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A MINOR PREVALENCE OF GRAYLEAF SPOT OF ST. AUGUSTINEGRASS IN SOUTHERN CALIFORNIA

*H. S. Gill and G. A. Zentmyer**

St. Augustinegrass *(Stenotaphrum secundatum)* is generally not beset by many diseases in southern California. However, in the summer months of 1975 gray leaf spot caused by *Pyricularia grisea* (Cke.) Sacc., was seen in a dooryard planting in Riverside County. This disease is known to cause severe injury to St. Augustinegrass in the southern United States (1,3).

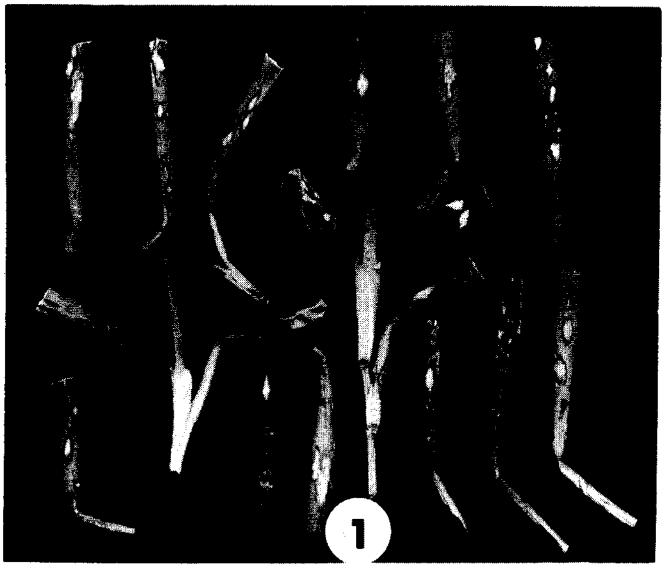

FIGURE 1. Leaves and leaf sheaths of St. Augustinegrass infected by Pyticularia grisea.

At a distance, affected turf appeared blighted or scorched. Leaf blades and sheaths exhibited numerous, small, gray or tan spots with purplish-brown margins (Fig. 1) . A microscopic examination of freshly collected spotted leaves, incubated overnight in a moist chamber at 24 C., revealed heavy sporulation of the causal fungus (Fig. 2).

The disease diminished or declined with the advent of hot and dry weather in the summer months in southern California.

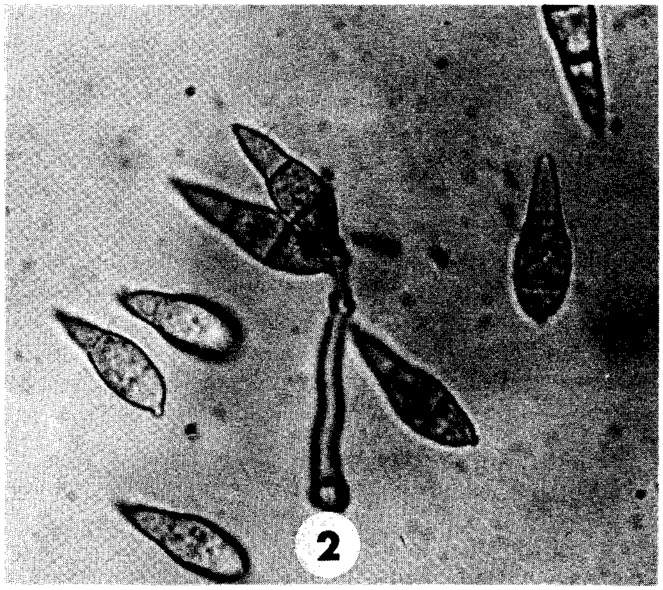

FIGURE 2. Conidia and a conidiophore of P. grisea (X 640).

The same disease was recently observed on St. Augustinegrass in the coastal areas of Orange County, California (2). Information obtained from other area plant pathologists (personal communication) and a survey made to determine the spread of gray leaf spot established the minor occurrence of the disease in southern California.

