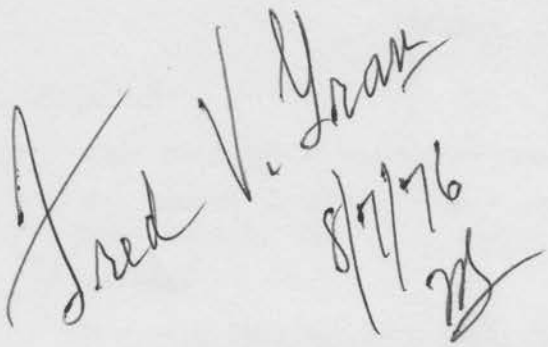
PROCEEDINGS

47 TH

ANNUAL CONFERENCE
MID-ATLANTIC ASSOCIATION OF
GOLF COURSE SUPERINTENDENTS

January 5-6, 1976

HOLIDAY INN
WOODLAWN, MARYLAND



The Proceedings of the 47th Annual Conference of the Mid-Atlantic Association of Golf Course Superintendents were published through the combined effort of the University of Maryland Cooperative Extension Service, the University of Maryland Department of Agronomy and the Mid-Atlantic Association of Golf Course Superintendents.

Manuscripts were edited by John R. Hall III, Turfgrass Specialist, Department of Agronomy, University of Maryland.

Program Planning Committee

Alex D. Watson, President, MAGCS

Robert J. Orazi, Chairman

William J. Emerson

Ronald E. Hall

John R. Hall III

George B. Thompson

PROGRAM

Monday, January 5

10:00 a.m. Call to Order - Main Ballroom

Mr. Robert J. Orazi, Superintendent, Hunt Valley Golf Club, Hunt Valley, MD

Welcome

Dr. J. R. Miller, Chairman, Department of Agronomy, University of Maryland, College Park, MD

President's Message and Welcome

Mr. Alex D. Watson, Superintendent, Sparrows Point Country Club, Baltimore, MD

10:30 a.m. "The Impact of Pesticide Use on Turfgrass Management Programs"

Dr. Alfred J. Turgeon, Assistant Professor, Department of Floriculture & Ornamental Horticulture, University of Illinois, Urbana, Illinois

11:15 a.m. "Carbohydrate Stress and Its Relation to Mowing, Fertilization and Irrigation"

Dr. Roy E. Blaser, Professor, Department of Agronomy, Virginia Polytechnic Institute & State University, Blacksburg, VA

1:30 p.m. Afternoon Session - Main Ballroom

Presiding:

Mr. Virgil G. Robinson, Jr., Superintendent, Andrews AFB Course, Washington, DC

"Identification and Control of Aquatic Weeds"

Mr. John E. Gallagher, Associate National Program Director, Turf and Aquatics, Amchem Products, Inc., Ambler, PA

2:15 p.m. "Do You Know Your Trees?"

Dr. Frank R. Gouin, Associate Professor, University of Maryland, College Park, MD

3:15 p.m. Panel Discussion

Bluegrass and Ryegrass - Strengths and Weaknesses

Bluegrass

Dr. John R. Hall III, University of Maryland, College Park, MD

Ryegrass

Dr. Henry W. Indyk, Rutgers - The State University, New Brunswick, NJ

Practical Experiences

Mr. Angelo Cammarota, Hobbits Glenn Golf Course, Columbia, MD

Mr. Lee C. Dieter, Washington Golf and Country Club, Arlington, VA

Mr. B. Edwin Wilson, Twin Shields Golf Club, Dunkirk, MD

7:30 p.m. Dinner - Main Ballroom

Toastmaster:

Mr. Vincent Bagli, Sportscaster, WBAL Sports

Introduction of Guests

Special Awards

Installation of Officers

Tuesday, January 6

9:25 a.m. Presiding:

Mr. William J. Emerson, Superintendent, Eagles Nest Golf Club, Timonium, MD

9:30 a.m. "Identification and Control of Turfgrass Insects"
Dr. John Lee Hellman, Survey Entomologist, University of Maryland, College Park, MD

10:15 a.m. "Increasing the Efficiency of Nitrogen Fertilization"

