1972

Summer 1972

Paul R. Harder

Joseph Troll

TURF BULLETIN

MASSACHUSETTS TURF
AND LAWN GRASS COUNCIL
INCORPORATED

Featured in This Issue:

Control of Common Turf Diseases and Weeds

Snow Mold Control

Purr-Wick System

SUMMER 1972

BETTER TURF THROUGH RESEARCH AND EDUCATION

Editor
Paul R. Harder
A-1 Cliffside Apts.
Sunderland, Mass.

Secretary-Treasurer & Advisor
Dr. Joseph Troll
RFD No. 2 Hadley, Mass.

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

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

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IMPROVING AN OLD LAWN

If the old lawn has not been a howling success, try to determine causes for its failure. Not a whole lot can be done in the way of grading or soil improvement, short of remaking the lawn. But you can introduce better-adapted grasses, check weeds, increase fertility, improve mowing practices, restrain pests, and lighten use of heavily trafficked sections.

Most old lawns have a layer of partially decomposed vegetation at the base of the sod, called thatch. Unless thatch is removed, new seed can scarcely reach the soil, which it must contact in order to root. Where thatch is heavy, fertilizer may not penetrate to the rootzone, nor pesticides reach the pests. Even rain may not soak through into the ground. A brisk raking can free a small lawn of thatch, but thatch is more efficiently removed from large areas by powered machines. These usually can be rented. Loosened thatch should be swept up for the compost pile.

Poor lawns often contain starved grass, a condition easily corrected with lawn fertilizer. Overseeding with quality grasses is a good accompaniment to fertilization. There are many new bluegrasses, fine fescues, bentgrasses and perennial ryegrasses from which to choose. Bolster seedings may be so light as half the normal seeding rate. It is probably well to forget chemical weed control until the new grass becomes old enough to have had a few mowings.

Spring weather provides the needed magic for turning a newly refurbished lawn into a resplendent sward. Growth comes easy in spring, but don't be lulled into repeating mistakes of the past. Don't mow the grass unduly low, nor use strong fertilizers in hot weather. Traditional bluegrasses and fine fescues are best mowed no lower than 1½ inches (new cultivars like Fylking, Pennstar, Baron and Sodco tolerate clipping at an inch or less). Colonial bentgrasses such as Highland mow neatly at 3/4 inch; they should be clipped each few days. Fescues require only light feeding, but the newer bluegrasses and bentgrass deserve some fertilization each several weeks to look their best.

Liming the Lawn

Grasses such as Kentucky bluegrass, fine fescue and colonial bentgrass seldom suffer for lack of calcium, the chief nutrient in lime. But at least bluegrasses and fescues "prefer" a soil that is not too acid, and lime does counteract acidity. About 50 lbs. of ground limestone to the thousand feet corrects mild acidity, common with once-forested soils in climates of moderate rainfall. Spreading is often convenient in early spring while the ground is still frozen. Seldom is liming needed oftener than each two or three years, even with quite acid soil. Lime requirements can be assessed accurately by a pH reading,—a numerical measure of acidity. Readings below 7 indicate an acid condition, and if your pH is below 6 almost certainly the lawn could stand liming. Arrangements for a soil test usually can be made through the county agricultural agent, or inexpensive test kits can be purchased at supply houses and garden centers for easy home testing of pH.

Weed Prevention

Not only are crabgrass preventers helpful in the lawn, but they can be applied at this time of year to shrub borders and garden areas which will not be cultivated. They should prevent the sprouting of annual weeds throughout spring.

Reprinted from Sports Turf Bulletin No. 96, Jan. Feb. Mar. 1972

Across the Atlantic

Management of Golf Fairways

Objective

At all times fairway maintenance should be aimed at producing a dry, firm and clean surface composed entirely of well groomed grass. This is essential in order to produce the basic requirements of good "lies."

The grass cover should be dense, sufficiently vigorous to withstand wear and heal after damage. The latter point includes the satisfactory re-establishment of properly replaced divots. On the other hand, the sward should not be so vigorous that soft, lush and excessive growth making slow fairways is produced.

Surface smoothness

This is important from the maintenance angle as well as from the point of view of finish. Gang mowers tend to skim the tops of acute ridges and banks, thus increasing wear on the machines as well as producing bare ground. In turn grass may be only partially cut in very pronounced, sudden hollows. The desirability of gently undulating contours are fully appreciated on a golf course but often considerable benefit could be obtained from correcting severe local surface variations. Such work is generally best done in the autumn winter months.

Good surface production also calls for divot repairs from time to time particularly on areas which are subjected to constant iron club play. Quite often it may be necessary to clean up loose divots as part of repair procedure. Filling of divot holes with compost and grass seed should commence in the spring and thereafter carried out on a progressive basis throughout the growing season.

Harrowing

Upright grass growth, sward vigour and density are greatly assisted by surface ventilation which can be readily provided by occasional harrowing, particularly in the springtime.

Unfortunately this relatively simple operation is often neglected primarily because of the fear of surface disturbance. This is, however, only a temporary inconvenience which is usually overcome once the next cut is made. The long-term benefits of harrowing far outweigh the disadvantages of such surface disturbance and the possibility of some additional divot filling.

Healthy fairway turf also requires strong root action; good root development as well as moisture penetration must be encouraged by spiking in the spring and autumn periods, two or three passes of a suitable spiker being the aim on each occasion. On heavy soils and where there is a build-up of fibre in the turf, such spiking plays a major role in helping surface water to get through to any drains which exist and can do much to improve water playing conditions. The benefits of such work are cumulative so that **regular** spiking is important.

Mowing

Considerable time is involved during the growing season each year in fairway mowing. Unfortunately this is often looked upon merely as a weekly or twice-weekly chore, consisting of the removal of unwanted grass. This is an unfortunate attitude—care and thought should be given to fairway mowing just as on any other area of the course.

The height of cut should be adjusted to meet requirements, weather conditions and season of the year, etc. Normally a suitable height of cut may be ½ in. (12-13 mm), raised slightly in long dry periods. Obviously additional grass cover should be allowed in the early spring and autumn periods, bearing in mind the state of growth and amount of play.

Tractor speed should also be carefully regulated to obtain maximum efficiency from the gang units with the minimum of wear or damage. Direction of cut should be varied whenever possible and practicable.

Weed Control

Apart from spoiling the appearance of a fairway weeds can interfere in various ways with the game. The cup formation of some types influence ball run and or bounce and may also give almost impossible lies. Numerous daisy flowers or extensive areas of white clover can result in ball hunting even on a fairway. These days such troubles can be overcome by using a selective weedkiller chosen for the control of the actual weed species present. To obtain the best results from weedkilling operations, pick a spell of sustained growth when rain is not expected to fall shortly after the application. Work of this nature can, of course, be contracted out, but where a suitable sprayer is available the job is best done by direct labour as it is then possible to choose and take advantage of the right local conditions.