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FERTILITY ASSAY OF SANDS"

Jack L. Paul**

Use of sand as growing media either as a component in soil mixes or alone stems from desirable physical properties imparted by sands, not their fertility. Generally, sands are thought of as being poor nutritionally. Under those circumstances where sand is used in potting soil, the fertility of sand is not important since nutrition in container culture is easily effected with combinations of chemical amendment, liquid fertilization, controlled release and dry fertilizers. Under conditions where sand is used as a sporting turf soil (putting green, football field) and will not receive the intense fertilizer management of a container soil, inherent fertility is important. If sand can provide some of the plant nutrients, management is easier. Fertility of sands, as a separate class of soils, has not been evaluated yet it would be useful to have this information.

The purpose of this work was to assess fertility of sands suitable for horticultural purposes with particular reference to sands used for turf. The present study evaluates N, P, K and S status of 35 sands using the pot testing method (Jenny, et al, 1950). Soil testing for estimating available phosphorus and potassium in sands is also presented.

Before discussing the results on fertility, it is worthwhile to review briefly the reason for using sand as a traffic soil. It is not necessary that all turf soils receiving traffic be constructed of sand. Under conditions of low to moderate traffic and with good management, soil other than sand can and will support good turf growth. Heavy traffic can cause extra demands on management to keep the soil permeable to water and air, and it is under such conditions that sands are most useful.

Soils containing silt and clay are more or less in a state of aggregation. Under a compactive force, moist soil aggregates deform and flatten, filling in the large air and water conducting pores between the aggregates. The remaining pores are very small and conduct water slowly. Sands form rigid networks of grains that can withstand compaction. After compaction, there is little change in numbers of conducting pores between grains and so permeability to air and water is preserved. This ability to withstand compaction is the principle reason for prefering sand rather than finer textured soil.

Particle size distribution. Since natural sands are generally unsorted sediments, particular attention should be given to the particle size distribution. Not all sands are ideal for growing plants or for managing. The particle size diameter of sands is given below:

Diameter-mm				
2.0-1.0	1.0-0.5	0.5425	0.25-0.10	0.10-0.05
Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand

Silt is 0.05-0.002 mm and clay is less than 0.002 mm. Fine gravel is greater than 2.00 mm. Sands having a broad size distribution, i.e. a fairly continuous particle size representation, are poor horticultural sands. The reason is that finer grains fit into pores between larger grains, and if silt and clay are also present (8-10% by weight), the problem is further aggravated. The resulting mixture is a very dense (bulk densities of 1.9 g/cc), tough, matrix with only fine pores. We seek uniform sands in Horticulture: medium sands for sport turfs and medium-coarse sands for potting soils. Uniform medium and medium-fine sands are permeable after compaction (6-12 in./hr.) and contain adequate available water 11/4-11/2 in.) in the surface four inches of a 12 in. depth following drainage. Medium coarse and coarse should probably be amended to increase plant available water. For a review of sands recommended for putting greens see Davis (a, b; 1973).

In selecting sand to meet the soil physical requirements for a traffic soil, to what extent is fertility sacrificed? Sands have little or no cation exchange capacity; sands taken from below the surface foot have no organic matter and probably a small microbial population. Visual inspection of some sands suggests that they consist primarily of quartz. Such sands would require careful and complete fertilization. Other sands appear to be rich in primary minerals such as mica, feldspars, and ferro-magnesium minerals. Thus, some sands appear to have no plant nutrient bearing minerals while others seem to have a full compliment of such minerals.

Fertility of sands. The pot test method was used to assess fertilizer requirements of 35 sands obtained from various commercial sources in Central California. The pot test consists of different subtractive fertilizer treatments compared to a full treatment. The elements under study were NPK and S. Treatments consisted of:

NPKS — Full
PKS — N_0
NKS — P_0
NPS — K_0
NPK -- S_0
— — Check

Plants were grown in It-inch plastic pots containing 650 g sand. The fertilizers were applied as chemically pure salts at the following rates:

Element	Fertilizer Salt	g/Pot	pounds/acre Element	pounds/acre Oxide
N	NH_4NO_3	0.281	300	—
P	$Ca(H_2PO_4)2.H_2O$	0.115	88	200
K	KC1	0.103	166	200
S	Na_2SO_4	0.144	100	—

'From: Proceedings, Twenty-Fourth Annual Calif. Fertilizer Conf. pp. 60-65.
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Nitrogen was applied as a split application with 1/2 applied 45 days after planting.