Dr. Henry W. Indyk, Professor, Rutgers - The State University, New Brunswick, NJ

11:00 a.m. Turfgrass Research Updates

Dr. John R. Hall, University of Maryland

Dr. Alfred J. Turgeon, University of Illinois

Dr. Roy E. Blaser, Virginia Polytechnic Institute & State University

1:30-3:30 "The Diversified Superintendent"

Panel Moderator:

Mr. George Thompson, Columbia Country Club

"Irrigation Renovation"

Mr. Alex D. Watson, Sparrows Point Country Club

"Golf Course Construction"

Mr. Robert J. Orazi, Hunt Valley Country Club

"Tennis Court Maintenance"

Mr. Robert C. Miller, Suburban Country Club

"Horticultural Plantings on the Golf Course"

Mr. J. Paul Barefoot, U. S. Soldiers Home

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THE IMPACT OF PESTICIDE USE ON TURFGRASS MANAGEMENT PROGRAMS

A. J. Turgeon
Assistant Professor, Department of Horticulture
University of Illinois

Pesticides are applied to turfs for a variety of purposes including weed control, disease prevention and reduction of destructive insect populations. Under some conditions, pesticide application may also result in observable turfgrass injury. However, deterioration of turf following pesticide use may not be easily traceable to a specific chemical unless causal relationships between specific pesticides and specific types of injury are clearly established. These relationships are frequently obscured in situations where injury only results following repeated use of a particular pesticide. For example, repeated applications of chlordane or dieldrin resulted in thatch development in an otherwise thatch-free Kentucky bluegrass turf (1). This was attributed to the earthworm inhibiting effects of the insecticides. A higher incidence of leaf spot (Helminthosporium vagans) disease was evident in the thatchy turfs during cool, wet periods in mid-spring. Mechanical removal of the thatch in one-half of each plot resulted in a substantially lower incidence of leaf spot in subsequent years. The contribution of thatch to the disease proneness of a turf is well documented; many disease-causing organisms can survive as saprophytes living off dead organic materials in the thatch and then infect living plants when environmental conditions become favorable.

The herbicides, Tri-calcium arsenate and bandane, were also found to be thatch-inducing pesticides when applied annually for at least two years to Kentucky bluegrass (2). In addition to higher leaf spot disease incidence, the thatchy turfs were found to be more prone to wilting during mid-summer stress periods. This was due, at least in part, to the restriction of roots to the thatch layer. A test to determine earthworm populations in the soil revealed no earthworms in plots treated with the thatch-inducing herbicides while untreated plots averaged over 50 worms per square meter. Results from more recent studies of the effects of these herbicides on the activity of soil microorganisms suggest that the capacity of some microorganisms to produce enzymes for decomposing organic debris is reduced by calcium arsenate and bandane. The thatch inducing effect of these herbicides may not be completely explained by their inhibition of earthworms. They may also inhibit the activity of an array of soil organisms that are important in decomposing organic debris and, thus, preventing thatch development.

Measurements were made to determine if the use of thatch-inducing herbicides indirectly affected soil physical properties. Field results showed that infiltration was substantially reduced in the thatchy turfs; however, this was not due to the hydrophobic properties of thatch or to the existence of an interface between the thatch and the soil. The physical condition of the soil under the thatch was different than that of the soil from the thatch-free plots. Presumably, this difference was

due to the restriction of most root and rhizome growth to the thatch and the relative absence of these plant organs in the underlying soil compared to the untreated plots. The absence of earthworm activity in the pesticide-treated plots was probably related to the lower water infiltration rates measured.

Laboratory measurements of hydraulic conductivity yielded lower values in soil cores from the calcium arsenate-treated plots. Bulk density was higher and shrinkage upon drying was less in soil cores from the calcium arsenate-treated plots. Results from these tests are consistent with the infiltration results in that they clearly show that application of thatch-inducing pesticides can indirectly affect soil physical properties. These effects increase the turfgrass manager's dependancy on irrigation, fertilization, cultivation and pesticide use in order to sustain the turf at an acceptable quality level during the growing season. Thus, a decision to implement a program of tri-calcium arsenate application for controlling annual bluegrass or other pests should be carefully considered to determine if the anticipated results warrent subjecting the turf to the apparently detrimental effects determined from this study.

Literature Cited

1. Randell, R., J. D. Butler and T. D. Hughes. 1972. The effect of pesticides on thatch accumulation and earthworm populations in Kentucky bluegrass turf. HortScience 7(1):64-65.
2. Turgeon, A. J., R. P. Freeborg and W. N. Bruce. 1975. Thatch development and other effects of preemergence herbicides in Kentucky bluegrass turf. Agronomy Journal 67:563-565.

