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A STUDY OF THREE SAND MIXES

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The greens on early golf courses in the United States consisted primarily of local soil graded into a comparatively small, aesthetically pleasing green that was seeded to a bentgrass. Play on these courses was limited so the small greens constructed of native soil were acceptable. As play increased over the years, greens became compacted, the large pore space in the soil was eliminated, the soil was frequently sealed and became overly wet. Air, water and nutrient entry into the soil profile was eventually restricted. At the same time, roots were restricted in growth and bentgrass was ultimately invaded by weedy species. The game of golf suffered in quality.

To alleviate the problem associated with compacted native soils, the use of sands as a medium for putting greens has been formally and informally studied. In the last 25 years recommendations for soils used in green constructlon included sand-soil-organic mixes, sand-organic mixes, and sand alone. The study reported here followed infiltration rate of newly installed sand-organic putting greens on three golf courses over several years. We wished to follow field infiltrator rate with time; to evaluate the predictive value of laboratory studies; and to learn if inkltration varied within a green because of traffic flow.

Methods

Test greens were located on Los Coyotes Country Club, Brea, the Balboa Course in Encino and Big Canyon Country Club in Newport Beach. The first two courses had greens rebuilt; Big Canyon was a new course at the initiation of this study (1970). The sand-organic mis on each course was selected by the individual architect, owner and/or superintendent.

The Balboa Course had a soil mix of 60% sand, 30% Loamite and 5% Nitrohumus; Big Canyon had 60% sand and 40% Loamite. During construction, a sand mix sample was taken from each green and submitted for laboratory testing at U.C. Davis; the analysis consisted of a mechanical analysis and a projected compacted infiltration rate. The results of these analyses are given in Table 1. The moisture release characteristics of the three soil mixes was also determined.

On the day the respective courses opened for play, infiltration rates were taken. Three months later another series of infiltration rate determinations were made of each green and again every ‘six months thereafter. Semiannual determination continued throughout the four-year test period,

The infiltration rates of the sand mix of each green were made using 12 infiltrometers. The rings were fabricated from metal oil drums. The top and bottom lids were removed and each drum cut crossway at midpoint of its height. The edges of each cut were filed to ease penetration of the putting surface of each green.

Three rings were set at each of four locations on the green. The four locations quartered each green into stations that respectively represented: (1) that portion that received the approaching golfers, (2) that which was most frequently used by players as they left the green, (3) and (4) those quarters used relatively less frequently. At each station the rings were positioned in a triangular arrangement so no one ring stood further apart than six inches from the other two rings at its closest point. Each ring was driven four inches deep.

Once driven into place the rings were filled with water. The water was allowed to infiltrate until the initial rapid rate subsided. Subsequent infiltration was recorded through the use of a hydraulic hook gauge (see Figure 1). The gauge measured the drop in water levels between stopwatch readings. The infiltration rate was computed

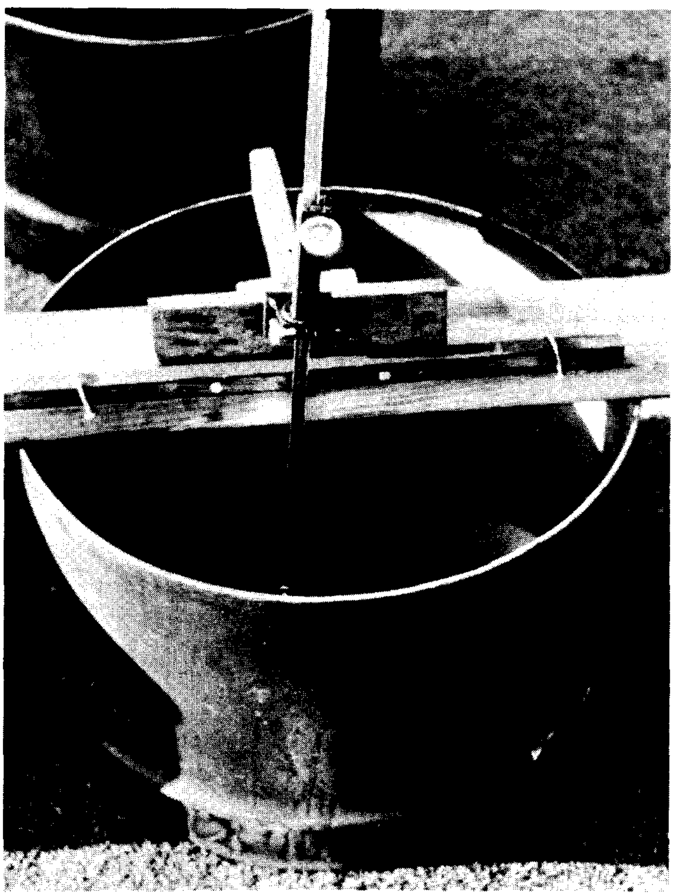

Figure 1. Ring infiltrometer with hook gauge.

