging sports arena. Although many of them are beautifully maintained as golf courses, they are not intended to replace a well-kept park. This emphasis on the golf course as a sports area has minimized the cost of rough and trap maintenance and has enabled the management to make decisions based on agronomic rather than aesthetic needs.

Minimum applications of fertilization and irrigation water to the turf by the greenskeepers apparently results in less disease. It encourages deep-rooting, therefore the turf is more resistant to drought. Lack of lush growth on the greens eliminates rapid build-up of thatch and problems accompanying it.

Infrequent applications of water to the greens helps keep the surface dry, This makes the grass less inviting to disease, the soil to compaction, and reduces the amount of damage caused by balls.

The use of parent soil in the top-dressing mixture, or compost, and then only in minimum amounts and light applications of this mix, has prevented significant stratification. Good drainage has been maintained by lack of pronounced stratification and compaction.

The use of hand rather than power equipment; systematic deep aerification, and particularly on the seaside courses by a naturally well-drained soil of dune sand; has assisted in maintaining good water penetration into and drainage of the greens.