CARBOHYDRATE STRESS AND ITS RELATIONSHIP TO MOWING, FERTILIZATION AND IRRIGATION

R. E. Blaser
University Distinguisyed Professor
Department of Agronomy
Virginia Polytechnic Institute and State University

I. THE FIGHT TO EXIST

In this discussion the so-called cool season species such as ryegrass, bluegrass, bentgrass, Poa annua, and others in this category will be called temperate grasses; a second category of grasses such as bermuda and zoysia will be referred to as semitropical grasses. Weedy grasses and broadleaf weeds also fit these categories, for instance, crabgrass is semitropical and quackgrass is temperate.

Pure stands of temperate species are usually invaded by other temperate or semitropical species to give objectionable characteristics. Likewise, bermudagrass or other semitropical species are invaded by temperate species during cool months and by semitropical ones during summer. Among mixtures of temperate species, such as bluegrass and ryegrass, shifts in the proportions of these species occur. Such "fights" among turf species are continuous processes.

Why invasion? It occurs because of differences in growth rate among the species with changing environments such as temperature, moisture, nutrients, soil pH, and light. Technically there is an aggressive competition; the species that grow the fastest under given soil, climatic, or biotic factors invade and force out the slower growing plants. Such invasion of one and subduing of another species is influenced by cultural practices and environmental factors.

II. REGROWTH OF A GRASS

With repeated mowing of turfgrass those that regrow to form dense sod and quickly exclude invaders are desirable. Regrowth after mowing of any grass is influenced by two primary factors: (a) Soluble carbohydrate. (simple sugars and meterials such as starch and fructosan that degrade into simple sugars) They are not a part of the cell structure but furnish energy for survival and production of new plant tissue. Hereafter we will refer to these as total non-structural carbohydrates (TNC). The TNC's are stored in excess amounts in the basal tissues and to a lesser extent in roots and leaves. (b) Leaf area. Growth occurs at a maximum rate when enough leaves are present to intercept 90% of the light. Thus, for actively growing plants in favorable environments, leaf area is much more important than TNC. On the other hand, after periods of prolonged dormancy caused by low temperatures or drought, where leaf canopies have disappeared, TNC's are needed energy sources for new growth. The formation of new shoots, new leaves, stolons, rhizomes,

and roots depends on TNC which may be obtained directly from newly synthesized TNC by leaves or from those stored in plant tissues. The newly synthesized TNC by leaves for immediate reutilization and the TNC stored in basal plant tissues are both very important for shoot and root growth to maintain healthy vigorous grasses.

III. TNC CONTENT AS RELATED TO GROWTH AND PHOTOSYNTHESIS

The TNC reserves in basal plant tissues alternately increase and decrease depending on their demand for developing new shoots, leaves, and roots, and the rate of TNC fixation by photosynthesis. During fast growth, rapid cell division and expansion, the demand for energy from TNC often exceeds fixation by photosynthesis. The amount of TNC stored in tissue depends on the rate of fixation by photosynthesis as compared to the energy requirements for growth. Opposing and dynamic processes occur in plants--photosynthesis fixes carbon dioxide into various sugars while respiration and growth processes utilize TNC, carbon dioxide being a by-product.

Requirements for optimum rates of photosynthesis and growth and respiration differ for each plant. Let us look at environmental factors as they cause a shifting to high and low TNC. We first consider only the temperate grasses.

A. Temperature:

Assume a favorable environment except for temperature which ranges from cool to warm. With cool 35 to 50°F temperatures photosynthesis of temperate species remains medium to high, whereas growth and respiration remains low; hence, TNC's increase rapidly because photosynthesis exceeds respiration. When shifting to high 90 to 100°F temperatures photosynthesis remains in the medium-low category; the very high respiration causes a sharp decline in TNC. At medium temperatures respiration also exceeds photosynthesis, causing declines in TNC as the need for TNC in growth exceeds the amount photosynthesized.