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as inches per hour. All data is presented as water infiltration in inches per hour.

The collected data was subjected to an analysis of variance and significance was determined by the Duncan's Multiple Range Test.

Cultural practices varied among the three golf courses. A summary of the management given each test green is presented in Table 2.

TABLE 1. Mechanical analysis and projected compacted infiltration rate of three sand mixes.

Separates	US Sieve Number	Diameter Range(mm)	Mechanical Analysis (Particle Size Distribution): Coyotes Burn off of Organic 3 2	Balboa 5½% Burn off of Organic	Big Canyon 9% Burn off of Organic
			% Separate-		
Fine gravel	10	2.00-Plus	17.26	1.08	1.26
Very coarse sand	18	1.00-2.00	13.20	4.64	1.84
Coarse sand	35	0.50-1.00	26.88	21.02	15.90
Medium sand	60	0.25-0.50	27.16	42.94	46.04
Fine sand	140	0.10-0.25	8.88	22.44	22.94
Very fin sand	270	0.050.10	1.78	2.60	4.90
Silt	—	0.002-0.05	2.80	3.20	6.70
Clay	—	— 0.002	1.70	1.50	
Compacted Infiltration Rate 64 Strokes (40 PSI)			3.5 in./hr.	1.66 in./hr.	5.8 in./hr.

TABLE 2. Operational Tasks and Frequencies Performed Pear Year

Tasks	1970 B[1]	1970 LC[2]	1970 BC[3]	1971 B	1971 LC	1971 BC	1972 B	1972 LC	1972 BC	1973 B	1973 LC	1973 BC
Aeration	0	0	0	0	2	1	2	3	1	2	6	3
Topdress	0	0	0	0	2	1	0	2	2	0	5	4
Verticut	0	0		o-o	0	2	2	0	1	3	4	3
Open	5/70	12/70-O-		—	—	5/71	—	—	—	—	—	—
Annual Rounds of Play	59536	-0-	-0-	93193	51764	10950*	101694	57289	29945	99228	56702	43725

*Estimated rounds of play. Records were not kept until 1974

1 Balboa
2 Los Coyotes
3 Big Canyon

Results

The mechanical analysis is presented in Table 1. Big Canyon and Balboa are very similar both in sand analysis and moisture retention (MR not shown). Balboa has slightly more coarse and very coarse separates and slightly less silt and clay separates. However, Big Canyon had considerably more organic matter than Balboa which could influence the openness of the green as related to water infiltration.

Los Coyotes has a very poor sand for a putting green mix. There is a high percentage of fine gravel, very coarse and coarse sand, but there is also a considerable range of separates in the fine sand through clay category. The mix has a much steeper moisture release curve in comparison to the Big Canyon and Balboa green mixes. It starts out