Fertilizer Treatment and Liming

A little fertilizer is often needed from time to time to maintain a satisfactory state of growth and a granular complete fertilizer is often quite suitable. Too much fertilizer, however, is likely to coarsen the sward, make the fairways play slow and, of course, increase mowing requirements. In general, however, the need for some sort of fertilizer is more often obvious than over use.

Most fairway turf tends to become more and more acid, particularly in industrial areas and on light sandy soils. In such instances the turf is invaded by weeds which thrive in 'sour' conditions, i.e., sorrel, woodrush, heath bed-straw, etc. The turf also tends to die out in patches during dry weather and to lack vigour in recovery from club damage.

Where such conditions exist an application of lime is often necessary but this material should never be applied indiscriminately, i.e. a guide to requirements should always be sought by having representative soil samples tested—a service available at the Institute to Affiliated Members.

Lime is usually applied in the autumn/winter months and in order to help overcome troubles which might follow liming (ophiobolous patch disease, etc.) and get the maximum benefit from the treatment, it is always good practice to follow up with a dressing of complete fertilizer in the spring.

Drainage

On light sandy soil there is usually little drainage trouble, but on heavier land fairways are often difficult to keep dry, particularly during winter. Much of the trouble experienced in this direction is of very long standing because in the past, the high cost of installing comprehensive tile drainage systems on golf courses was generally found to be prohibitive. Nevertheless many existing courses could be greatly improved by the introduction of efficient drainage systems.

Even where comprehensive tile drainage systems are not within the financial means of a Club much good can often be done by fairly simple exercises such as cleaning out ditches, improving and/or repairing existing drains and installing a limited number of carefully placed tile drains in local wet areas ensuring that positive outfalls (ditches or existing main drains) are provided.

Mole draining, too, can often prove beneficial in the right type of soil.

Earthworm Control

During the autumn and winter months fairways may in some instances become muddy and unpleasant to play on because of the presence of numerous wormcasts. In these circumstances striking improvements can be obtained by taking the necessary steps to effect earthworm control. Such measures should be taken when the worms are active near the surface—usually in mild, damp weather in the spring or autumn. The latter is generally found to be the most successful and convenient time.

Enzyme Liquification of Garbage

Rapid enzymatic liquification of common household garbage has been experimentally demonstrated by scientists at the Connecticut Agricultural Experiment Station in New Haven. Lester Hankin and Milton Zucker have investigated a group of enzyme producing bacteria (Erwinia and Pseudomonas) which rot plant and vegetable tissue. Primarily pectate lyases, the enzymes degrade pectin glues that hold the cells together and in the process kill the cells.

The enzymes were initially prepared and analyzed to determine relative activity. Test materials were ground to 1/8 inch pieces in a food type chopper, placed on a 20 mesh sieve, and sprayed with water; typically, 13% of the mixture passed through the sieve. The material and enzymes were then mixed, left to react, and again washed over a sieve. The experiment combined known concentrations of enzymes at 22-23 degrees C with chopped vegetable material (equal weights of potato, lettuce, carrots, and onion), 95% of which passed through the 20 mesh sieve after 18 hours. To test bacterial action on garbage containing material other than vegetable tissue, a mixture consisting of vegetable and fruit peelings, coffee grounds, meat scraps, and egg shells was prepared and tested at various enzyme concentrations. Garbage was rapidly macerated—residue after sieve washing consisted mainly of coffee grounds and egg shells. The rate of liquification was demonstrated to increase directly with the logarithm of the enzyme concentration.

Hankin and Zucker suggest several schemes for utilization of the nutrient rich liquified garbage: as animal feed, pasteurized in a dairy-type unit, spray dried, packed and distributed; or as a nutrient or culture medium for yeast and mushrooms.

Performance of Seven Fungicides for Control of Snow Mold

Paul R. Harder and Joseph Troll

INTRODUCTION

As pressures from state and federal environmental agencies increase and greater numbers of fungicides become unavailable on the market, many turf diseases become more difficult to control. Since new fungicides have become available, the need to examine their effectiveness exists. The performance of the new fungicides in controlling Gray Snow Mold (Typhula spp.) as compared to standard chemicals was made. Treatments were made to determine if time and/or rate of application would have any significant effects on the control of the disease.

MATERIALS AND METHODS

Three golf greens were used as test sites. Two were located at the Amherst Golf Club and the other on the campus of the University of Massachusetts. Each green was divided into 66 randomized 10' x 10' plots. There were 21 treatments and three replications of each. There also were three untreated check plots. The treatments and rates are shown in Table I.

Green number 1 (largely Poa annua) was treated at the above rates (see Table 1) on October 13, 1971, and again on November 12. A power sprayer delivering 1 gallon of liquid per 1000 square feet at 40 lbs. pressure was used. Green number 2 (largely Poa annua) was treated only once on November 12 using the same rates and equipment. Green number 3 (UMass campus) was treated on December 10 (Penncross) using the same technique. Snow fell on November 25 and test areas were covered only intermittently throughout the winter. Infections of Gray Snow Mold occurred in early December and again in March on all test areas. No winter injury other than Gray Snow Mold infection appeared on any of the areas. The following tables indicate the treatments, percent infection and severity of infection.

Table 1. Fungicides and Rates Used

Fungicide	Rate per 1000 sq. ft. (manufacturer's recommended rate)		
Tersan OM (WP)	4 oz.	8 oz.	10 oz.
Tersan SP (WP)	3 oz.	6 oz.	7.5 oz.
Cadminate (WP)	2 oz.	4 oz.	5 oz.
Acti-Dione TGF (WP)	2 oz.	4 oz.*	5 oz.
Daconil 2787 (WP)	2 oz.	4 oz.	5 oz.
Consan 20 (liquid)	1 oz.	2 oz.*	2.5 oz.
Thiram (WP) and	2 oz.	4 oz.	5 oz.
Lime	4 lbs/ 1000 sq ft	4 lbs/ 1000 sq ft	4 lbs/ 1000 sq ft

*Manufacturer's recommended rate not established

WP—Wettable Powder

Table 2. Green Number 1—Treated October 13 and November 12, 1971

Fungicide	Rate/1000 sq. ft.	% of Plot Infected	Severity of Infection*
Tersan OM	4 oz.	0	
	8 oz.	0	
	10 oz.	0	
Cadminate	2 oz.	13%	Moderate
	4 oz.	0	
	5 oz.	0	
Tersan SP	3 oz.	0	
	6 oz.	0	
	7.5 oz.	0	
Acti-Dione TGF	2 oz.	25%	Moderate
	4 oz.	30%	Severe
	5 oz.	23%	Moderate
Daconil 2787	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Thiram and Lime	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Consan 20	1 oz.	8%	Slight
	2 oz.	3%	Slight
	2.5 oz.	0	
Check	No Treatment	65%	Severe