These temperature relationships can be associated with seasons. The cool season grasses grow (respire) slowly during the autumn season causing TNC's to accumulate to a high content because photosynthesis remains high as compared to respiration. During the spring months when temperatures get warm, topgrowth with favorable fertility is very high, causing sharp declines in TNC because root and shoot growth requirements are high. Hence, during the spring season the growth requirements for TNC (respiration) exceeds the amount fixed by photosynthesis, thus the sharp decline. During the warm summer months, temperatures in sods are higher than at the 5 ft. level under normal weather conditions. High summer temperatures cause temperate species to be inefficient in photosynthesis because of photorespiration where some fixed TNC's are respired during photosynthesis. Also, high temperatures stimulate cell division and expansion (high respiration); hence, with inefficient photosynthesis there are sharp declines in TNC.

B. Nitrogen Fertilization:

It is important to consider how low and high nitrogen fertilization influences TNC, when all other environmental factors are favorable. Nitrogen availability controls cell division and expansion and rate of growth; high N rates stimulate the rate of photosynthesis but the respiration requirements for the rapid cell division and expansion exceeds photosynthetic output, causing sharp declines in TNC. Low N reduces photosynthesis but growth (cell division and expansion and respiration) is reduced more than photosynthesis; thus, TNC increases rapidly with low N.

Now consider temperature and nitrogen relationships for temperate grasses. When applying N during the late September-October season, photosynthesis is high because of the combined favorable effect from nitrogen and cool temperatures whereas growth is slow. Thus, N applications during the cool autumn-winter and early spring causes TNC to increase or remain high because photosynthesis is higher than respiration. This is a sound reason for autumn nitrogen fertilization.

Conversely, liberal nitrogen during the summer months, when temperatures are high, causes very sharp increases in respiration while photosynthesis remains in the medium range thereby reducing TNC to a low level and causing stress.

C. Irrigation

If you refer back to A and B you conclude that any factor that stimulates growth (respiration) causes lower TNC with slow or static growth. Thus, liberal irrigation with all other factors favorable causes sharp declines in TNC as respiration requirements for TNC are higher than fixation of sugars by photosynthesis. Irrigation does increase rate of carbon dioxide fixation (photosynthesis); however, with moisture and all factors favorable, respiration exceeds photosynthesis causing soluble carbohydrates to decline. All of our data show higher soluble carbohydrates with some moisture stress than under favorable moisture conditions. With low N regimes, excessive irrigation would not stimulate growth.

D. Semitropical Species:

What has been said for nitrogen fertilization and irrigation in regard to TNC is similar for semitropical and temperate species. However, high temperatures do not appear to hinder TNC accumulation in semitropical species. The semitropical grasses are generally efficient in photosynthesis as photorespiration does not occur as with temperate grasses. As temperatures increase, photosynthesis nearly parallels respiration; thus, severe depression in TNC at high temperatures does not occur for semitropical species. However, at the cooler temperatures well above frost, TNC for the tropical species is higher than at the high temperature. High N and

favorable moisture for fast summer growth causes reductions in TNC; however, TNC stress in summer is not apt to be as serious in semitropical grasses as in temperate grasses.

Tropical weedy grasses such as crabgrass are similar to bermudagrass and zoysia in adaptation.

IV. MOWING

Mowing strongly influences TNC and interacts with nitrogen fertilization practices at various seasons. Very frequent and close mowing of bluegrass reduces leaf area and photosynthetic potential thereby reducing TNC as compared with a recommended mowing height from 2 to 3½ inches. Frequent close mowing reduces the root depth and rhizomes because TNC, the energy source for their development, is reduced. When nitrogen fertilizer is added during the growing season this stimulates growth and further reduces the TNC. Temperature also has a strong influence upon TNC. For example, mowing closely during the summer months means that there is much less sod residue to moderate the temperature with close as compared with a taller sod residue. Thus, with close mowing and high summer temperatures there is severe TNC stress. Now suppose a homeowner cuts the bluegrass from a 2-inch canopy height to a 1-inch sod residue during the summertime when temperatures are high and uses nitrogen fertilizer liberally. This combined effect causes very high respiration and utilization of TNC as compared with the rate of TNC fixation by photosynthesis.