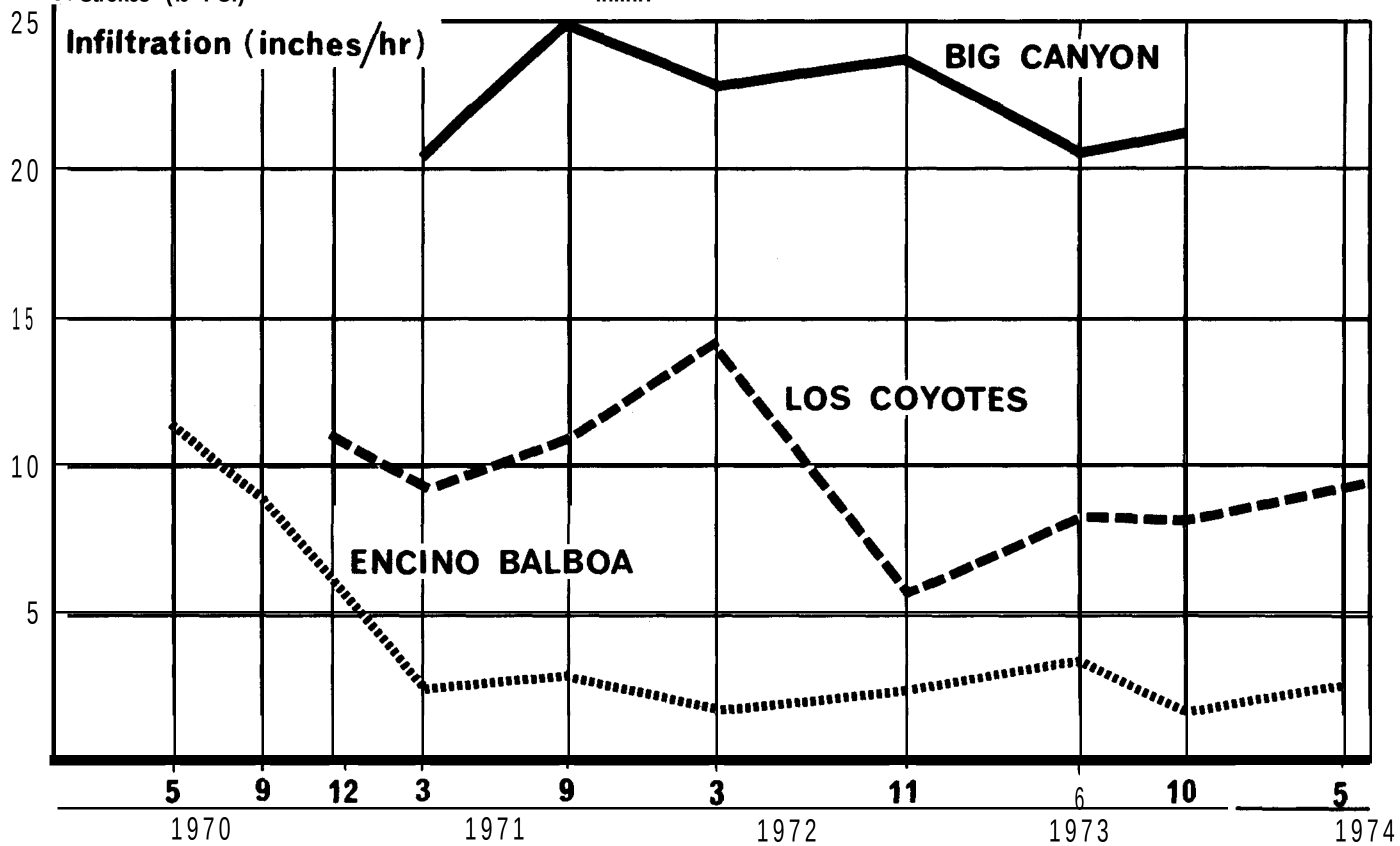

Figure 2. Infiltration rates of Big Canyon, Los Coyotes and Balboa courses for the period of study.

the same but as tension (depth) increases, the water retained in the surface 3-4 inches is rapidly lowered. Without a high amendment of organic matter this type of sand with its very large particles would be very droughty.

The infiltration rates for the three greens over the recording period are presented in Figure 2. Big Canyon had the highest initial infltration rate and the soil maintained that characteristic throughout the test period. Los Coyotes and Balboa had identical initial infiltration rates, however, Balboa decreased rapidly, whereas Los Coyotes maintained a comparatively higher infiltration rate throughout the study period.

Table 3 presents the average, final and proiected infiltration rates for the three test greens. It will be noted that Big Canyon had the highest rate, followed by Los Coyotes, and lastly Balboa as was previously noted. The actual infiltration rate was much higher than the laboratory projected infiltration rate for two of the three greens tested, namely Big Canyon and Los Coyotes. When the amount of play and management is examined the high infiltration rates maintained at Big Canyon was likely assisted by the relatively low play. The heavier play at Balboa and limited coring would account for the green nearly reaching its projected lab infiltration rate. The soil mix at Los Coyotes is characterized by a high percentage of coarse particles but the range of particle sizes reduces the expected infiltration rate. The frequent coring program evidently accounts for the higher than expected infiltration rate.

TABLE 3. Average infiltration, final infiltration and laboratory projected infiltration at the three greens.

Location	Average Infiltration for Test Period	Final Infiltration*	Projected Infiltration from Analysis
Big Canyon	22.3 x	20.8	5.8
Los Coyotes	9.7 Y	8.6	3.5
Balboa	4.2 z	2.6	1.66

*Average of three final readings.

The average infiltration of the three test greens for the period of study is presented in Table 4 in terms of four traffic flow patterns that were evaluated. Infiltration rates were different among the four traffic locations within each green, however, the differences were small and they followed no consistent pattern. As an example, at Big Canyon Country Club the lowest infiltration was recorded where the traffic flowed onto the green. Conversely, the same location on the Los Coyotes green recorded the highest infiltration rates. There was little difference in infiltration rates because of foot traffic flow at the Balboa Course.

It was apparent that traffic flow on a green did not consistently influence the infiltration rate. The differences in infiltration rates on a green were small in comparison to the differences among the three greens in this study. This indicated that the soil mix and management were more important in restricting water entry than was the flow of foot traffic across a green.

TABLE 4. infiltration of four traffic flow areas of test greens on three golf courses.

Station	Big Canyon (1971-1973)	Los Coyotes 1970-1974)	Balboa (1970-1974)
1*	19.4 v**	11.0 w	4.2 YZ
2	25.0 S	10.2 w	4.1 YZ
3	21.3 U	8.4 X	3.6 Z
4	23.5 T	9.0 x	4.9 Y

*l-player entry; 2-player depart; 3 and 4-less player traffic.
**Values followed by different letters are significantly different at the 5% level.