*0-10% Slight; 10-30% Moderate; 30-100% Severe

Table 3. Green Number 2 — Treated November 12, 1971

Fungicide	Rate/100 sq. ft.	% of Plot Infected	Severity of Infection*
Tersan OM	4 oz.	0	
	8 oz.	0	
	10 oz.	0	
Tersan SP	3 oz.	0	
	6 oz.	0	
	7.5 oz.	0	
Cadminate	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Daconil 2787	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Thiram and Lime	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Acti-Dione TGF	2 oz.	3%	Slight
	4 oz.	0	
	5 oz.	0	
Consan 20	1 oz.	8%	Slight
	2 oz.	3%	Slight
	2.5 oz.	0	
Check	No Treatment	15%	Moderate

*0-10% Slight; 10-30% Moderate; 30-100% Severe

Table 4. Green Number 3—Treated December 10, 1971

Fungicide	Rate/100 sq. ft.	% of Plot Infected	Severity of Infection*
Tersan OM	4 oz.	0	
	8 oz.	0	
	10 oz.	0	
Tersan SP	3 oz.	0	
	6 oz.	0	
	7.5 oz.	0	
Cadminate	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Daconil 2787	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Acti-Dione TGF	2 oz.	6%	Slight
	4 oz.	0	
	5 oz.	0	
Thiram and Lime	2 oz.	0	
	4 oz.	0	
	5 oz.	0	
Consan 20	1 oz.	12%	Moderate
	2 oz.	8%	Slight
	2.5 oz.	0%	
Check	No Treatment	25%	Severe

*0-10% Slight; 10-30% Moderate; 30-100% Severe

DISCUSSION

There were no phytotoxic symptoms of any of the chemicals at any rates when observed 24 hrs after spraying. Turf treated with either Acti-Dione TGF or Consan 20 were the only plots that showed Gray Snow Mold infection and were most severely damaged. The other five chemicals tested resulted in good control at all the rates. There were no discernable differences relating to time of application. The October-November, November, and December applications appeared to be equally effective. The December application was made after the season's first snowfall had melted and some infection had already taken place. No further incidence of disease was noted after application of the chemicals. The erratic weather conditions of alternately snow-covered and open ground and several periods of exceptionally high temperature for the winter months made the interpretation of these trials more difficult. Repetition of these same trials next season will yield more substantive results.

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The authors wish to thank the Northeast Golf Course Superintendents Association for their contribution to this work.

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CONTROL OF COMMON TURF DISEASES

disease: **RHIZOCTONIA SOLANI (Brown Patch)**
recommended Fungicides: ACTI-DIONE THIRAM: DIACONIL 2787; DYRENE: FUNG-CHEX: GUARD-ALL M: PANOGEN: PMA: SEMESAN: TERSAN LSR: TERSAN OM: THIRAM M: THIRAM 75

disease: **CORTICIUM FUCIFORME (Red Thread)**
recommended Fungicides: ACTI-DIONE FERRATED: ACTI-DIONE THIRAM: CADEX: DYRENE: FUNG-CHEX: GUARD-ALL M: PMA: SEMESAN: THIRAM PMA

disease: **ERYSIPHE GRAMINIS (Powdery Mildew)**
recommended Fungicides: ACTI-DIONE RZ: ACTI-DIONE THIRAM: DACONIL 2787

disease: **PHYTHIUM BLIGHT (Greasy Leaf Spot)**
recommended Fungicides: DEXON: PARZATE C: KOBAN

disease: **HELMINTHOSPORIUM (Leaf Crown & Root Diseases)**
recommended Fungicides: ACTI-DIONE FERRATED: ACTI-DIONE THIRAM: DACONIL 2787: DYRENE: FUNG-CHEX: GUARD-ALL M: PANOGEN: PARZATE C: SEMESAN: TERSAN LSR: PMA: TERSAN OM: THIRAM M: THIRAM PMA

disease: **SCLEROTINIA HOMEOCARPA (Dollar Spot)**
recommended Fungicides: ACTI-DIONE FERRATED: ACTI-DIONE THIRAM: CADEX: DYRENE: DACONIL 2787: FUNG-CHEX: GUARD-ALL M: PANOGEN: PMA: SEMESAN: TERSAN: TERSAN 1991: TERSAN OM: THIRAM M: THIRAM 75: THIRAM PMA

disease: **FUSARIUM NIVALE (Pink Snow Mold)**
recommended Fungicides: CADEX: DACONIL 2787: DYRENE: FUNG-CHEX: PANOGEN: PMA: SEMESAN: SNOW MOLD X: THIRAM M: THIRAM PMA: THIRAM 75

disease: **PUCCINIA (Rust)**
recommended Fungicides: ACTI-DIONE: DYRENE: GUARD-ALL M: PARZATE C: TERSAN LSR

disease: **CURVULARIA (Black Mold)**
recommended Fungicides: ACTI-DIONE FERRATED: ACTI-DIONE THIRAM: DACONIL 2787: DYRENE: GUARD-ALL M: PMA: PANOGEN: SEMESAN: TERSAN LSR: THIRAM M: THIRAM PMA

disease: **TYPHULA ITOANA BLIGHT (Gray Snow Mold)**
recommended Fungicides: CADEX: DAÇONIL 2787: DYRENE: FUNG-CHEX: PANOGEN: PMA: SEMESAN: SNOW MOLD X: TERSAN OM: THIRAM M: THIRAM PMA: THIRAM 75

disease: **GLOEOCERCOSPORA SORGHI (Copper Spot)**
recommended Fungicides: ACTI-DIONE THIRAM: CADEX: DYRENE: GUARD-ALL M: PMA: PANOGEN: TERSAN OM: THIRAM M: THIRAM PMA

OPHIOBOLUS GRAMINIS
Fungicides: PMA: TERSAN OM

STRIPE SMUT
Fungicides: PCNB: TERSAN 1991

FAIRY RING: recommended Fungicides: PMA: PANOGEN

*Certain chemicals may not be available in some states.