One hundred mg of seed of Bentgrass *(Agrostis tenuis* cv. "Penncross") were planted per pot. The grass was grown for 60 days, and three harvests were made by taking clippings 30, 45 and 60 days after planting. Total dry weight yield per pot was obtained by summing the three harvests. There were four replicates per treatment. Relative yield (yield of subtractive treatment/yield of full treatment, X100, issued to compare fertilizer responses between sands.

All experiments were performed in a cool greenhouse (night temperature 55°F and day temperature 80°F) from April through October.

Results-The following table summarizes the extent and frequency of fertilizer response obtained for 35 sands.

Relative Yield Percent	Percent of Sands Treatment N_o	P_o	S_o	K_o
0-20	100	3.1	6.2	0
20-40	–	6.2	18.8	3.1
40-60	–	25.0	31.3	6.2
60-80	–	15.6	25.0	37.6
80-100+	–	50.0	18.7	53.1

In the left column R.Y. (relative yield) is divided into 20% increments and the right columns show the percentage of sands tested which fall into the ranked R.Y. categories.

Nitrogen. The N_o treatment for all sands had R.Y.'s of 0-20%,. Yields of this treatment were no better than the check which suggests that the sands were absolutely deficient in available nitrogen. This is not too surprising if the source of sand is considered. All come from sub surface deposits. Nitrogen deficient grass was stunted and light yellow.

Phosphorus. Fifty percent of the sands tested were well supplied with available phosphorus (R.Y. 80-100% and 9% were severely deficient. It is interesting to note that in the P, treatment for some sands, growth rate increased after the first clipping. This suggests that with time more phosphorus became available. Moderately phosphorus deficient grass is stunted and dark green with narrow blades.

Sulfur. Sulfur deficient sands appeared to be more or less represented in all R.Y. categories. It is speculated that S compounds originally present in these sands were leached with low sulfate waters and since no organic matter is present, there is no mineralization from organic sources. Sulfur deficient grass is very similar to N deficiency.

Potassium. Fifty-three percent of the sands were adequately supplied with available K. Three percent were severely deficient and 38% were moderately deficient. Potassium bearing minerals such as mica and the feldspars microcline and orthoclase would be the main sources of K, clay derived K would be minor since clay was generally less than 3% of the sand sample.

Micro-nutrient treatments were included in many of the sands, but no significant yield increment was obtained in these treatments. None of the sands tested indicated a need for lime and no Ca or Mg deficiency symptoms were noted, but this does not rule out the possibility that some sands will be deficient in these nutrients. Since only 35 sands were evaluated, no generalizations can be made regarding micronutrient and lime requirements.

Chemical analyses. The pot testing method provides a reliable means for assessing the fertility status of soils, but it requires proper facilities and time. Soil tests are not as reliable but if they are well correlated with fertilizer requirement, they are very useful. They are also less expensive. Soil analyses for phosphorus and potassium were performed on all sands and were correlated with appropriate subtractive treatments. The test for sulfur has not yet been done for these sands. Nitrogen need not be considered for obvious reasons.

Conclusions: The results of the pot test for a limited number of sands indicate that they behave as might be anticipated for subsoils. The extent and frequency of P deficiency is similar to surface soils which have been tested (Vlamis, 1966). Nitrogen is completely lacking. Occurrence of S and K deficiencies is probably more frequent than in valley soils in California.

It is apparent that all sands will require N to start grass and many will also require S. Soil tests can help decide whether P and K should be added also, but sand well supplied with P and/or K, initially, may eventually become deficient in these nutrients as clippings are removed. Soil and tissue tests may be useful to indicate when these nutrients should be applied.

The work is part of the Turfgrass Adaptive Research Program, supported by a grant from the Northern California Golf Association.

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THE BOWLING GREEN

Edgar R. Haly*

Lawn bowling, one of the more popular sports of the English-speaking world, is slowly gaining popularity in this country. Until very recently, the construction and management of lawn bowling greens has been a step-child of the golf green. As such the quality of bowling greens has been mediocre and the enthusiasm for the game has suffered.