Introducing the crabgrass problem in bluegrass lawns complexes the problem. Crabgrass, a semitropical grass, responds to high temperatures and nitrogen fertilization. Close mowing management of bluegrass means little sod residue, much light reaching the soil surface; hence germinating crabgrass seedlings grow rapidly. Maintaining close mowing during late spring and summer, coupled with nitrogen fertilization, stimulates the crabgrasses compared to the bluegrasses as crabgrass is much better adapted to the high summer temperatures. With adequate N the prostrate spreading stolons and leaves of crabgrass take over and shade out the bluegrass. Now assume that the homeowner waters lightly almost every day as some homeowners do. The shallow rooted crabgrass is thus benefited as compared to the deep rooted bluegrass so favorable surface moisture, high nitrogen, and close mowing causes crabgrass lawns.

An ideal management to exclude or minimize crabgrass invasion in bluegrass lawns is to cut closely in the late September-early October season when the soil is moist and apply nitrogen liberally. Close cutting removes dead thatch sod material; also, this would be a good time to remove the surface thatch. Close mowing in autumn removed most of the crabgrass. During this cool season, crabgrass grows slowly or not at all. Ideally such close mowing with nitrogen fertilization should be done during a hurricane-type of rain so as to have everything favorable during the autumn season for bluegrass to develop new shoots to form a dense sod. Subsequently, during the autumn months the mowing heights may be gradually raised to 1-1/4 inch

and then 1-1/2 inch. Additional nitrogen may be applied during November and December. Ideally, 1 to 1.5 lbs./1000 sq. ft. of nitrogen should be used in late September-early October with no more than 1 lb. of N/1000 sq. ft. in November and December. This now completes the nitrogen regime for the entire year, except for a very light application of less than 1 lb. of N/1000 sq. ft. in late May.

Close mowing with N fertilization in fall develops new shoots giving thick dense beautiful green turf during autumn and winter when crabgrass dies. In the spring, mowing heights are raised up to a 2.5-inch residue by the date that crabgrass germinates, maintaining that height all summer. A dense sod with a high unmowed residue, excludes light at the soil surface so that germinating crabgrass seedlings are exterminated. During the summer months when the temperature is ideal for crabgrass growth, exclude nitrogen to restrict growth of crabgrass seedlings. A compromise is necessary and one should be satisfied with a slightly greenish-yellow bluegrass lawn during mid summer to exclude crabgrass. Such a semi-nitrogen starved situation is desirable since it keeps crabgrass from growing rapidly and maintains high TNC's during heat stress in summer.

When watering it is best to irrigate infrequently and to a depth of 12 inches. The soil surface dries out first, thus with infrequent irrigation shallow rooted crabgrass invasion is inhibited.

The nitrogen fertilization-mowing management relationships discussed also apply to bluegrass or bermudagrass dominance. Autumn and winter N and high summer mowing favors bluegrass. On the other hand, minimizing the presence of bluegrass or shifting of bluegrass-bermudagrass mixture to bermudagrass may be accomplished by liberal nitrogen fertilization from late May through mid August along with very close and frequent mowing leaving a 0.5 inch unmowed residue. Bluegrass with erect growing leaves is severely defoliated. The combination of severe defoliation, high nitrogen fertilization, and high summer temperatures depresses bluegrass for reasons given earlier.

Nitrogen fertilizer and irrigation should be controlled; growth should be slow. However, judicious growth to heal bare spots and compete against unwanted invaders is necessary. Maintaining a highly favorable environment for fast growth of established turf is objectionable. Such fast growth causes thatch, shallow roots, high mowing costs, diseases, low TNC, and poor physiological conditions and survival of temperate grasses during summer.

IDENTIFICATION AND CONTROL OF AQUATIC WEEDS

John E. Gallagher
Program Director, Turf and Aquatics
Amchem Products, Inc.

By the time of this presentation, some questions about using aquatic herbicides will already have been answered. Most primarily pertaining to label status, are concerned with whether we can use them in a manner consistent with EPA regulations, rather than whether they will work.

EPA is and will continue to be a part of our way of life. In terms of what we can do to control water weeds, EPA has a direct influence. Pesticides must be labeled and approved for use before we can take even the first step in aquatic weed control -- purchasing a herbicide.

Relatively few proprietary herbicides are available for aquatic weed control, and even these have little or no patent protection time left. Because of the high cost of registration clearance, new products are not being developed rapidly. These two factors -- cost and short-term protection -- do not encourage extensive research programs in the field of aquatic weed control.

Regardless of the above, weed problems do exist and at times must be taken care of. You would like to know just what you can do to solve your own weed problems.