1972*

CONTROL OF COMMON TURF WEEDS

weed: **CRABGRASS**
recommended herbicides: Preemergence: BENEFIN (BALAN**) BENSULIDE (BETASAN**) DCPA (DACTHAL**) SIDURON (TUPERSAN**); Postemergence: DSMA, MAMA or MSMA, PMA, SIDURON and DSMA

weed: **ANNUAL BLUEGRASS (Poa Annua)**
recommended herbicides: BENSULIDE (BETASAN**)

weed: **ESTABLISHED BROADLEAF WEEDS**
recommended herbicides: 2,4-D, SILVEX (2,4,5-TP), MECOPROP (MCPP), DICAMBA (BANUEL**), ENDOTHALL (ENDOTHAL**)

NEWLY SEEDED TURF: BROMOXYNIL and DICAMBÁ
COMPLETE PLANT KILL: short term residues—PARAQUAT; long term residues—AMITROLE and SIMAZINE (AMIZINE**), AMS (AMMATE**), SIMAZINE (PRINCEP**)
SEED-BED STERILIZATION: METHYL BROMIDE (DOWFUME**), METHAM (VAPAM**) (VPM**); METHYL-ISOTHIOCYANTE (VORLEX**)

*Certain chemicals may not be available in all states.
**Trade Name

EDITORIAL

UMass. Turfgrass Research Fund

There are many reasons why sophistication and expansion of turfgrass research is essential today. Professional turfgrass managers are faced with the double-edged problem of perfecting the manicuring of their turf while being given fewer and fewer chemical aids due to pressures to improve our environment. Many more people have increased leisure time which increases the numbers of people using recreational areas, such as golf courses, where turfgrasses are placed under heavier stresses for greater and greater lengths of time. All of these trends are becoming more intense and the need to obtain additional knowledge about every facet of turfgrass management is evident.

The research program at the University of Massachusetts has been maintained at a relatively low level in the past due largely to a lack of support from the industry. The potential for reversing this situation exists and the initiation of an ambitious campaign for contributions to the University of Massachusetts Turfgrass Research Fund is the first step toward an expanded research program. Superintendents and greens chairmen of the golf clubs of Massachusetts have been asked to appropriate money for research in their yearly budgets. The response to this program to date has been only minimally successful. The following alumni and clubs have contributed:

ALUMNI CONTRIBUTORS

Charles Baskin
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William J. Emerson
John Espey
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David Stimson
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Quaboag Country Club
Vesper Country Club
Weston Golf Club
Whitinsville Golf Club
Winchester Country Club
Woodland Golf Club

Credit goes to Mr. Paul O'Leary (1948) for initiating the research fund and for working towards creating a permanent and self-perpetuating source to allow for development of the programs most needed by students at the University and professionals in the field. Contributions appropriated by golf clubs generally amount to less than 1% of the total budget. A small price to pay for keeping on top of the latest developments in turf management. The next few months will be decisive in the development of a lasting program. The entire operation is one that involves several groups (the University, golf course memberships and alumni) who must work together for the entire process to succeed.

Available Now

The sensational new baron Kentucky Bluegrass exclusively from LOFTS!

Today, when knowledgeable agronomists talk about The Greening of America, they're talking about Baron Kentucky Bluegrass—the remarkable seed discovered in Holland and now grown in America exclusively by Lofts Oregon and Washington growers.

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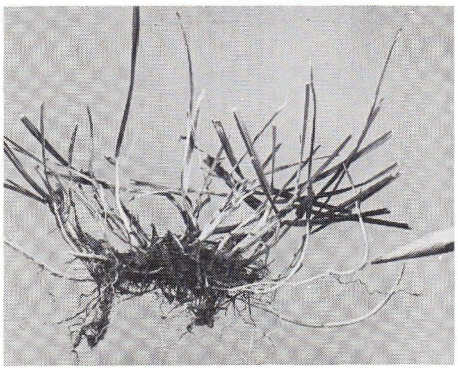
Baron Bluegrass grows slowly and requires mowing less often. It can be cut as low as ¾" beautifully. The sturdy, broad blades interlock to make a "crisp" surface that holds a golf ball well on the fairway. The dense turf is winter hardy, has a fine winter color. And its leaves stay relatively unblemished by leafspot, rust or stripe smut.

Baron is one of the few elite bluegrasses having stiff, relatively broad-bladed foliage, more pronounced in these respects even than Merion. It has a deep green color especially appealing to the American market. The reclining growth makes Baron suited to a low clipping height, so demanded these days for posh lawns, industrial properties and golf fairways. It is a vigorous variety, too, the seed sprouting quickly, the rhizomes knitting a strong sod rapidly. All Baron seed is Certified Blue Tag, poa annua and bentgrass free.

Dr. C. R. Skogley examines a strip of Baron sod.
Dr. C. Richard Skogley, Professor of Agronomy, Plant and Soil Science at the University of Rhode Island, reports: "In America, Baron has perhaps been grown longer on the proving grounds at Rhode Island than at any other locale and has performed exceedingly well in our trials. It has consistently rated among the best. It resembles Merion in many respects but seems less subject to dollarspot and less demanding of fertilization. So far we have seen no stripe smut, and leafspot incidence has been light." Dr. Skogley has recently released from the University three new improved varieties of grasses (namely, Jamestown, Red Fescue, Exeter Colonial Bentgrass and Kingstown Velvet Bentgrass).



Baron, new rave in bluegrasses. Pencil points out to one of the abundant rhizomes from a culm cluster only 8 months old.

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PURR-WICK Rootzone System For Turf

Prepared by Dr. W. H. Daniel, turf specialist, Purdue University, based on thesis research by David Ralston, 1970; David Bingaman, 1969; Mel Hansen, 1963; and Robert Montgomery, 1960, with the cooperation of Dr. H. Kohnke, Dr. Ed Monk and others.

ABSTRACT

PURR-WICK provides a rooting matrix which uses the large pores of compacted particles above an impermeable underlay (plastic sheeting). Drainage tubes—placed just above the barrier—have adjustable outlets, which can redistribute, conserve or remove water as needed.

Such a system permits fast infiltration and constant redistribution of water by capillary (wick) action to active roots (absorbing water), and to the rootzone surface (when evaporating water). It, thus, maintains uniform growing and playing conditions (for golf, athletics, etc.).

When excess rain occurs, rapid percolation favors fast removal through sand and drains to controlled exits. When conservation is desired and daily water use is high, reserves can be created by upward adjustments of terminals. Thus, the designer and contractor provide the turf manager maximum storage, plus control of both dry and wet fluctuations.

This prescription for a rootzone attempts to provide designers, contractors and users with guidelines and explanations. The letters PURR-WICK stand for PLASTIC UNDER sand RESERVOIR ROOTZONE, which utilizes the principle of wick (capillary) action at low soil moisture tensions.

This is ONLY one of TEN possible ways to build a rootzone, BUT it gives control of that necessary, but so variable factor—soil water. Specifications are given as steps in construction; then follows comments, research data and experiments which interpret the idea.

REVIEW

A prescription for a compacted media for plants (turf) has long been sought. Muddy, soft, wet soils may become hard, dry and tight as water content changes. The compaction caused by heavy play and maintenance equipment increases the problem.

Generally extensively modified mixtures of soil, sand, peat, etc., are drastically influenced by even a low percentage of fines (silt and clay). Thus, mixtures of only 10 per cent soil may still act essentially as soil. And, if the soil was initially granular in structure, it is soon dispersed and compacted so that individual particles predominate.