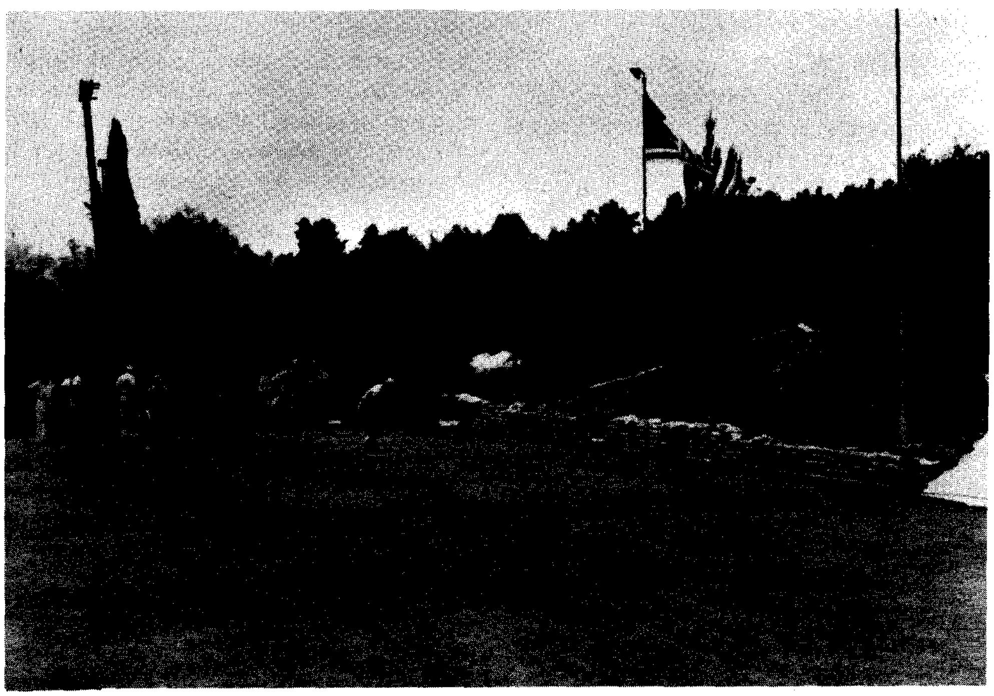
Within the past five years a considerable change of a fundamental nature has taken place. Bowling greens are being constructed based upon the research of soils in relation to the demands of the game.

The game of bowls requires a hard dry surface, completely smooth, absolutely level, and the height of the turf no more than 1/8" to 3/32" above the actual soil. The excessive foot traffic on the turf adjacent to the playing ditches tends to cause severe compaction. With these demands in view, it appears obvious that the construction of the bowling green is considerably more critical than that of the golf green.

Based upon accepted research a bowling green in Escondido was constructed two years ago. The soil consisted of a nine inch layer of sand (approximately sieve 35, with less than 5% silt or clay) surmounted by a surface nine inch layer of medium-fine sand (sieve 55, with 93% of the particles having diameters lying between 0.15 mm and 0.5 mm and containing no silt nor clay) . The use of these sands and the depth of the layers were carefully tested for drainage characteristics, including sufficiency of available water and air porosity at the root zone level, arbitrarily taken at 8". Beneath the 18 inches of sand lie drainage pipes (ADS) on 5' centers. The sand envelopes the drainage pipe, with no sleeve of gravel. Upon this predictable model the turf of Tifgreen is healthy, vigorous and deep rooted despite being maintained at a constant 1/8" to 3/32" height above the actual sand.

The green is playable, in excellent condition, within 10 minutes of heavy rains (2+ inches in 48 hours). There are no weeds, including *Poa annua,* and there has been no need for any fungicides. It is completely free of thatch.

This green, to the best of our knowledge, is the most consistently excellent green in the United States and is probably the easiest to maintain in this condition.