This conclusion is further supported by the results in Table 5. Here, data for the three greens were averaged for each traffic location. Little difference was found in infiltration rates because of location on the greens. Locations 1 and 3 had slightly less water infiltration than the other two locations, however, the difference was small and unrelated to traffic.

TABLE 5. Average infiltration at the four green location sites for Big Canyon, Los Coyotes and Balboa greens.

Traffic Location	Average Infiltration (in./hr.)
1	11.5 z
2	13.1 x
3	11.1 z
4	12.5 Y

Values followed by different letters are significantly different at the 5% level of significance.

Conclusions

The study and observations showed that Big Canvon had the highest initial infiltration rate. It maintaihed that rate throughout the test period. Los Coyotes and Balboa greens had identical rates initially but the rate of the Balboa green declined rapidly in contrast to that of the Los Coyotes green.

Records showed that the Balboa green had received substantially large volume of play. At the same time it received considerably less equivalent maintenance in contrast to that received by the other two greens.

Rate comparisons between the projected laboratory rate and the actual field rate showed that the field infiltration rate for both Big Canyon and Los Coyotes were substantially higher than their respective laboratory rates. Those for the Balboa green were substantially the same. Laboratory methods appeared to predict a minimum infiltration rate which was not necessarily reached in the field.

When the greens, divided into quarter sections, were compared as to traffic flow received, the study showed significant differences in the infiltration rate but differences were not related to traffic. Further, these small differences failed to show any consistent pattern. The differences within a green were small compared to differences among the three greens. This would indicate that the sand mix and other factors were more important in restricting water flow than was the flow of traffic.

AIR POLLUTION EFFECTS ON TURFGRASSES*

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Plant damage from air pollutants (industrial fumes and dust) has been known for over 100 years. Many toxic chemicals, if present in the air, can cause plant injury in localized areas. However, only a few are sufficiently widespread and common to be major problems (Table 1). Photochemical air pollutants (smog) were recognized and plant injury symptoms described in the late 1940's. Of this group of gasses; ozone, nitrogen oxides and peroxyacetyl nitrate (PAN) cause the most widespread and serious injury.

TABLE 1. Common Phytotoxic Air Pollutants

Gasses
- Sulfur Dioxide
- Hydrogen Fluoride
- Ethylene
- Nitrogen Dioxide
- Peroxyacetyl Nitrates (PAN)
- Ozone

Particulates
- Sulfuric Acid Droplets
- Industrial Dusts

Various environmental factors have been found to increase plant injury from photochemical air pollutants (Table 2). Most of these are factors which favor high levels of physiological activity within the plant, especially high rates of gas exchange within the leaves. Injury to cool season grasses may be greatest at moderately cool temperature while to warm season grasses it will be greatest at high temperature. Low nitrogen rates may act principally to reduce the plant's rate of recovery.

TABLE 2. Environmental Factors Increasing Toxicity of Smog

- Leaf Surface Moisture
- High Humidity
- High Soil Moisture
- Cool Temperatures
- High Temperatures
- Light
- Low Nitrogen

Bobrov and coworkers (1955) first described the injury symptoms of smog on annual bluegrass *(Poa annua L.)* . Later, similar symptoms were recognized on other common cool season grasses. Wilton et al (1972) were the first workers to show differences in susceptibility to ozone among strains of Kentucky bluegrass *(Poa pratensis L.)*.

Bobrov showed that necrotic areas on annual bluegrass leaves following exposure to smog resulted from disintegration of chloroplasts and plasmolysis of mesophyll cells in the vicinity of the substomatal chambers in the leaf. The amount of tissue damage depended upon the concentration of pollutants in the air and the length of the exposure time. Greatest damage occurred in areas of mature but not senescent cells. Therefore, cell necrosis would usually appear in distinct bands across the leaf. The location of these bands at the tip, in the middle or at the base of the leaf, would depend upon the age of any given leaf at the time of exposure to the smog.

Air pollution injury to bermudagrass *(Cynodon spp)* was recognized about 1960. Injury was greatest on African bermudagrass *(Cynodon transvaalensis* Burtt-Davy) and many hybrids in which this species was a parent. Common bermudagrass *(Cynodon dactylon* (L.) Pers.) appeared to be highly tolerant. Under field conditions during warm summer weather, Tifgreen, Tifway and Tifdwarf hybrid bermudagrasses have been highly susceptible to smog. In 1966, Santa Ana, a similar hybrid that was highly smog tolerant was introduced by the California Agricultural Experiment Station. It is gaining in favor throughout California for several other reasons besides smog tolerance.

Through many years of field observations the common turfgrasses can be rated as to smog tolerance (Table 3). Recent laboratory studies using ozone and PAN in general confirm the field observations. However, bermudagrasses have not shown the degree of injury observed in the field. This may have been because of cool temperatures at the time of smog treatment.

