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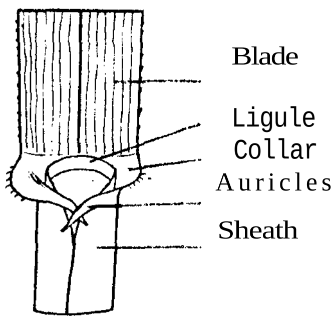
TALL FESCUE INCALIFORNIA

*V. A. Gibeault, V. B. Youngner, D. R. Donaldson**

Tall fescue *(Festuca arundimcea Schreb.),* a native of Europe, is a coarse textured, cool season grass that is used for turf throughout the United States. It is best suited for athletic fields, parks and playgrounds, airfields, and other high use and/or minimum management facilities where the coarse texture is acceptable.

Tall fescue can be described as folows (3) : blades-rolled in bud; flat, 5-10 mm wide, glossy on underside; ligule-membranous, truncate (as though squarely cut across) 0.2-0.8 mm; auricles — small, with pubescence (hairy) ; collar — broad, pubescent on margins; sheath — round, smooth, split, reddish at base. Tall fescue is a bunch-type, perennial grass. Occasional plants have a few short thick rizomes, however, the majority tiller only at the base. Figure 1 depicts the vegetative characteristics.

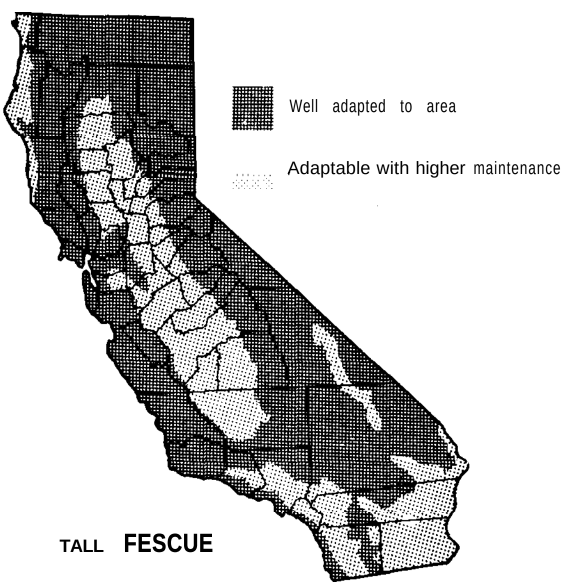
FIGURE 1



ADAPTATION AND GROWTH

Tall fescue is well adapted to much of California (Figure 2) (4)) in fact it is the most widely adapted cool season grass that is used in this state. It is especially useful in transitional zones because of its tolerance to warm summer temperatures and its ability to perform well in relativelv cool, but not severe, winter conditions. As the map indicates, there are better adapted grasses for use in the true warm season zones.

FIGURE 2



Tall fescue responds well to various soil types, however, it is best adapted to fertile, moist, fine textured soils. Its optimum growth occurs in a pH range of 5.5 to 6.5 (1) but it will produce a suitable turf from pH 4.7 to 8.5. Tall fescue tolerates wet soils and extended submersion. It is therefore frequently used in drainage ways where a grass cover is needed. This species is more tolerant of saline soil conditions than many other cool season grasses, as is shown in the comparative ranking below (5).

SALINITY TOLERANCE

High — Improved bermudas
Common bermuda
Creeping bentgrass
Zoysia
St. Augustine
Tall fescue
Perennial ryegrass
Meadow fescue
Red fescue
Kentucky bluegrass
Colonial bentgrass
Low — Dichondro

Tall fescue is characterized by a relatively dense and extensive root system. Rooting depths of 2.5 feet are not uncommon when correct mowing, irrigation and fertilization practices are employed. The root system has the ability to penetrate, and survive in, compacted soils. This characteristic gives the species a greater tolerance to a high traffic-poor soil facility. The deep rooting pattern positively influences the species' ability to survive periods of prolonged drought. Also, it allows for infrequent but deep irrigation which is a desirable management tool.