First, you can operate on the premise that a product use that has Federal label registration is still legal. You should check to be sure the specific state has no additional restriction; states have the prerogative of being more restrictive in their approval for use.

Second, the following herbicides are still available for use unless their manufacturers have decided to give up the fight:

2,4-D -- many formulations: salts, esters, liquids, granulars.
Diquat -- liquid.
Endothall -- liquid and granular, aquathol and aquathol plus.
Dichlobenil -- granular.
Copper sulfate and organic copper formulations.
Simazine.
Diuron.
Fenac -- drawdown useage.
2,4-D + dicamba -- state label in Virginia

Assuming that you want to control aquatic weeds, what procedure do you follow?

A. Chemical control

1. Identify the weed problem and choose a material which lists the species on the label.

2. Be able to define and describe the body of water so application permits can be filled out. Under this heading, you will have to know where the treated water is likely to move. Once the water leaves your property, you have no control of it, but you are liable if the treated water causes damage or injury to downstream properties.

3. Obtain an application permit if required by the state. Most states require a permit for all waters except those exclusively within the property boundaries.

4. Treat your problem weeds, adhering strictly to the label directions. Read the entire label.

5. Things to worry about:

   a. Fish kill, if fish are to be maintained in the water being treated.
   b. Irrigation; unintentionally overdosing with certain chemicals in herbicide-treated water can be hard on bentgrass greens.
   c. Personnel making application; they must follow all safety pre-precautions.

B. Alternatives to chemical weed control

1. Mechanical. This includes everything from handraking along the shoreline to underwater cutters. In all instances, the vegetation must be removed to a disposal site.

2. Drawdown. This is a practice that is being revived. For weed control the most important part of the drawdown is the weather following water removal. It is drying which kills the weeds, not freezing.

3. Biological control. For this technique, the herbivorous fish White Amur (Ctenopharynogodon Idellus Val.) is a possible answer. It will tolerate low temperatures and other water extremes. It has a voracious appetite. Stocking rates of 40 or more 6-inch fingerlings per acre are needed to show effects. The fish's size partly determines the extent of weed control. There is considerable controversy over this biological control agent. Before you decide on this method, be very sure that your state game and fish people issue permits for its use. Most fishery biologists express a strong concern about the possibility of Amur reproduction. If they do reproduce, the probability of long-term detrimental effects on game fish could be real.

To summarize, let me list the key words. Identify weed problem, define water body, obtain permit. Application -- read label and abide by all cautions. Worry about fish kill, irrigation response, safety to personnel.

What you can do to help: let your members know about water weed control and lack of available products . . . keep records of all aquatic weed work set out . . . be prepared to pay more for what you have had in the past.

AQUATIC WEED CONTROL PUBLICATIONS

1. Aquatic Weed Identification and Control Manual. Price $2.50

   Published by: Bureau of Aquatic Plant Research and Control
   Florida Department of Natural Resources
   Larson Building
   Tallahassee, Florida 32304

   A complete discussion of aquatic weed control and identification. Covers all methods, chemical, biological and mechanical. It discusses application equipment, calibration and safety. It has color photos and text giving description and distribution.

2. State Weed Control Guide Free
   The 1975 Virginia Weed Control Guide

   Published by: Extension Division
   Virginia Polytechnic Institute
   State Extension Service
   Blacksburg, Virginia 24061

   A state weed control guide listing chemicals labeled for aquatic weed control. All states should have a similar publication.

3. Controlling Plant And Animal Pests In Farm Ponds With Copper Sulfate. Free

   Published by: Phelps Dodge Refining Corporation
   300 Park Avenue
   New York, New York 10022

   Discusses the use of copper sulfate for algae and aquatic plant control, dosage rates and calibration methods.

4. The White Amur For Aquatic Weed Control.

   Reprint from Weed Science, Vol. 20, No. 1, January 1972

   Write to: Dr. David Sutton
   Univeristy of Florida
   Agricultural Research Center
   Ft. Lauderdale, Fla. 33314

   Discussion of feeding habits and plant preferences.

DETERMINING POND VOLUME FOR AQUATIC WEED CONTROL

The volume of water in a pond or lake is determined by multiplying the surface acreage times the average depth.

1. For a square or rectangular shaped pond multiply the length times width times average depth.*

2. For a circular shaped pond multiply the total feet of shoreline by itself, divide by 547,390 and multiply by the average depth.