TABLE 3. Susceptibility of Common Turfgrasses to Smog Under Field Conditions

Tolerant ↓ Highly Susceptible

- Zoysiagrasses
- St. Augustinegrass
- Santa Ana Bermudagrass
- Common Bermudagrass
- Tall Fescue
- Bentgrasses
- Red Fescues
- Kentucky Bluegrass
- Ryegrasses
- Annual Bluegrass
- Tifton Hybrid Bermudagrasses

Treatment of Kentucky bluegrass cultivars with known concentrations of ozone and PAN have shown a wide range in susceptibility among strains (Table 4). Cultivars highly susceptible to one of the pollutants would not necessarily be equally susceptible to the other. Although Kentucky bluegrass is considered to be moderately susceptible to air pollutants, some cultivars were observed to be quite tolerant of both ozone and PAN.

TABLE 4. Comparative Susceptibility of Selected Kentucky Bluegrass Cultivars to Two Common Constituents of Smog

CULTIVAR	OZONE	PAN
Newport	Slight	Slight
Fylking	Slight	Slight
Park	Moderate	Slight
Prato	High	Slight
Windsor	Moderate	Moderate
Pennstar	Moderate	Moderate
Baron	Moderate	High
Merion	High	Moderate
Glade	Moderate	High

*From: Proceedings of the 1975 Turf and Landscape Institute, pp. 21-25.

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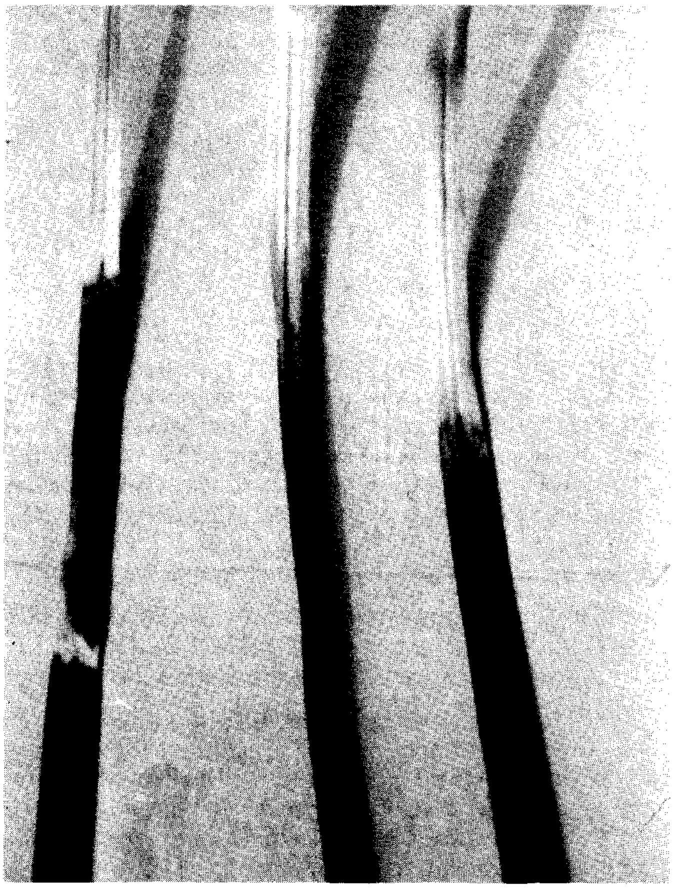

Figure 1. Blade tip injury to Kentucky bluegrass caused by ozone.

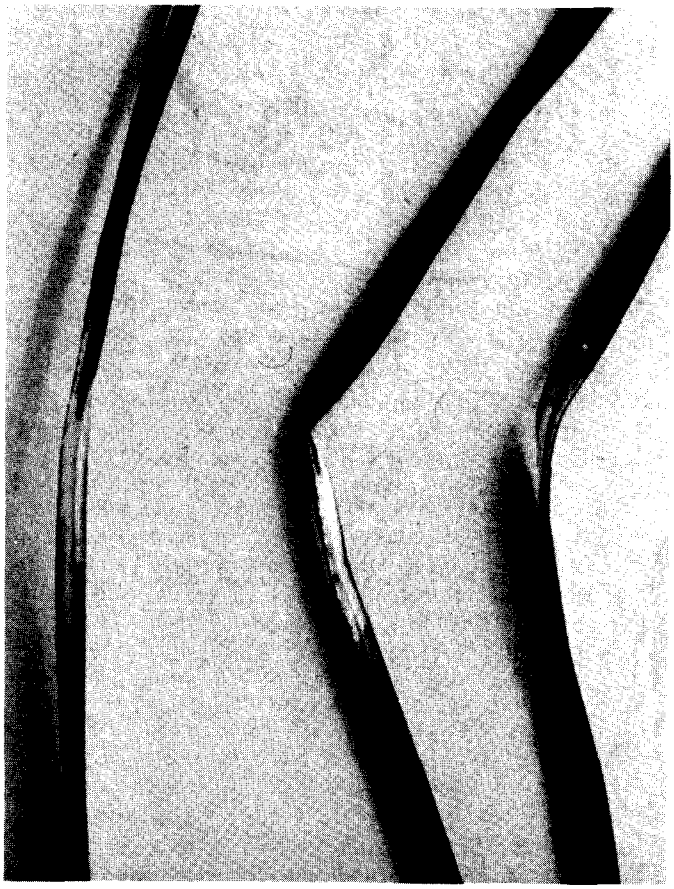

Figure 2. Midleaf injury to Kentucky bluegrass caused by PAN.