Under normal management and environmental conditions in California, tall fescue is not usually affected by the common turfgrass diseases, however, in other areas, susceptibility to brown patch *(Rhizoctonia solani),* Fusarium patch *(Fusarium nivale)* Helminthosporium spp., and other diseases have been noted (2). Insect damage is also uncommon in California.

Tall fescue is considered a minimum management grass, as previously indicated. Although a good response is observed with monthly applications of 0.4 to 1.0 pounds of nitrogen per 1000 square feet (1), adequate growth and appearance are achieved with much lower annual rates. A comparison of the tall fescue nitrogen requirement to other commonly used turfgrass species is given below (4).

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NITROGEN FERTILITY REQUIREMENT

cow ↑

Zoysia
Red fescue
Toll fescue
Meadow fescue
St. Augustine
Kentucky bluegrass
Perennial ryegrass
Improved bermudas
Common bermuda
Colonial bentgrass
Dichondra
Creeping bentgrass

High ↓

Other characteristics that account for its minimum management requirement include reduced thatch production (no rhizomes or stolons, therefore seldom needs vertical mowing) and the ability to grow in heavy, compacted soils so the need for aeration is minimized.

Tall fescue is among the most tolerant turfgrass species to heavy wear and its recovery from normal foot and equipment traffic is adequate. However, if the sward is severely injured by tearing or mechanical damage, recovery is poor. The absence of rhizomes or stolons makes "fill in" a slow, and oftentimes impossible, process which, if not corrected by overseeding, will result in a clump or bunchy appearance.

VARIETIES

Alta

In California, Alta is the most widely used cultivar of tall fescue for turf. It was released in 1940 from the cooperative breeding program of Oregon Agricultural Experiment Station and the Crops Research Division, ARS. It was selected for forage quality and yield (3).

Kentucky 31

This variety was released by the Kentucky Agricultural Experiment Station in 1940. It was selected as an improved, naturalized plant type from a Kentucky farm. Kentucky 31 is the most commonly used turf variety in Eastern United States (3).

Other varieties of tall fescue have been released however are not extensively used for turf in California. These would include Fawn, Goar, Kenmont, Kenwell and Traveler. As one can gather, little work on varietal improvement strictly for turfgrass characteristics has been done. Turfgrass managers must therefore rely on forage types for available plant material. Fortunately a few public and private organizations have embarked on a turf type tall fescue improvement program.

MANAGEMENT

Establishment — A seeding rate of 10 pounds per 1000 sq. ft. is common. Significantly lighter rates can result in a clumpy turfgrass stand. The species generally has excellent seedling vigor.

Mowing — Turf must be maintained at 1.5 to 2.5 inches. Closer mowing reduces shoot density to an unacceptable level and weed invasion frequently becomes a problem. The frequency of mowing is dependent on the growth rate which, in turn, is dependent on cultural practices and the climatic conditions. As mentioned, vertical mowing is generally not practiced because of limited thatch, however, when done, the appearance and vigor is improved.

Irrigation — The appearance of tall fescue greatly depends on an adequate irrigation program during the dry months. Water use rates are similar to other turfgrass species, ranging from an average daily use of approximately 0.04 inches in January to 0.20 inches in July (at Santa ,Ana, California). Because of the relatively deep root system, the frequency between irrigations can be extended, especially if deep watering is practiced.

Fertilization — Although tall fescue has a relatively low nitrogen requirement, regular feeding at six to eight intervals will give a good appearance. However, as with all fertilizer practices, the time and rate of fertilizer application is dependent on the growth rate of the species, the appearance desired, and the level of management that can be given.

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THE ECONOMICS OF OVERSEEDING AND COLORIZING DORMANT BERMUDAGRASS

John Van Dam*

For periods of three or more months, warm season grasses go dormant in most areas of California. The most common methods used to mask the dormant turf include overseeding or the application of a colorant. It was the objective of this economic study to compare the cost involved in these methods. The costs given here are intended as guidelines; they do not represent absolute costs for all facilities.

Colorants

The cost and labor figures represent applications made with a bulk tank sprayer. The pressure approximated 40 pounds at the spray nozzle with size 8 flat T-jets set at 20-inch intervals. The boom was mounted on the rear of the spray tank at a height of 21 inches above the ground. Travel was three miles per hour. Following the initial coverage of the area, a subsequent pass was made at right angles to the first pass. There was a 14-minute wait between first and second passes.