The Escondido Bowling Green

A number of other greens have been constructed along these basic principles, both before and since the Escondido green was built. In most cases the landscape contractor did not quite follow the recommendations, apparently due to the influence of accepted golf green construction. These greens have proven to be much better than previously built greens, but none have been quite the success shown by the Escondido green.

It is acknowledged that a 2-year experience is too short for drawing definite conclusions. The really tremendous improvement in the green surface for lawn bowling, to date, warrants careful scrutiny of the principles involved when construction or re-building of lawn bowling greens is contemplated.

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PROBLEMS AND SOLUTIONS ASSOCIATED WITH HEAVILY USED TURFGRASS AREAS

*Prepared by Forest Cress, Victor Gibeault**

At the 1976 Turf and Landscape Institute, a panel discussion with five turfgrass researchers was held. This presentation summarizes the two-hour session that was moderated by William Davis of U.C. Davis. Panel members were Drs. V. B. Youngner, U.C. Riverside; J. Madison, U.C. Davis; J. Butler, Colorado State University; J. B. Beard, Texas A&M University; and A. Turgeon, University of Illinois.

There are four major dimensions of traffic on turfgrass. The two that are of most concern are soil compaction and turfgrass wear. Of lesser concern are divot damage to turf, resulting from sport activities, and rutting which can be caused by vehicles on certain soil textures under high moisture conditions.

Which Grass to Use

It was noted that research by Youngner has shown that zoysiagrass, bermudagrass and bahiagrass, in that order, are the best warm-season grasses to survive the combined effect of wear and soil compaction. Zoysiagrass, once injured, is slower to recover than bermudagrass which often influences its lack of selection for high trafficked areas, especially where there is continuous traffic. Dr. Youngner explained that a zoysiagrass breeding program is underway in California to develop varieties that will recover more rapidly. Meyer zoysiagrass, which is used quite widely in the midwest and east, isn't recommended for California because it is dormant for several months of the year.

Of the bermudagrasses, Tifway and Tifgreen have shown superior tolerance to traffic because of their greater accumulation of total vegetation. In California, it was noted that Santa Ana has significantly gained in popularity on heavily used facilities.

Madison pointed out that the best grass for traffic tolerance is the one that can be best grown on a facility. He often suggests using common bermudagrass in warm season areas where management may be minimum because of limited finance available.

Beard observed that kikuyugrass, a weed problem for California turfgrass managers, had good traffic tolerance. He reported that in Africa golf tees were established to kikuyugrass where they were mowed and irrigated frequently: and were maintained at a quite high nitrogen level. Maybe there are going to be some new grasses coming along . . . that we call weeds now," he said, "that might help out on these intensely trafficked turfgrass areas. There are going to be increasing problems with more traffic on them in the future."

Turning to a comparison of the cool-season turfgrasses, Turgeon commented that ryegrasses have given an advantage over the bluegrasses by having the same color and texture but a tremendously improved resistance to wear.

Turgeon added that tall fescues also has advantages. In a large area, they do give a uniform appearance without disease problems that tend to appear when you have Kentucky bluegrass. Tall fescues also have great wear potential. The species is fairly economical with respect to water, according to Turgeon, and is tolerant to a fair amount of shade.

Turgeon said that the tall fescues and ryegrasses are good turfgrasses for intermediate transition zones, and they both have high fiber content which gives good wearability.

With respect to the ryegrasses and tall fescues, Beard noted, one should keep in mind that their recuperative potential isn't the greatest, if one is looking for speed of recovery in a turfgrass. A lot of the recuperative potential, he said, comes from lateral stem development, which is minimal with most ryegrasses and tall fescues. An exception, he added, is Manhattan, a ryegress which he said appears to have a certain degree of creeping tendency to it. It's the one that really stood out in the wear tolerance tests he conducted. He noted that many ryegrasses he tested rank way below many Kentucky bluegrasses in wear tolerance.

Butler noted that the wear tolerance of Kentucky bluegrass is very good in areas of its adaptation. In areas where Kentucky bluegrass is only marginally adapted, it does not have good wear resistance.