These results indicate that it may be possible to breed or select new cultivars which will be better adapted to urban environments where air pollution is common. However, it is not known as yet to what extent air pollution may affect general turf vigor and quality other than occasional discoloration. Air pollution may affect growth of plants which do not show any of the acute toxicity symptoms. Air pollution induced growth reduction and loss of vigor could be an important factor in turfgrass disease or other management problems. Studies are now underway seeking answers to these questions.

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CHEMICAL GROWTH OF GROUNDCOVER SAND SHRUBS*

Henry Hide **

There are two chemicals which are registered for growth of ground covers and shrubs in California. This discussion will deal with the effectiveness of these chemicals on different species as well as some information on new experimental chemicals which should achieve registration. The registered chemicals, Maleic Hydrazide (MH) and Maintain CF125 (Chlorflurenol), should be used in accordance with their label recommendations. Some effective uses of these chemicals will be shown which do not yet appear on the label. Until these new uses have been added to the label these treatments are not permitted.

*From; Proceedings of the 1975 Turf and Landscape Institute, pp. 16-17.

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Ground Covers

Approximately 17 years ago it was demonstrated that MH would effectively inhibit growth of ivy. Ground covers because of their generally low-growing nature. usually do not require control for height of growth. Exceptions, where height control is desirable, are around sprinkler heads, around adjoining trees and shrubs and occasionally with rosemary and baccharis where a lower overall height is desired. The primary need for growth control of the ground covers is to limit their lateral spread. Applications of growth control chemicals for ground covers are therefore generally only made on the borders where limiting growth is desired. They are applied in 3 to 6 foot bands as narrower applications have shorter effective periods of control because of untreated shoots growing through the treated zone.

In more recent years, Maintain CFl25 has been registered for ivy growth control. Thus, there are two chemicals CF125 and MH which may be used on *Hedra canariensis* and *H. helix.*

Another ground cover where chemical growth control is practiced is the iceplant, *Carfiobrotus edule.* Here only CF125 has proven effective and is appropriately registered. The label recommendation calls for a 4-pint rate. Our recent testing with CF125 on Carpobrotus (1) has ind:-cated that 1 or 2 pints with 0.1% X 77 was very effective and that a spray program with the treatments repeated 2 or 3 times during a year gave maximum retardation. The most successful spray program is therefore one where the treatments are repeated as the plants begin to resume growth. The result is a longer time of suppression with the minimum use of chemical.

Experimental testing for growth control of *Rosemarinus officinalis "Prostratus"* has demonstrated that high concentrations of chemicals are required to gain growth suppression. MH has been more effective than CF125. An experimental chemical Atrinal has also shown a desirable response. The outlook is thus good for a chemical to develop for use on this plant. It is possible that treatments of entire plantings may prove to be desirable since Rosemary frequently becomes too high and pruning exposes woody stubs which are slow in regrowing to a uniform green cover.

Baccharis pilaris (Dwarf Coyote Bush) is responsive to low concentrations of CF125. Two years of testing have given effective growth control at between 50 and 100 ppm. Registration has not been obtained for CF125 use on Baccharis.

Osteospermum fruticosum is now widely used in freeway and commercial landscaping. Experiments for border control of African Trailing Daisy have indicated that both CF125 and MH are effective. Desirable responses have been found at from 0.5 to 0.75% MH and from 0.03 to 0.04% CF125. Both of these chemicals eliminate flowering in the treated border for the period of growth control.

For the chemicals which do not influence flowering, Alar was not effective at a 1% level and Amcymidol gave some control at 0.1% concentration. The cost of the latter chemical eliminates its possible use. No chemical is now registered for use on Osteospermum.

Shrubs

The use of MH for growth control of shrubs is detailed in Bulletin 844 by Sachs et al. (2). The Maintain CF125 label recommendations list treatment for 13 shrubs.

There have been many successful commercial uses cf these growth inhibitors on several shrub species. These uses have been primarily in locations where there are large plantings of a vigorous species. Because of variabilitv in required concentrations, conditions of growth for timing of treatment and chemical specificity, a single chemical concentration for growth control is not possible.