These per-acre costs of colorant application made on dormant bermudagrass areas would not have been possible without the cooperation of the Park Division of the

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City of Bell, the San Bernardino Public Golf Course, the Arrowhead Country Club of San Bernardino, the B l Air Country Club of Los Angela, and cooperating suppliers of materials.

Overseeding

The cost and labor figures are based on the timed overseeding of golf course fairways and city parks. The areas were flail mowed, aerated, swept, and seeded.

TABLE 1. PER ACRE COSTS FOR COLORIZING DORMANT BERMUDAGRASS

Date: February 1972

No depreciation or interest computed; cost is nominal and equipment is assumed to exist for other purposes.

Based on: 2 Acres Golf Course Fairways
1 Acre City Park Facility

Labor: $3.75/hr.

Operation	Annual hours	costs Labor	Equipment	Material	Combined Total Costs per acre	
Preparation:						
Mowing[1]	0.2	$0.75	$0.80		$1.55	
Sweeper[2]	0.7	2.65	1.05		3.70	
Helper	1.0	3.75	—		3.75	
						$ 9.00
Cultural:						
Colorized[3]	0.5	1.90	1.10	Colorant 8 gal. @ $9/gal.=$72.00	75.00	
Helper	1.0	3.75	—		3.75	
						78.75
						$87.75

[1]A light mowing with fairway mower to provide uniformity in appearance. Operational cost of $3.90/hr. based on 2,080 hours of annual use.

[2]Removal of clippings, litter and debris. Operational cost of $1.47/hr. based on a sweeper capacity of 0.68 acre per hr.

[3]100 gal. tank sprayer boom equipped with dripless size 8 flat T-jet nozzles. Covers 7,000 sq. ft. in 4% min.

TABLE 2. PER-ACRE COSTS FOR OVERSEEDING DORMANT BERMUDAGRASS (Cyndon dactylon)

Date: February 1972

No depreciation or interest computed as costs are nominal and equipment is assumed to exist for other purposes.

Based on: 200 acres on golf courses and 5 acres of city parks.

Labor: $3.75/ hr.

Operational tasks	Annual hours	Labor	Equip-ment	Material	Material Costs	Costs per acre Combined Total	
Preparation'							
Mow	16.0	$60.00	$62.40			$122.40	
Sweep	1.0	3.75	1.50			5.25	
Spike	2.0	7.50	2.60			10.10	
							$137.75
For establishment'							
Seeding	0.5	1.90	1.10	Seed 400 lbs. @ lOc/lb.	$40.00	43.00	
Irrigation	1.0	3.75	—	Water, 1 acre-inch	7.25	11.00	
							54.00
Following establishment3							
Irrigation	8.0	30.00		Water, 8 acre-inches	58.10	88.10	
Fertilizer	1.0	3.75		850 lbs. 1644	34.00	39.10	
Mow	1.6	6.00				8.35	
							135.55
							$327.30

[1]Mowed with flail mower in several directions at an operational capacity of 4 hrs./acre @ $3.90/hr.; spiked at a 2-hour-per-acre capacity @ $1.30/hr.

[2]Seeding capacity 3-acres-per-hour at combined tractor and equipment cost of $1.45/hr. For uniform seed distribution, half allotted seed spread in one direction and remainder in a direction crossing the first. The area lightly irrigated to prevent germinating seeds and seedling from drying out before becoming established.

[3]Based on weekly irrigation of l-acre-inch-per-week for minimum of 8 weeks; mowed weekly during that period at capacity of 2 1/2-acres-per-hour @ $3.90/hr. Costs increased substantlally as overseeding period extended beyond the d-week study period.

CALCULATING IRRIGATION NEEDS*

*By Victor A. Gibeault***

The time has arrived in turfgrass irrigation procedures that one can no longer solely rely on his artistic judgment in the design, installation or use of sophisticated irrigation equipment. Instead, decisions must be based on knowledge of the grass being grown, the characteristics of on-site soil, the water use rate, and, ultimately, the resupply of water by irrigation to insure an adequate soil-water reservoir.