3. For ponds of less than one acre in size with uniformly sloped bottom, the volume in acre feet is determined by multiplying the surface acreage by 1/2 the maximum depth.

PPM

Herbicide concentration for aquatic usage is often expressed in terms of ppm (parts per million). This can be determined on a weight or volume basis.

1 lb. in 1 million lbs. of water = 1 ppm-W
1 gal. in 1 million gals. of water = 1 ppm-V

A surface acre one foot deep contains 325,850 gallons or 43,560 cubic feet of water and weight 2,718,144 lbs.

One gallon of water weighs 8.34 lbs. One cubic foot of water weighs 62.6 lbs.

2.7 lbs. active ingredient in one acre foot of water equals 1 ppm-W concentration.

Herbicide in pounds of toxicant need for a treatment equals the ppm concentration required x 2.7 lbs. times the acre feet.

Problem Submersed Aquatic

Control: 2 ppm compound X
Lake Size: 10 acres
Average Depth: 5 feet
Compound X is available as a 4 lb/gal. liquid or 20% granular formula.

2 ppm x 2.7 lb. x 50 acre ft. (5' depth x 10' surface area = 50 acre feet.)
5.4 X 50 = 270 lb. toxicant.
Liquid 4 lb/gal. 270 ÷ 4 = 67.5 gallon.
Granular 270 ÷ 20 = 13.5 x 100 = 13,500 lb. granular.

*Average depth equals the average of 15 uniformly spaced soundings.

Part of the above information was taken from the Phelps Dodge Refining Corporation bulletin, "Controlling Plant and Animal Pest in Farm Ponds with Copper Sulfate".

If pool surface is 10 acres, then 2000 lbs. of granules will be needed. 200 X 10 = 2000.

Granules are usually distributed by the broadcast method, but may be applied in a slurry of water.

Reprinted from WEEDS TREES AND TURF, January 1966.

CALCULATING THE APPROPRIATE AMOUNT OF AQUATIC HERBICIDES TO USE

Determining the amount of aquatic herbicide needed for weed control in pools (ponds, lakes) often is a troublesome and wasteful task if dosages are not calculated correctly. Incorrect application rates can mean too much or not enough herbicide may be used, and either poor control or an uneconomical treatment will result.

When recommendations on the label, or from agricultural stations, are given in gallons or pounds of toxicant per surface acre, the only measure needed to calculate a correct dosage is the surface area of the pool.

GALLONS of concentrate needed for treatment of a surface acre may be calculated as follows.

Formula:

$$\frac{\text{Recommended lbs. of toxicant per acre (A)}}{\text{Lbs. of toxicant per gal. of conc. (B)}} =$$

Gallons of concentrate needed for each acre (C).

Example

(A) = 10 lbs. of toxicant desired for each acre, according to approved recommendations.

(B) = 8 lbs. of toxicant per gallon of concentrate in the aquatic herbicide you are using.

(C) = $\frac{10}{8}$ = 1.25 gallons of concentrate needed for each acre.

If a pool surface is 30 acres, 37.5 gallons of concentrate will be needed (1.25 X 30 = 37.5 gallons). Water may be added to the concentrate to facilitate adequate coverage during application.

POUNDS of granules to apply for each acre, when recommendations are expressed in pounds of toxicant per surface acre, are calculated as follows. The actual percent of toxicant in the granules is given, by weight, on the label.

Formula:

$$\frac{\text{Recommended lbs. of toxicant per acre (X)}}{\text{Percent toxicant in granules (Y)}} =$$

Pounds of granules needed for each acre (Z).

Example

(X) = 30 lbs. of toxicant desired for each acre according to approved recommendations.

(Y) = Granules are 15% toxicant, or .15 lb. toxicant per lb. of granules, as stated on the label.

(Z) = $\frac{30}{.15}$ = 200 lbs. of granules needed for each acre.

DO YOU KNOW YOUR TREES?

Francis R. Gouin
Associate Professor
Department of Horticulture
University of Maryland

It has become increasingly apparent that the designers of golf courses have a very limited knowledge of tree species. The three most popular species of trees used for landscaping the fairways are Lombardy Popular, Weeping Willow, and pine. Of these three species, only the pine should be considered to be of any lasting value. The other two are inferior species because they are short lived, and messy.