Both MH and CF125 eliminate flowering which is often undesirable. Alar which permits flowering is effective but the treatment cost is excessive.

There are several experimental chemicals which could possibly reach the market within the next two years.

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UC TURF CORNER

*Victor A. Gibeault, Forrest Cress**

Golf Traffic Simukzted on Overseeded Turfgrasses

What effect does golf traffic have on establishment and performance of cool-season grasses overseeded on dormant bermudagrass putting greens?

Researchers in Florida have provided us with some answers by evaluating the effects of simulated golf traffic on 21 cool-season grasses overseeded into a Tifgreen bermudagrass putting green.

To simulate wear from foot traffic on putting greens under play, a self-propelled, water ballast roller with golf shoe spikes was used. Traffic intensities of 150 and 300 round of simulated golf traffic per unit area per day were

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selected for the study and compared with the no-traffic check plots.

In general, the Florida researchers report, those grasses that were most tolerant to traffic were those which had fast germination and establishment rates. The ryegrasses as a group were superior to the bentgrasses, bluegrasses, and fescues. As expected, many of the grasses performed well without simulated traffic, but major differences occurred under both traffic levels. Manhattan ryegrass was superior to all other grasses during the first four weeks of the test but was no better than most of the ryegrasses after eight weeks of daily traffic. The study was ended eight weeks after it began due to excessive competition from the bermudagrass.

("Effects of Simulated Golf Traffic on the Establishment and Performance of Several Overseeded Turfgrasses," by A. E. Dudeck and E. 0. Burt, University of Florida, Florida Turf, Vol. 8, No. 3, January 1975.)

Grass and Legume Responses to Soil pH

Rutgers University researchers have completed a study aimed at determining the responses of 19 varieties of grasses and legumes to soil pH ranging from 4.2 to 7.6 in field plots of a Freehold sandy loam.

Results of their research show that Pennlawn and Highlight red fescue had significant negative linear correlation in plant weights as soil pH increased from 4.2 to 7.6. All other grasses and legumes were inhibited in growth in the most acid soils.

In this Rutgers research, the reason for the ability of the red fescues to grow well in the most acid plots may be their low aluminum content as found in Pennlawn red fescue. The content of aluminum in Kentucky bluegrass and Manhattan perennial ryegrass increased as soil pH decreased below 5.5, but this response was not noted in Pennlawn. The toxic aluminum concentrations in these species are not known, the Rutgers researchers note.

("Responses of Grasses and Legumes to Soil pH," by A. J. Palazzo and R. W. Duell, *Agronomy Journal,* Vol. 65, Sept.-Oct. 1974.)

Relative Wear Tolerance of Turfgrasses Measured

A study was conducted recently at Michigan State University to develop methods for differentiating wear tolerance among turfgrass species and to compare the relative wear tolerance of seven cool-season turfgrasses.

The wear tolerance of the turfgrasses tested was determined for sled (foot-like) and for wheel (vehicular) wear injury. Four methods of evaluation were used: (1) visual rating of wear injury; (2) percent total cell wall content; (3) percent verdure; and (4) percent chlorophyll/unit area remaining after wear treatment.

The Michigan researchers found that wear tolerance differentiation among species for the four methods tested was in close agreement. However, percent verdure remaining was the preferred method for quantitatively evaluating wear tolerance differentials. It eliminated arbitrary decisions, they report, that were inherent in the visual rating system and required fewer procedural steps than either the percent total cell wall content or percent chlorophyll content determinations.

Manhattan perennial ryegrass was most tolerant to wheel wear; Kentucky 31 tall fescue and Merion Kentucky bluegrass ranked second; Pennlawn red fescue and Italian ryegrass were intermediate; Cascade chewings fescue and rough bluegrass ranked lowest.

Visual ratings indicated that Manhattan, Kentucky 31, and Merion were equallv tolerant of sled wear. However, Merion was the most tolerant of sled wear, according to ratings based on the percent verdure remaining after treatment. Manhattan and Kentucky 31 ranked second and third, respectively; Cascade chewings fescue and rough bluegrass were almost destroyed by the crushing and tearing action of the sled.

("Turfgrass Wear Tolerance Mechanisms: I. Wear Tolerance of Seven Turfgrass Species and Quantitative Methods for Determining Turfgrass Wear Injury," by R. C. Shearman and J. B. Beard, Agronomy Journal, Vol. 67, March-April 1975.)

IBDU Nitrogen Release Research

Use of slow-release and slowly soluble nitrogen fertilizer can cut a turfgrass manager's fertilization labor costs and also offers other advantages such as less risk of foliar burning than readily soluble materials.

Currently, there's much interest in isobutylidene diurea (IBDU), a synthetic organic condensation product of urea and isobutraldehyde. IBDU is a slow-release high-analysis material (theoretically containing 32.19% nitrogen with guaranteed analysis at 31%) which doesn't produce objectionable odors when moistened.