If one observes turfgrass "in profile" it then becomes more obvious that the infiltration of water into the profile, the percolation of water through the profile, the depth of roots in the profile, and the water holding capacity of the soil are important in determining the design and use of an irrigation system.

Infiltration and Percolation

Water must first enter the soil through the process of infiltration. Variation in infiltration rates are dependent on soil texture, topography, thatch accumulation and its degree of wetness, and level of compaction. As an example, a relatively level, sand-based putting green with limited thatch can have infiltration rates ranging from 1 to 20 inches per hour. In contrast, a clay loam soil on a rolling, moderately compact fairway can have an infiltration rate of 0.10 inches per hour or less. Irrigation equipment must be designed and used with knowledge of this ultimate infiltration rate. Water applied at rates in excess of the infiltration rate results in ponding and/or runoff with all problems there relating.

If a soil is of uniform texture and acceptable depth, percolation rates are seldom a limiting factor in irrigation practices. Variables such as shallow soils or layered soils of different texture, however, must be considered if they are a component in the water reservoir profile.

Water availability

All soils contain two water fractions when viewed in terms of plant absorption. The first, unavailable water, is tightly held by mineral and organic particles and is unavailable for plant use. The second, available water, is that amount the plant can absorb for transpiration and metabolism.

The amount of available and unavailable water differs with different soil textures. The following table (2) gives a general relationship between soil moisture characteristics and soil texture.

Table 1. Available and unavailable water per foot of soil.

	Inches per foot	
Soil Texture	**Available**	**Unavailable**
Sand	0.4-1.0	0.2-0.8
Sand' and Loam	0.9-1.3	0.9-1.4
Loam	1.3-2.0	1.4-2.0
Silt Loam	2.0-2.1	2.0-2.4
Clay Loam	1.8-2.1	24-2.7
Clay	1.8-1.9	2.7-2.9

*Article from: 10th Annual Sprinkler Irrigation Conference Proceedings. 3541. 1972.

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These data are approximate but nevertheless give an insight into the amount of water that is available per unit depth for plant use. This information, in conjunction with a knowledge of root depth, gives an indication of the amount of water that should be resupplied by irrigation if plants reach water stress.

Turfgrass Species

When considering turfgrass in profile, it must be emphasized that turf species naturally differ in their rooting ability. In addition to species difference, root depths are also influenced by seasonal fluctuations (greatest root growth occurs in fall, winter and spring), management practices such as mowing and fertilization, and on-site soil compaction. The best method to determine root depth in a particular location is through physical inspection, however, a general guide to root depths would be as follows:

Table 2. Approximate root depths of cool and warm season turfgrass under normal use conditions.

Cool Season Grasses	Root Depth
Kentucky bluegrass	6"-1.5
Creeping bentgrass	4"-1.5
Colonial bentgrass	4"-1.5
Red fescue	6"-1.5
Tall fescue	1.5'-4.0'
Annual bluegrass	l"-4"
Warm Season Grasses	
Bermudagrass	W-8.0
Zoysiagrass	15'-8.0'
St. Augustinegrass	1.5'-8.0'

As can be seen, rooting depths vary from a few inches to many feet. Since it should be the objective of irrigation to supply water throughout the root system, root depths and soil texture play an important role in both the amount of water to apply per irrigation time, and the irrigation frequency.

Up to this point I have been concerned with water entry into the soil, the water holding characteristics of soils, and the rooting depth of turfgrass species. With this background one can picture water use more clearly.

Water Use

Water is used or lost from a turfgrass area in four ways: percolation below the root system, runoff because of a differential between application and infiltration rates, evaporation from the soil surface and plant leaves, and transpiration/metabolism through the plant. Evaporation and transpiration generally describe water use and, together, they are referred to as evapotranspiration. Water use by evaporation is influenced by the following factors:

1. Radiation-As the total radiant energy that reaches the turf increases, there will be an increase in water use (more water use during long clear days than short, overcast days).
2. Temperature- Water use increases as temperatures increase.