The subgrade, if compacted heavy soil, restricts percolation, but with time favors continued drying—by capillary pull—and causes early water stress on shallow-rooted plants.

Generally systems of horizontal layers or vertical cores,

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which may reduce wetness by improved drainage, are still limited by dryness at the surface as soil water tension changes.

Therefore, the PURR-WICK system, which isolates the subsoil, gives zero tension at the base and low tension within the porous rootzone, yet allows redistribution of soil water, is unique and different both in construction and management.

EARLIER WORK

In the experimental green at Purdue University, plastic under rootzones was first installed as four replications of six entries in 1959, but no drainage restriction was developed.

In 1966 four areas, including 41 varying rootzones with drainage control and subsurface irrigation, were installed.

In 1968 a 5,000 square foot experimental practice green was built at L & N Golf Course in Louisville, Kentucky.

Built in 1969 were a 4,000 square foot green at Carmi, Illinois, a 6,000 square foot green at Columbus, Ohio, and 20 greens at Perry Park, Kentucky. A tee has been built in Cleveland, Ohio.

Also in 1969 six new sections were built into the experimental putting green at Purdue University. Slow release sources of nitrogen and potassium were added among other surface treatments.

A. Design and Contours

ARCHITECT SHALL SUBMIT AND SECURE OWNER APPROVAL OF DETAILED PLANS. EACH SITE OF PURR-WICK CONSTRUCTION SHALL HAVE COMPLETE CONTOUR AND DESIGN DETAILS INCLUDING SUBGRADE/AND/SURFACE FEATURES.

GREENS: PURR-WICK may extend to the edge of traps; include portions of collars and aprons so that similar turf elevations are served by the same system. Tier width and length can be varied to obtain the desired contours of final grade with minimum variation in depth of sand. See Figures 1 and 3.

TEES: Base of rootzone may be one level if desired, and extend to the crest of the edge, or just past the crest.

ATHLETIC FIELDS: Entire field may be one level provided the crown elevation is less than one per cent (or 10 inches for football).

a. Center section could have higher tier if desired.

FOR SHRUBS, if used, increase the depth of the matrix above the level impervious layer as needed.

PLANTER AND WINDOW BOXES: Design outlet in corner, or where excess water can be conserved or discarded. Observation of the reserve would be desirable.

B. Surface and Subsurface Watering

CONTRACTOR SHALL PROVIDE WATER TO SITE DURING CONSTRUCTION SINCE SAND WORKS BETTER WHEN KEPT MOIST.

ARCHITECT SHALL DESIGN IRRIGATION SO THAT PURR-WICK AREAS CAN BE UNIFORMLY WATERED TO REPLENISH MOISTURE AND RINSE IN CHEMICALS. Either:

1. One valve at edge for hose and sprinkler (least desired).
2. Install irrigation pipe above plastic to center sod cup, plus one valve at edge for hose watering as needed.
3. Perimeter pop-ups, which water green and edges, either automatic or manual (adjustable part circle preferred; variable speed also available) plus one valve at edge.
4. Subsurface via an adjustable float valve control for each tier:
   a. Must be adjustable in depth for 4 inches or more.
   b. Must be sensitive to less than 1 inch change.
   c. Container must be strongly built and adequately covered to withstand normal maintenance and use in area.
   d. Design must include necessary drains, overflow, cutoff and unions.

ADJACENT AREAS TO PURR-WICK SHALL HAVE SOME SOURCE OF WATER.

NOTE: *The soil area will dry on banks, aprons, edges, and may need more frequent water additions than the green. Conservation by PURR-WICK will exceed that of adjacent soils, thus the need for water sources to edges.*

C. Shaping of Subgrade

CONTRACTOR SHALL DEVELOP SUBGRADE OF PURR-WICK AREAS UNDER CONDITIONS AND WITH EQUIPMENT THAT GIVES FIRM SURFACES SO THAT LATER SETTLING IS AVOIDED.

Water settling or compacting as constructed shall be assured by an inspector since level base of tiers must be maintained. Backfill of drains, waterlines, etc. where they are necessary, should be firmly settled.

1. **GRADE TO DESIRED CONTOUR AS DESIGNED**
   a. **SUBGRADE UNDER THE BARRIER SHALL BE FORMED AS A SERIES OF LEVEL STEPS OR TIERS AS CONTOURS OF FINAL SURFACE DICTATE.**
      1. **SHALLOWEST DEPTH SHOULD GIVE PROTECTION FROM NORMAL USE DAMAGE.**

         Cup cutters are 7 inches deep, so 10 inches seems absolute minimum for any part of matrix in green.

NOTE: *Two systems only 7 inches deep have performed well for 3 years in small plot observations. When sands varied from 10 to 18 inches deep, all depths were serviceable over 3 years of test to date.*

2. **DEPTHS OF SAND IN TIERS MAY NOT CHANGE MORE THAN 50 PER CENT.** Example: If 16 inches, then less than 8 inches change in tiers. See F.

NOTE: In first demonstration green each tier had a 6 inch change in depth with 12-18 inches of sand.

3. Tiers may be any width and shape as contours dictate. Large tiers may need larger pipe and/or multiple drains.

b. EACH TIER SHALL HAVE AN INTERNAL LEDGE OF 4 INCHES OR MORE TO PERMIT WATER RETENTION.

1. Form with soil, soil banked along aluminum or plastic edging, pipe, or equivalent which gives firm, stable support.
   a. Consider using 4 inch pipe for strength and ease of installation.

c. EACH TIER SHALL BE UNIFORMLY LEVEL.

1. Greens ± 1 inch within a tier.
2. Athletic fields and tees may be ± 2 inches due to large size.

NOTE: Within large sections, sub-sections may be made to minimize effect of variation. For example, divide field into 3 to 10 sections as desired. The wick action of sand permits more variation. However, for better drainage control accurate levels should be developed.

d. CONTOURS AROUND PERIMETER SHALL BE FIRM AND STABILIZED.

1. During delivery and distribution of rootzone, supports and sheeting as needed shall be provided by contractor for trucks, etc.
2. Inspector shall stop work at any point, providing mistakes are evident, and only upon correction permit continued work.

e. VERTICAL EDGE OF PLASTIC SHEETING MUST EXTEND TO FINAL SURFACE.

D. *Place an Impermeable Underlayer*

Any material of any thickness, or any layers, or any arrangement must still provide initial and long-term water retention and zero tension.

MATERIALS SHALL BE NEW, FREE FROM DEFECTS, AND STORED UNTIL USED TO AVOID WEATHER DAMAGE. PLASTIC, WHEN LAID, SHALL BE COVERED PROMPTLY TO MINIMIZE SUN'S EFFECT ON IT.