Beard commented that in Kentucky bluegrass comparison studies he conducted with wear simulator for short-term abrasive effects on Kentucky bluegrasses, he found quite a range of tolerance. Out of 18 tested varieties, he would only rate A-34 as excellent. In the good category were Merion, Baron, Nugget, A-20 and Georgetown. Mcdium were Primo, Fvlking, Adelphi, Newport. Fair were Sodco, Galaxy, Bonnieblue, and Belturf. Poor were Campus, Sydsport, Kenblue and Park.

For intensely trafficked putting grasses, bentgrasses would be the best choice, according to Beard. In comparison studies for wear tolerance, he found Penncross to be the best of the commercially available varieties. One that had poor wear tolerance, he added, was Emerald. Toronto and Congressional didn't do very well, either. He found considerable variation among the cultivars with respect to wearability.

Turgeon pointed out that the improved varieties of perennial ryegrass are being used. Ryegrass, when compared with the Kentucky bluegrasses, has a very rapid germination rate, and because of its seedling vigor in its early immature stage of growth, presumably has what might be called an induced recuperative potential by virtue of an overseeding operation. This is being done today, he noted, not only during the renovation program on football fields but even during the season of play,

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itself. An overseeding program is practiced perhaps right after a game so that there is some new grass developed prior to the next game which, say, might be two weeks away.

On the other hand, he added, with Kentucky bluegrass that is properly managed you can develop over a period of time what he calls a rhizome base or underground system of extensive rhizome development that he believes can add to the wear tolerance of the grass as well as provide for a rapid recuperative potential given a certain amount of wear injury.

He finds it intriguing to compare the two grasses and then to consider the possibility of a combination of the two. "I don't know that we've adequately worked that out," he said. "I think that it is certainly of need of further research and evaluation."

Influence of Cutting Height

The turf experts agreed that height of cut can have a considerable effect on the wear resistance of turfgrasses.

Youngner, as an example, said that if you have a turf of Kentucky bluegrass and are mowing at l/2 to 3/4 inch you're going to very drastically reduce its wear resistance, because you're weakening its root system and reducing the density of the grass and that both of these factors influence wear resistance. On the other hand, he added, if a turf, say a bermudagrass, is cut too high, it tends to become very fluffy. Wear resistance will be decreased again but for a different reason: "You'll have a loose, open, rather fluffy turf that will tear rather easily, particularly under cleats and that type of wear action.

He noted that he ran a series of tests many years ago at UCLA where turfgrass was mowed very low, below the desirable range, and then allowed to grow again to the desirable cutting height. There was a time lag before its wear resistance was at the level of turfgrass which had been mowed within the desired range throughout the same period of time.

Turgeon says he thinks it is fair to generalize that within the mowing tolerance range for a particular grass, there is a general increase in the wear tolerance of turf as one increases mowing height. Associated with this, he said, we see an overall increase in biomass which occurs in two dimensions : an increase in the verdure or above-ground biomass or what is left of the green growing turf after mowing, and, second, the below-ground biomass, the root and rhizome system. Usually, he added, both of these increase significantly with even small increases in mowing height.

For vertical mowings, Youngner said, once or twice a year should be ample for bermudagrasses for most athletic field uses. The mowings should be when the grass will recover very quickly and early enough that recovery will be sufficiently complete before the time for germination of fall weeds. He recommends vertical mowing of bermudagrass early in the summer for southern California, during its main growing season.

Wetting Agents on Trafficked Turf

Beard said that considerable work was done while he was at Michigan with wetting agents on sand soils possessing hydrophobic characteristics. Soil microorganisms were active in these soils. When they died, they coated the sand particles with an organic material similar to a wax. Water wouldn't penetrate it. Under those conditions, Beard said, one can show a response to certain wetting agents, but, Beard stressed, he was talking about effective use of wetting agents on a hydrophobic, water-repelling soil, and that he was not talking about a compacted, high density, low aeration/low pore space soil. There are no data, to his knowledge, which show a response by compacted soils to wetting agents.

Turgeon commented that with wetting agent compounds and biological dethatching compounds, he would suggest that turfgrass managers initially try such products for a specific problem on a small-area basis. Some of these products conceivably might work under a particular set of conditions.