3. Wind-As wind increases, water use increases.
4. Humidity-Water use decreases as humidity increases.

Other factors such as rainfall, soil fertility, growing season. etc., also influence water use. The question then arises, "how do we calculate the amount of water that can be expected to be used from a turfgrass sward?" The answer is important both for the designer, who needs peak monthly water use data for design purposes, and for the user, who should have an idea of water use under environmental conditions.

Calculating Water Use

To obtain a method that could be used to calculate anticipated water use in a given area, the Blaney-Criddle (1) formula was tested. The Blaney-Criddle formula relies heavily on total radiant energy, expressed as daytime hours, and temperature, expressed as mean monthly temperature in °F.

It has been a very successful tool for predicting water use of agricultural crops in areas with low humidity. The seasonal formula is expressed as U=KF where:

U=Water use in inches (consumptive use)
K=A calculated seasonal coefficient
F=Sum of monthly factors (f) where
f = t x p
t is the mean monthly temperature in ° F
p is the monthly percentage of daytime hours which is based on latitude.

The monthly consumptive use can be calculated as follows :

u=k f
u=monthly water use in inches
k=a calculated monthly coefficient given in Bulletin #1275 (1)
f=txp
where t=mean mean monthly temperature in ° F and p=mean percentage of daytime hours.

By using U.S. Weather Bureau information for the Santa Ana, California, area, the Blaney-Criddle formula was calculated to estimate water use at the Santa Ana location. The results are presented in Table 3.

To provide a method of comparing the results obtained from the Blaney-Criddle analvsis to water use at the Santa Ana location, information derived from a trial at the U.C. South Coast Field Station, Santa Ana, was used. The Field Station trial, under the direction of Drs. V. B. Youngner and A. W. Marsh was initiated with the objectives of evaluating various irrigation schedules for warm and cool season turfgrass species. The water use data for this discussion were obtained from a particular irrigation treatment that, in turn, were derived from a Bureau of Plant Industries (BPI) evaporation pan.

Table 4 provides a comparison between the estimated water use (Blaney-Criddle U) with that derived from evaporation data at Santa Ana. As can be noted, the two are close. The greatest divergence can be observed in the months of May and June. Interestingly, these are overcast months at the Santa Ana location which could account for high values for the Blaney-Criddle formula. For practical use, both should be corrected for beneficial rainfall.

Because of the close relationship shown between the estimated Blaney-Criddle consumptive use and the evaporation derived water use, individuals concerned with calculating water use rates on a monthly or yearly basis could consider Blaney-Criddle. It must be emphasized, however that the Blaney-Criddle formula is an estimate. Any extensive unnatural conditions such as high winds (Santa Ana conditions), long periods of cloud cover or higher than normal humidity, can, and do, alter the estimated water use rates significantly.

The question then arises, "Is this method of calculating water use applicable to the turf manager who is interested in daily water use figures?" Unfortunately the most this information can provide is a "ballpark" idea of water

TABLE 3. BLANEY-CRIDDLE FORMULA APPLIED TO TURFGRASS WATER USE IN SANTA ANA

Month	Mean Temp. (T)	Day Hours (P)	Use Factor (F) T x P	Use* Coeff ic't (K)	Use Inches FxK	Avg. Rain	Effect. Rain	Use Minus Rain	Irrigation Requirement
Jan.	53.0	7.09	3.76	.24	.90	2.90	2.61	-1.71	Actual Use / % efficiency — Dependent on Irrigation Efficiency
Feb.	54.5	6.90	3.76	38	1.43	3.14	2.57	-1.14	
Mar.	57.1	8.35	4.77	.55	2.62	2.16	1.94	0.68	
Apr.	60.6	8.79	5.33	.70	3.73	1.33	1.26	2.47	
May	63.8	9.71	6.19	.88	5.45	0.25	0.25	5.20	
June / July	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Aug.	72.3	9.33	6.74	.92	6.20	0.05	0.05	6.15	
Sept.	71.0	8.36	5.93	.80	4.74	0.18	0.18	4.56	
Oct.	65.6	7.90	5.18	.72	3.72	0.51	0.51	3.21	
Nov.	59.5	7.02	4.18	.54	2.26	1.19	1.13	1.13	
Dec.	55.1	6.92	3.81	.35	1.33	2.83	2.55	-1.22	
Total					40.34				

*from reference (1)