WORKERS SHALL BE ADVISED AND TRAINED TO PROTECT LAYER DURING INSTALLATION. INSPECTOR MAY USE WATER TO CHECK SUSPECT MATERIAL. OVERLAYS MAY BE REQUIRED, WHERE SUSPECT, TO ASSURE SEAL. EITHER:

1. Overlap edges 1 to 3 feet of single layer 10 mil (.010") or 8 mil polyethylene sheeting.

NOTE: Strongly suggest consider taping edge for better stability and definite seal.

2. Use 1 to 2 feet insert of folded 6 mil (.006") into split to form continuous double layer over area.
3. Use 50 per cent overlay of separate sheets to minimize seam effect (of 6 mil).

NOTE: Folded .006 inch polyethylene sheeting has been most tested. Such is usually available in local building supply houses. (Machine placed asphalt layers have been tested for agricultural use toward producing zero tension, but may not give pool effect.)

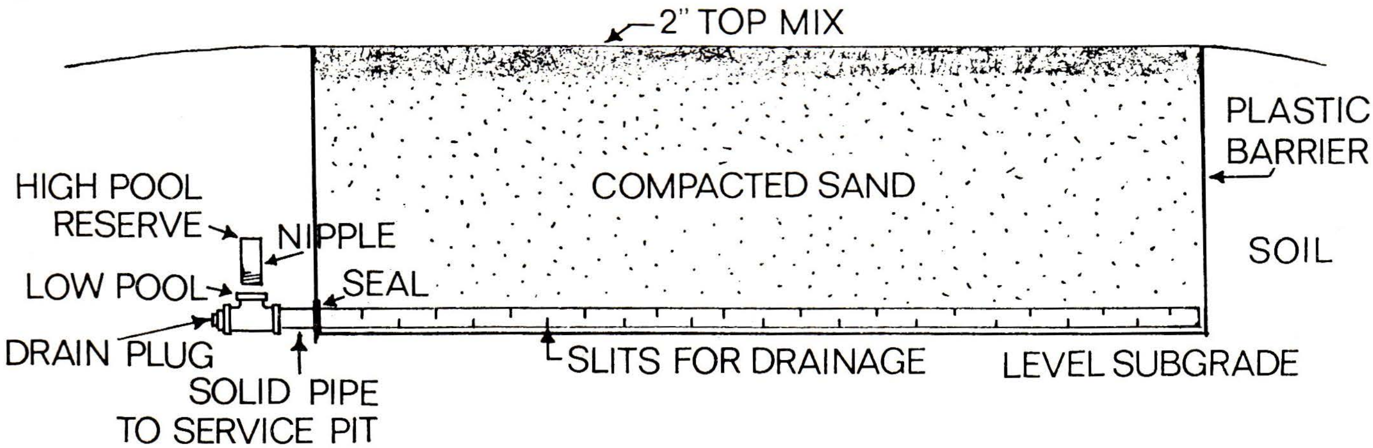
4. Suitable reinforcements such as flange collars, adapted masking tape, mastic or concrete shall be used around necessary pipe exits through plastic to provide a positive seal for water retention.

NOTE: Cut + cross in plastic less than size of pipe, then gradually force pipe through. Add pipe mastic, extra plastic sheets then pour concrete seal around pipe. Consider bolted flange collars of plastic such as available from well drilling suppliers.

E. *Drainage Above Underlay*

1. HORIZONTAL COLLECTOR DRAINS SHALL BE DEVELOPED USING PLASTIC PIPE WITH NUMEROUS NARROW OPENINGS PLACED ONTO FLAT UNDERLAY. SEE FIGURE 2.
   a. Secure or prepare pipe with slit openings (which sand grains can bridge, but not plug)
      1. Cut one-third of way through pipe with coping

Figure 2. Idealized cross section of one tier of PURR-WICK.



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saw, or narrow hacksaw on 4 to 6 inch centers on alternate sides.

NOTE: Avoid rotating pipe. Cut along labeling to keep alternate side pattern.

2. Pipes may be placed in depressional trench 1-2″ if desired.
3. Pipe may be secured to plastic sheet with tape.
4. Pipe connections should be glued for stability during sand placement.

NOTE: Have ample openings for long-term efficient water movement. Pipes placed 10 to 25 feet apart have been used to date. Twenty feet apart is considered wide spacing.

b. **SEAL AROUND SOLID PIPE WHERE IT EXTENDS THROUGH VERTICAL EDGE OF PLASTIC. See D-4**

2. **ADJUSTABLE CONTROL OUTLETS TO CONSERVE AND DRAIN WATER SHALL BE INSTALLED FOR EACH TIER. SEE FIGURE 2.**
   a. Preferred is a pipe tee threaded at terminal with removable plug for complete drain (winter), plus threaded upright for low pool with removal nipple extension for high reserve. (summer)

NOTE: Visual water checking in this is easy and subsurface water additions could be made if desired.

   b. An elbow and nipple could be used, but is less concise.

3. **SUITABLE ACCESS VIA PIT AND COVER SHALL PERMIT EASY INSPECTION AND ADJUSTMENT OF OUTLETS.**

NOTE: Outlets may be extended and clustered into fewer pits as desired.

4. **ADEQUATE SUBSURFACE TILE AND FILTER DRAINAGE SHALL PROMPTLY REMOVE EXCESS WATER FROM PITS.**

F. Rootzone Above Plastic

ARCHITECT, CONTRACTOR AND OWNER REPRESENTATIVE SHALL CONFER AND ARRANGE FOR ASSURED SUPPLIES OF PEFERRED SAND MATRIX. ARCHITECT SHALL SPECIFY DEPTH RANGE AND SECURE OR PROVIDE AMPLE DATA ON CHOSEN SUPPLY TO OWNER REPRESENTATIVE. INSPECTOR SHALL HAVE THE RESPONSIBILITY TO OBSERVE, SAMPLE, REQUEST CORRECTIONS (IN WRITING) AND STOP WORK UNTIL AN AGREEMENT IS REACHED, FAULTS IN CONSTRUCTION SHALL BE REPLACED. DEPTHS MAY NOT BE REDUCED, BUT MAY BE EXCEEDED BY 25 PER CENT UPON APPROVAL.

1. **A COARSER SAND FRACTION 0.5 to 2.0 mm MAY BE USED AROUND DRAINS.**
   a. And in any low spots or as ribbon waterways (as 1-2″)
   b. This may be a lower blanket of one-third of total depth—upon agreement.
2. **MOIST SAND MAY BE PLACED—BULK DELIVERY—OVER PLASTIC AND PIPES. AVOID SHIFTING OF DRAINS OR SHEETING BY PRESSURE OF SAND.**
   a. Force water into pipes in quantity to make backwash filter at slits.
3. **SAND SHALL BE COMPACTED MOIST BY ADEQUATE EQUIPMENT**—yet avoid possible damage to plastic or pipes. (Motorized vibrators work well.)