Research in progress at the University of Illinois is aimed at obtaining a better understanding of how IBDU behaves in different soils. Researchers there are attempting to characterize its nitrogen release rates in incubated soil samples at various soil pH levels and the release rates from its various particle sizes. This research eventually may result in a mathematical description of nitrogen release from IBDU which could be used for making accurate application rate recommendations.

One problem encountered to date in determining the effects of soil pH on release of nitrogen from IBDU is the change in soil pH which results from the release of nitrogen. The Illinois research findings show that when IBDU is added to a soil at a rate of about 1.5 pounds of nitrogen per 1,000 sq. ft. the soil pH is reduced as much as 1 pH units in about six weeks. Study results do show that rate of release are significantly greater in soil with an original pH of 5.7 than 7.7. Soil pH does appear to be a factor which must be considered when making IBDU application recommendations.

The Illinois work indicates that the release of nitrogen from 0.6 to 0.7 millimeter IBDU particles is complete in about six weeks. This rate compares with a 50 percent nitrogen release after 10 weeks for 1.7 to 2.0 millimeter particles.

During the Illinois IBDU studies, it has been noted that losses of available nitrogen occur. Why or how has not been determined nor whether losses would occur under field conditions.

("Slowly Soluble Nitrogen Fertilization," by T. D. Hughes, proceedings, 14th Illinois Turfgrass Conference, Nov. 29-30, 1973. Cooperative Extension Service, College of Agriculture, University of Illinois at Urfana-Champaign.)

Subirrigation of Bent Greens

Creeping bentgrass greens are very popular on golf courses in the desert climates of the Southwest because they provide high putting quality. However, management of creeping bentgrass, a cool-season grass, is especially difficult during the hot summer months.

Scientists at the University of Arizona Turfgrass Research Center began a study in 1972 of the merits of subirrigation of "Penncross" bentgrass. A plastic barrier was used two feet below the surface. Three irrigation treatments were compared:

(1) Subirrigation and nitrogen fertilization from a static water table one foot below the surface;

(2) a water table that was allowed to fluctuate between about four inches (after subirrigation) and 20 inches (after depletion by turf);

(3) sprinkler irrigation.

Washed mortar sand and a 2: 1 :l mixture of washed sand, sandy loam soil and Loamite were compared in conjunction with the irrigation treatments.

In August and September, when the cumulative effects of temperature stress were greatest, growth was significantly higher from the sand. The more consistent growth, which is obtained on sand, is a definite advantage.

Subirrigation from a static water table gave poorest growth. The combination of subirrigation and sand with a fluctuating water table provided the most uniform growth of all treatments.

Sprinkler-irrigated turf was consistently darker green than turf irrigated by either of subirrigation techniques. The lighter color of the subirrigated turf appears to have been caused by a nitrate toxicity that resulted from a lack of oxygen in their soils.

Total root weights were greater in the sand than in the mix. The largest difference was found under sprinkler irrigation which had 60 percent more roots in the sand. Average root weights were 26 percent greater for sub irrigation by the static water table and 55 percent greater for subirrigation by fluctuating water table than were root weights for sprinkler-irrigated turf.

Distributions and depths were poorest in the sprinkler-irrigated mix where 98 percent of all roots were in the top two inches and the longest roots extended to only eight inches.

("Subirrigation of Bent Greens in the Southwest," by G. V. Johnson, The Golf Superintendent, August 1975.)

Kentucky Bluegrasses, Red Fescues Evaluated For Sod Production

Rhode Island researchers recently studied some popular varieties of Kentucky bluegrass and red fescue, singly, blends, and in mixtures, for commercial sod production.

"Merion," "Baron," "Fylking," and "Pennstar" Kentucky bluegrasses and "Jamestown," "Highlight," and "Pennlawn" red fescues were examined for their compatibility in mixtures, rate of establishment, durability and rate of sod knitting.

Here's what they found: All cultivars and mixtures provided acceptable visual turf quality. Baron, Pennstar, Baron-Pennstar, and Merion-Baron provided the highest turf quality ratings. Tensile strength wasn't altered by use of improved Kentucky bluegrass cultivars alone or in blends. Red fescue significantly reduced sod strength when included in mixtures with Kentucky bluegrass. This reduction did not affect handling of the harvested sod when up to 67% red fescue by weight was included in the seed mixture. Jamestown and Highlight red fescue produced significantly more tillers than Pennlawn and were better able to compete with Merion Kentucky bluegrass.

Cultivar compatibility in mixtures was evaluated by turf quality ratings and tiller counts, rate of establishment, durability as measured by tensile strength of harvested scd, and rate of sod knitting after transplant.

("Evaluation of Kentucky Bluegrass and Red Fescue Cultivars for Sod Production," by R. H. Hurley and C. R. Skogley, University of Rhode Island, Agronomy Journal, Vol. 67, January-February 1975.)

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