TABLE 4. A COMPARISON OF TURFGRASS WATER NEED CALCULATED FROM EVAPORATION AT S.C.F.S. (SANTA ANA) AND THE BLANEY-CRIDDLE WATER USE ESTIMATES

	Calculated from Evaporation				
Month	**1967**	**1968**	**1969**	**Avg.**	**Blaney-Criddle U**
Jan.	1.36	1.53	.98	1.29	.90
Feb.	2.24	1.30	1.18	1.57	1.34
Mar.	2.48	2.88	2.65	2.67	2.62
Apr.	2.87	4.39	3.72	3.66	3.73
May	4.87	4.71	3.45	4.34	5.45
June	4.43	5.15	3.35	4.31	5.99
July	6.39	6.10	5.94	6.14	6.67
Aug.	6.00	5.96	6.32	6.09	6.20
Sept.	4.17	4.72	4.28	4.39	4.74
Oct.	4.21	2.98	3.78	3.66	3.72
Nov.	1.68	2.05	2.72	2.15	2.26
Dec.	1.46	1.46	1.91	1.61	1.33
			Total	41.88	43.04

Table 5. The relationship between a BPI evaporation reading and water use for warm and cool season turfgrasses.

	Water Use		
BPI evaporation reading per unit time	**Warm Season Grasses Winter**	**Summer**	**Cool Season Grasses Year around**
1 **inch**	.75"	.85"	.85"

use during the particular time of year. As an example, water use rates on a daily basis for the month of January would average .03 to .04 inches where as for the summer months, use data would indicate an average of .20 - .22 inches per day. Extreme variation from such averages could be expected on a daily basis because of changes in environmental conditions.

There is a method that turf managers can rely upon to more accurately obtain daily use figures. It has been shown from the U.C. South Coast Field Station study that warm season grasses have water use rates approximating 75% of the Bureau of Plant Industries evaporation pan during the winter months and 85% during the late spring, summer, and early autumn months. Water use for cool season grasses approximates 85% of the evaporation readings throughout the year. The following table provides an example in this regard.

With this relationship in mind, turf managers who want a more precise understanding of daily turfgrass water use under their environmental conditions can install a Bureau of Plant Industries pan to obtain the needed information.

Conclusion:

Turfgrass irrigation, like all turf management, is the combining of science and art. Like any science, the important factors must be segmented into recognizable parts that are comprehended. Like any art, the end product results from a vision and a working understanding of the media.

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TWO NEW BOOKS OF INTEREST

THE BIOLOGY AND UTILIZATION OF GRASSES By Drs. V. B. Youngner and C. M. McKell

This book is the result of a symposium on grass biology held at Riverside, California. The meeting brought together outstanding specialists to provide an in-depth review of grass biology. The book not only covers the fundamental concepts of grass evolution, genetics, morphology, physiology, and ecology, it also emphasizes the relationship of these basic concepts to the use of grasses for forage, turf, and rangelands.

The early chapters present basic information on grass evolution and genetics and discuss practical grass breeding problems. The next chapters are concerned with the vegetative growth and development of both the seedling and the mature plant, followed by chapters which discuss grasses primarily from an ecological viewpoint. The book then presents both basic and applied information on soils and mineral nutrition as related to grass growth. It closes with discussions of the effects of defoliation (mowing or grazing), carbohydrate reserves, physiology of flowering, seed and grass production.

This book will be of interest to students and workers in agronomy and agriculture sciences.

CONTENTS:

G. Ledyard Stebbins, The Evolution of the Grass Family.

B. Lennart Johnson, Polyploidy as a Factor in the Evolution and Distribution of Grasses.

A. A. Hanson, Breeding of Grasses.

J. A. Long Developing Superior Turf varieties.

R. Merton Love, Selection and Breeding of Grasses for Forage and Other Uses.

C. M. McKell, Seedling Vigor and Seedling Establishment.

William R. Kneebone, Breeding for Seedling Vigor.

Carton H. Herbel, Environmental Modification for Seedling Establishment.

D. Koller and J. Kigel, The Growth of Leaves and Tillers in Oryzopsis Miliacea.

J. R. Goodin, Chemical Regulation of Growth in Leaves and Tillers.

Horton M. Laude, External Factors Affecting Tiller Develpoment.