CRITERIA FOR SAND SELECTION

Since the desired end result is storage space for roots, water, air, nutrients, etc., a maximum volume of pores is desired. Pore diameter between UNIFORM particles is considered to be one-third of the particle diameter. Pore diameter is greatly reduced when fines occupy space between particles, thus reducing air and water movement within the rootzone.

Therefore, it is important that the sand selected be UNIFORM in particle size, with most of the particles within the medium sand range (0.25-0.50 mm), (60-35 mesh). Sharp sand is preferred to round sand only when both materials are of the same uniformity. Coarse gravel should be screened out, and fine silt and clay washed out of sand if present in the source material.

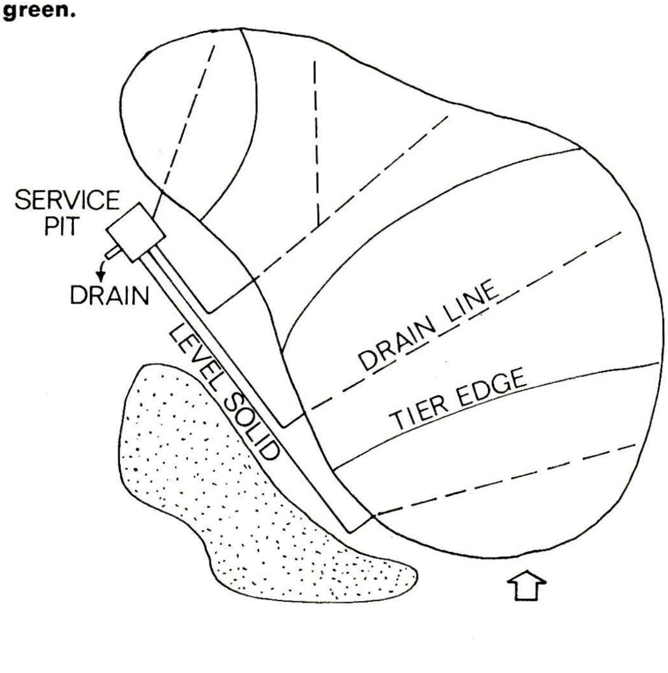
Have a good sieve or mechanical analysis made on a REPRESENTATIVE sample to determine suitability of a sand for Wick action. Figure 4 shows analysis of sands actually used in PURR-WICK greens built in 1967-69. The steeper the curve, the more uniform the particle size.

Once a sand has been found which falls within the desired distribution range, the depth of the sand in the rootzone can be specified.

General rule: The finer the sand, the deeper the rootzone should be to provide adequate air space. Lab results and field testing indicate that the coarser sands should range from 10 to 18 inches and finer sands from about 15 to 23 inches.

In design it is most desirable to keep variation within a tier as small as possible. Experience indicates that the higher

Figure 3. Schematic of four tiers and drains in a golf green.



tier should have a higher internal retainer wall for reservoir than lower tiers, since water has a tendency to move to lower elevations.

The finer fractions control the action when compacted. It is estimated that the finer 10 per cent of particle size controls pore space, capillary action, rate of infiltration and air exchange. Thus, detailed sampling, particularly on very fine sands is important.

Be ample in depth rather than shallow for increased reserves by upturned drains can increase water reserve. (Also, with time, dust, organic matter and roots will reduce pore space. To counteract this, topdressing with sand and aerifying should regulate surface mixture.

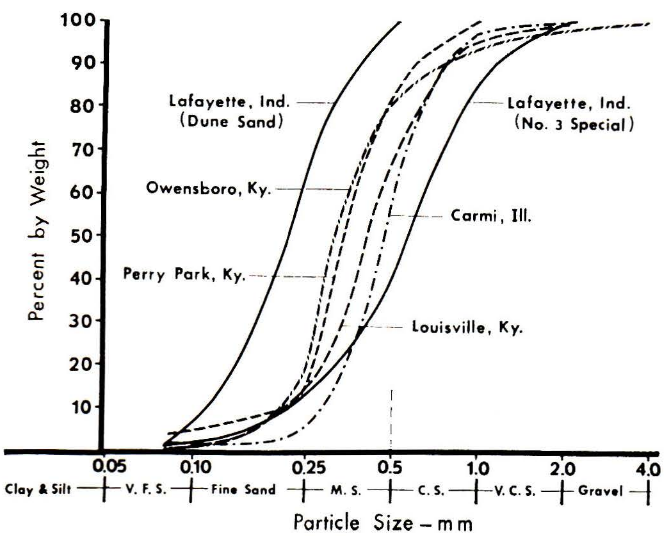
Practical test 1. Visual particle sorting in water

a. Use a tall container (1000 ml graduate or tall jar).
b. Fill one-fourth full of sample.
c. Add water till 90 per cent full.
d Shake vigorously with a swirl motion.
e. Let settle; coarser is near bottom.
f. Estimate percentages. The finer 10 per cent regulates action. Repeat; improvise.

Practical test 2. Construct and maintain model to evaluate and test material while preliminary plans and construction are underway.

a. Set up plastic in a frame, box, pit of 1 to 10 square foot area.
b. Install small pipe with slits and control drain exits.
c. Fill to desired depth based on sieve analysis.
d. Plant desired sprigs, seed or sod.
e. Grow turf and observe drying cycle.

Figure 4. Mechanical analysis curves for sands used in PURR-WICK greens.



G. User's Inch—The Upper Surface

UPON APPROVAL OF CONTOURS, DEPTHS AND SURFACE CONFORMITY (ACCORDING TO SPECS) THEN THE TOP 2 INCHES SHALL BE EITHER:

1. Bulk mixed in advance, then delivered and spread uniformerly. Blending into sand by spike-tooth harrow is desirable.
2. Spread additives uniformly ON site and UNIFORMLY mix into upper 2 inches of sand.
3. If sod is used, fewer additives may be spread and mixed. Cut sod as thin as possible, then within 10 days operate Greens-aire over area, topdress heavily with pure sand and break up or remove cores. Repeat as needed.

	Estimated	*Per 1,000 sq. ft.*		
Some materials	*lbs./cu. ft.*	*amount*	*lbs.*	*inches*
Sand, moist	120–150	5 tons	10,000	1.0
Peat, bulk	About 25	1 cu. yd.	700	.4
Calcined aggregates	30– 40	20 bags	1,000	.4
Terra Lite, 7% K, #3 or 4	7– 12	2 bags	100	.2

NOTE: Other materials may be adapted to improve nutrient retention. The question is simply: "How can materials serve the principle of storage, nutrition and durability?" Because of wide availability and low cost, sand is most discussed here.