Modifying Soil Compaction on High Trafficked Turf

Turgeon reported that at the University of Illinois researchers have been evaluating the new concept of subsurface cultivation. They are comparing it to coring, measuring results three months following cultivation and then a year later using a soil cone penetrometer to measure soil strength which would be rated as soil compaction. Characteristically throughout the area, he said, they encountered a zone of resistance or a subsurface compaction layer at about the 3-inch depth. "The only thing we could come up with to explain the existence of this sub surface compaction Iayer, "he said, "was the effect of coring over many years. That site had been core-cultivated at the maximum depth of penetration for that aerifier." The results indicate, according to Turgeon, that through a regular system of core cultivation one actually might be doing some damage to the soil system by inducing a compaction zone, and that perhaps from time to time some measures should be taken to break that zone up. Perhaps there is a role for a new concept or system of cultivating the subsurface by deep slicing.

Butler said there's a need for improvements in mechanical aerifiers since the same techniques, are being used today that essentially were used 15 to 25 years ago.

Beard said he believes that the preventive approach is best for solving or ameliorating surface compaction problems for those who can afford it. By prevention, he explained that he meant proper surface drainage, a root zone of a texture that excess water can be removed rapidly, and that there are subsurface drainage tiles to remove excess water from the soil. If this approach is not affordable, then turf culture approaches must be used to ensure active deep root systems. Finally, if one must, there is cultivation such as coring and slicing, spiking, and shattering. He doesn't see cultivation as a standard practice in a program that is to be done at a certain time according to a schedule. He said one should go out and core only as a specific problem is assessed.

Turgeon saw three fundamental approaches to deal with traffic intensity: (1) trying to prevent or reduce traffic intensity on a site through design layout (e.g. design to encourage traffic to flow over a broad area rather than being confined to a relatively narrow area); (2) develop a soil medium that is relatively resistant to compaction over time; and (3) compensating for intensive use by physically improving the soil by a method or methods of cultivation.

UC TURF CORNER

*Victor A. Gibeazult, Forrest Cress**

Two Letters Commenting on Previous Research Reviews

Editor:

I did note in the recent issue Volume 26, No. 1, the article concerning controlling moss and algae in turf. If you were quoting regarding moss control, I am afraid that 1 to 3 oz. of iron sulfate or ferrous ammonium sulfate would be entirely too low. As a matter of fact, 4 lb. per 1000 sq. ft. is rather marginal and we go all the way up to 10 for real effective moss control where the growth is fairly heavy.

If readers have any kind of heavy moss growth in turf such a lawn type turf, the light rates just won't do it. We have one famous brand of moss killer marketed up here which is a ferrous ammonium sulfate and they recommend 10 lb. per 1000 sq. ft. At those high rates it is quite effective on moss control.

Sincerely yours,
/S/
Roy L. Goss
Agronomist
Washington State Univ., Puyallup

Editor:

I enjoyed reading the resume you wrote for California Turfgrass Culture of our article on phosphorus deficiency of St. Augustinegrass (Vol. 26(1)) . Your synopsis seems quite accurate. However, the point we were most trying to make, but maybe didn't emphasize enough, was that the deficiency resulted from poor fertilizer distribution. Apparently, the 20% superphosphate in the fertilizer mix wasn't thrown the full assumed width of fertilizer distribution pattern. The tissue analyses indicated this, for K was about the same in the good and bad areas, but only half as much P was found in the bad areas as in the good. Dr. Allen has done some follow-up work on this and observed that 20% superphosphate, being fine and dusty, is not thrown as far as murate of potash. The relative distribution of triple superphosphate and potash is closer, however.

There's nothing unexpected in these results, but occasionally we need to remind turf managers of the importance of uniform fertilizer distribution, and this experience illustrates this point well.

Thank you.

Sincerely,
/S/
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Dichondra Rust

Rust of dichondra *(Dichondra repens Forst.)* caused by *Puccinia dichondrae* Mont. has been prevalent in the San Francisco Bay Area this spring (March-April), particularly in southern Alameda County and Santa Clara County.