O. T. Denmead, The Microclimate of Grass Communities.

R. M. Endo, The Turfgrass Community as an Environment for the development of Facultative Fungal Parasites.

James R. Watson, Effects on Turfgrass on Cultural Practices in Relation to Micro-climate.

S. K. Jain, Population Interactions, Diversity, and Community Structure.

Raymond A. Evans and James A. Young, Competition within the Grass Community.

Lewis H. Stolzy, Soil Aeration and Gas Exchange in Relation to Grasses.

Daniel Hillel, Soil Moisture Control for Maximum Grass Response.

O. R. Lunt, Problems in Nutrient Availability and Tox icity.

Roy L. Goss, Nutrient Uptake and Assimilation for Quality Turf vs. Maximum Vegetative Growth.

V. B. Youngner, Physiology of Defoliation and Regrowth.

D. N. Hyder, Defoliation in Relation to Vegetative Growth

Dale Smith, Carbohydrate Reserves of Grasses.

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TURFGRASS: SCIENCE AND CULTURE By James B. Beard

This book emphasizes the principles, decisions and methods of operation in turfgrass culture. It contains a summary of significant research and utilizes illustrations for added clarification. It gives equal attention to cool and warm season turfgrasses, discussing their characteristics, adaptation, use, cultural requirements, and varieties. A third of the book is devoted to an in-depth discussion of environmental factors affecting turfgrasses and their culture.

CONTENTS:

THE TURFGRASSES

Cool and Warm Season Turfgrasses: Adaptation, Use, Culture, Characteristics. Turfgrass Communities: Competition, Mixtures and Blends, Compatability Within a Turfgrass Community, Turfgrass Communities of the Warm and Cool Climates.

THE TURFGRASS ENVIRONMENT-Light, Temperature and water

Light Quality, Absorption, Duration and Intensity. Turfgrass Shade Ecology. Modifying the Shade Environment. Modifying Temperatures. High and Low Temperature Stress and Injury. Prevention of Low Temperature Kill. Wilt Prevention and Control. Drought Resistance. Winter Desiccation Prevention. Physiological Drought and Flood Injury Prevention. Scald Prevention and Treatment.

THE TURFGRASS ENVIRONMENT-Air, Soil and Traffic

Preventing Wind Erosion. Preventing Salt Spray and Atmospheric Pollution Injury. Correcting Soil Acidity-Liming Procedures. Correcting Moderately Alkaline Soil Conditions. Correcting Soil Salinity and Sodic Problems. Soil Modification: Materials, Procedures, Mixing Procedures. Composting Procedures, Traffic Control. Divot and Ball Mark Injury.

MOWING

Cutting Height. Scalping. Mowing Frequency Turfgrass Species Influences on Mowing Effectiveness. Clipping Removal. Mowing Equipment. Grain. Types of Mowers. Growth Regulation. Chemical Growth Regulators.

FERTILIZATION

Essential Nutrients. Nutrient Deficiency Symptoms. Fertilizers. Tissue Tests for Nutrient Deficiency. Soil Tests. Selecting a Fertilizer. Use of Fertilizers. Timing and Application Procedures for Fertilizing. Establishment Fertilization.

IRRIGATION

When to Irrigate. Irrigation Frequency and Quantity. Water Source. Water Quality. Irrigation Methods: Overhead Irrigation-Sprinkler Heads, Sprinkler Systems Control, Water Distribution Lines. Design and Installation of the System. Surface Irrigation. Subsurface Irrigation. Surfacants. Wetting Agents.

CULTIVATION AND THATCH

Cultivating Techniques: Coring, Groving, Slicing, Forking, Spiking, Rolling, Topdressing, Thatch Control, Vertical Mowing.

ESTABLISHMENT

Soil Preparation : Control of Persistant Weeds, Surface and Subsurface Drainage, Application of Fertilizer and Lime. Seeding: Seed Quality, Planting Procedures. Mulching. Seed Germination. Post Germination Care. Sodding. Plugging, Stolonization and Sprigging. Renovation and Reestablishment. Winter Overseeding.

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