RESEARCH

Under experimental putting green use, more than 40 combinations for rootzones have been tested for 9-3 years. In the greenhouse more than 20, and in laboratory more than 10, were tested in detail. Experimentally, peat, ground sponge rubber, expanded and unexpanded vermiculite, fritted and calcined aggregates, activated charcoal, ion exchange resins, and other additives have been used.

Even AFTER COMPACTION large pore sizes (above 0.06 mm) are desired to permit rapid water and air movement. Therefore, soil is to be avoided because, under compaction, the fine silt and clay particles will fill pores between sand grains, thus restricting rapid water and air movement.

These principles apply to PURR-WICK:

a. The finer 10 per cent control wick action and infiltration.
b. Uniform particles give most pore space.
c. Excessive fines (silts and clays) may degrade efficiency.
d. Coarse large particles (above 0.5 mm or 1/16 inch, or 30 mesh or coarse sand) contribute little but occupy space.

The maximum playability of surface is the key objective.

Give the player (user) what he needs! Actually moist sand can grow good turf. However, the cushion against mismanagement or abuse is least with pure sand surfaces. Once growing, the cover and binding of good turf predominates over mixture.

H. Fertilizing

AMPLE NUTRITION SHALL BE INCORPO-

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RATED INTO SURFACE FOR INITIATION OF GROWTH. FOUNDATIONS WHICH MINIMIZE SALT EFFECT AND HAVE LONG-TERM RELEASE SHALL BE SELECTED.

Example, in cool weather per 1,000 square feet mix in 50 pounds of Milorganite, or equal, plus 20 pounds 16-4-8 with slow release N and minor elements, or equal. Modify for grass, region and time of year.

PURR-WICK holds much available water at low tension, so ample soluble nutrients can be stored in solution. Normal rates of nitrogen application may be ample, but consider using less as maintenance develops. Excess rains may leach out a portion, but would affect any rootzone some.

The use of clumps of peat, nutrient mudballs, coarse porous aggregates, ion exchange resins, etc., permit much leeway in developing the potential of nutrition.

Since leaching is minimized and storage is maximum, conservation of both nutrients and water is maximized.

I. Planting and Early Care

AREAS SHALL BE UNIFORMLY PLANTED IN AGREED MANNER. ALL AREAS MUST REMAIN MOIST FOR NORMAL PLANT DEVELOPMENT.

1. Seed 1 lb. per 1,000 sq. ft. Penncross or equal
   2 lbs. per 1,000 sq. ft. bluegrass or equal, or
   3 lbs. per 1,000 sq. ft. mixture of grasses where desired
   Rake or drag or cultipack in; then roll or compact surface.
2. Stolons—8 to 10 bushels or equal per 1,000 square feet. Spread stolons, partially cover with topmix, and roll. See G.
3. With either of the above a straw or net type mulch will reduce surface damage and drying—particularly important when construction is finished in early winter.
4. Sod—shall be as thin as practical and after laying be Greens-aired once or more, plus topdressed. See G.
5. Combinations of systems above as designed may be used upon approval.

RESEARCH

Until the turf protects the surface, use mulch and/or surface watering as needed. After establishment wick action minimizes the need for frequent watering.

It is suggested that those responsible for maintenance shall assume the earliest possible control of each completed unit of construction and that the contractor be released 24 hours after final planting is accomplished if all work has been approved as specified.

The PURR-WICK system is ONLY one of TEN ways to construct turf rootzones. It requires specific work to accomplish, and provides specific features to the manager and users. DON'T LOUSE IT UP! Do it right or leave it alone!

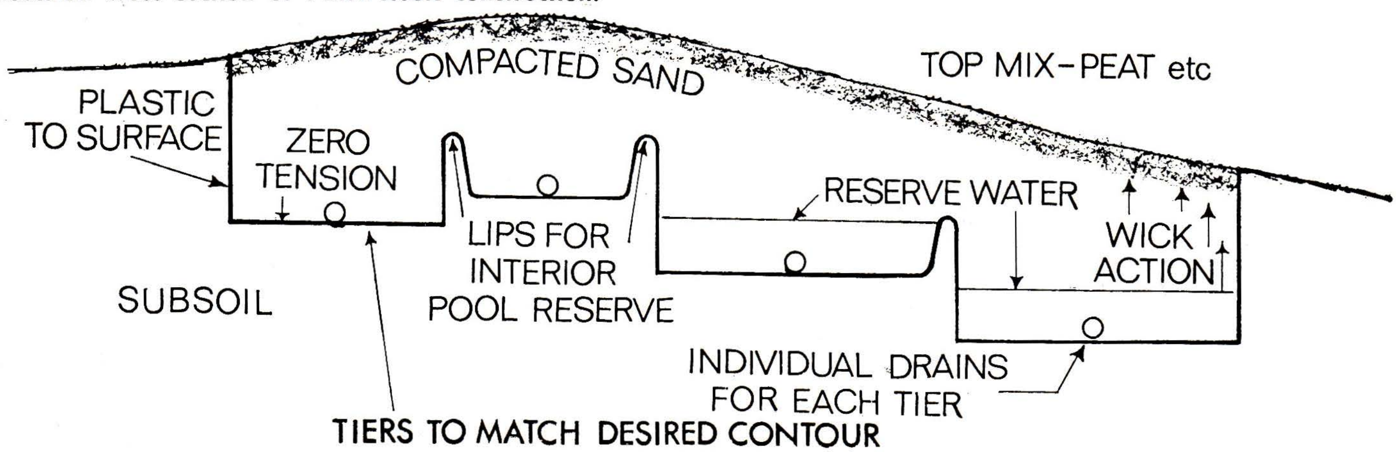
SOME DISADVANTAGES

1. Requires EXACT PLANNING.
2. Requires CAUTIOUS, CAREFUL INSTALLATION.
3. Requires CORRECT MACHINERY—to get sand onto plastic and pipes (drag lines, rubber belt elevators, terratires or light wide track bucket-dozers).
4. Requires early WATER SUPPLY to site during building.
5. RESTRICTS some modifications.
6. LIMITS some uses—or abuses.
7. It is DIFFERENT—compacted, layers, no soil.
8. MISTAKES must be corrected by reconstruction.
9. UNDERSTANDING by operators and inspectors reduces errors.

SOME ADVANTAGES

1. Allows SPECIFIC construction STANDARDS in ample detail and can be inspected.
2. Uses BULK raw material and permits direct delivery.
3. All work DONE ON SITE—as additives.
4. Can be done in RAPID sequence—compact and plant.
5. Can be done ON ANY SUBGRADE material.
6. Gives manager ABSOLUTE water control.
7. Allows LONG PERIODS between irrigation.
8. CONSERVES water to the MAXIMUM.
9. STORES some nutrients as dilute solution, but may need more frequent fertilizer.
10. Plays UNIFORMLY MOIST at all times.

Idealized cross section of PURR-WICK construction.



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