The disease is readily identified by the powdery appearing chestnut colored pustules which are predominantly on the lower leaf surface. The spores in the pustules are all teliospores, no urediniospores are produced by the fungus. The teliospores may be dislodged and spread somewhat by air currently or more likely by splashing water. The teliospores do not infect directly but germinate to produce basidiospores which are carried by air currents and may infect dichondra leaves. Aeciospores are known to form on dichondra only in South Africa. Pustules that result from basidiospore infections produce more teliospores.

Control measures may not be necessary because last year with the advent of warm weather, dichondra plantings heavily rusted, appeared to be free of rust by early summer. To aid in recovery, the dichondra should be fertilized and not watered too frequently.

("Dichondra Rust" by Dr. A. H. McCain, California Plant Pathology, No. 31. April 1976. pp. 4-5.)

Vegetatively Establishing Kentucky Bluegrass

Field studies by University of Illinois researchers investigated establishment of "A-20" Kentucky bluegrass from plugs and shredded sod planted in prepared soil in early summer.

They found that plug spacing was more critical than plug size in determining the rate of turfgrass establishment. Where companion grasses were seeded in conjunction with plugging, faster ground cover resulted, but the lateral growth of the A-20 plugs was retarded. Planting of shredded sod resulted in poor turfgrass cover due to desiccation of the plants and annual weed development initially. However, good turfs were developed within two years with heavier planting rates resulting in faster establishment.

("Techniques for Vegetatively Establishing Kentucky Bluegrass Turf," by E. G. Solon and A. J. Turgeon, Agronomy Journal, Vol. 67, No. 4, July-August 1975.)

Effects of Pre-emergence Herbicides on Turfgrass Thatch Development

Extensive use of pre-emergence herbicides in recent years to prevent annual weed development has been suspected of causing reduced turfgrass quality. A study was conducted at the University of Illinois Agricultural

Experiment Station to determine whether repeated use of pre-emergence herbicides resulted in thatch development and other effects associated with turfgrass deterioration.

Six pre-emergence herbicides were applied annually for four years to "Kenblue''-type Kentucky bluegrass growing on Flanagan silt loam.

Calcium arsenate and bandane applications resulted in increased leaf spot disease, higher wilting tendency, reduced shoot and root growth, and substantial thatch development. The thatching tendency was associated with a complete lack of earthworm activity in the underlying soil. Bandane residue was largely confined to thatch, while calcium arsenate was more generally distributed throughout the upper thatch-soil profile. Verdure was significantly reduced in plots treated with bensulide, while benefin, DCPA and siduron treatments produced no measurable effects.

("Thatch Development and Other Effects of Preemergence Herbicides in Kentucky Bluegrass Turf," by A. J. Turgeon, R. P. Freebork and W. N. Bruce, Agronomy Journal, Vol. 67, No. 4. July-August 1975.)

Phytotoxicity of Herbicides to Tifgreen Bermudagrass

Results of a recent three-year study at the University of Tennessee reflect the hazard posed by consecutive annual herbicide treatments. They also show, however, that grass recovery can occur with some herbicides if they are not used continually for too long a time.

A "tifgreen" bermudagrass golf-type green was treated with one post-emergence and seven preemergence herbicides at two rates each for three consecutive years to assess their phototoxicity. A few of the herbicides tested were applied on a second, third and fourth treatment date during the year with applications made in separate plots.

Severe foliage injury occurred the first year with siduron. moderate injury with bromacil and DCPA, and slight injury with benefin, bensulide, and terbutol. No injury was 'observed with bandane and tri-calcium arsenate.

Following renewal treatments the second year, injury was severe with siduron and bromacil, moderate with benefin, bandane, DCPA and terbutol, and silght with bensulide and t&calcium arsenate.

Injury in the third year following repeat applications was severe with siduron, trebutol, bandane, bromacil, benefin, and DCPA, slight to moderate with bensulide, and slight with tri-calcium arsenate.

Injury observed the fourth year resulting from residues was moderate with bandane, slight with terbutol, benefin, bensulide, and DCPA, and none with siduron, bromacil, and tri-calcium arsenate,

("Phytotoxicity of Herbicides to a Tifgreen Bermudagrass Green," by L. M. Callahan, Weed Science, Vol. 24. No. 1. January 1976.)

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