Since golf courses are long term investments, greater care should be taken in selecting trees that will add interest and value to the property. Only trees that are long lived and require minimum care should be selected. To eliminate present and future failures, special attention should be placed on soil drainage conditions, and in selecting trees that can tolerate special problem areas. More trees are killed from having been planted in poorly drained soils than from having been planted in excessively well-drained areas. There have also been more trees killed from having been planted too-deep than from having been planted too-shallow. Therefore, to insure tree survival select the proper tree for the proper location and plant it properly.

Since poor soil drainage is the major cause of tree deaths, the following list of trees have been divided into two separate groups. Group A includes only trees that will grow on well-drained soils; while Group B includes trees that will grow in both well drained and poorly drained soils. To further assist you in selecting the proper trees, the estimated mature heights as well as the most desirable soil pH are provided with each species.

A. Trees that will tolerate only well-drained soil conditions.

1. Nordman Fir, Abies nordmanniana 100', pH 5.0-6.0, narrowleaf-evergreen. A dense columnar evergreen tree with few pests. Mature trees often develop rounded tops giving the tree a gum-drop appearance.
2. Amur Maple, Acer ginnala 20', pH 5.5-6.5, deciduous. A small but upright rounded tree with dense branching. Produces green inconspiuous but fragrant flowers in June, and attractive red foliage in the fall. An extremely winter-hardy tree.
3. Paperbark Maple, Acer griseum 25', pH 5.5-6.5, deciduous. It has a rounded but rather open habit of growth producing light shade. The cinnamon-brown, exfoliating, paper-thin bark give this tree outstanding fall and winter landscape interest. It is not widely grown because it is difficult to propagate.

4. European Hornbeam, Carpinus betulus 60', pH 5.5-7.0, deciduous. A pyramidal tree when young, but becomes rounded at maturity. It has good dark-green summer foliage and provides dense shade. There are several cultivars available.

5. Ironwood, Carpinus caroliniana 36', pH 5.5-7.0, deciduous. The ideal tree for that difficult hole. Its hard and sturdy trunk will withstand the beating on any golf club. It has a dense rounded habit of growth and frequently seen with multiple trunks. It also developes orange-red fall colors.

6. Deodar Cedar, Cedrus deodara 125', pH 5.0-6.5, narrowleaf-evergreen. A very graceful pyramidal tree with pendulous branches. It's evergreen needles often occur in bunches along the stem. It is one of the most disease and insect resistant plants on the market. There are also several other species of cedars on the market that should be given landscape consideration.

7. Eastern Redbud, Cercis canadensis 30', pH 5.5-6.5, flowering-deciduous. Redbuds come in two colors, white and pink. Redbuds flower in May and produce interesting heart-shaped leaves. It has an irregular flattop, open habit of growth and grows in either full sun or partial shade.

8. Lawson False Cypress, Chamaecyparis lawsoniana 100', pH 5.5-7.0, narrowleaf-evergreen. This evergreen has scalelike foliage and is often mistaken for arborvitae. Depending on variety, their habit of growth is a slender to broadly pyramidal tree. Recommended for use as a tall screen.

9. Flowering dogwood, Cornus florida 40', pH 5.5-7.0, flowering-deciduous. Depending on varieties, dogwood flowers are white, creamy-white, pink, pink-white and red. Double-flowering and single-flowering varieties are available as well as fastigiate, pendulous and variegated foliage forms. Dogwoods grow well in either full sun or in partial shade. The trick to growing dogwoods without difficulty is to plant them very shallow and only in well drained soils, and prune them severly immediately after transplanting.

10. Japanese Dogwood, Cornus kousa 21', pH 5.5-7.0, flowering-deciduous. This dogwood differs from our native dogwood in that it flowers after the leaves have developed in mid June. The trunk is also more resistant to dogwood borers. In late summer it produces raspberry like red fruit which contrast well with the lush-green foliage.

11. Cornelian Cherry, Cornus mas 24', pH 5.5-7.0, flowering-deciduous. Not a cherry, but the earliest flowering dogwood on the market. To encourage early golfing, plant this tree where its bright yellow flowers will be fully appreciated in early April. This plant has a habit of growth similar to the flowering crabapple without the messy fruit. Once established, this tree requires little attention because it is resistant to most disease and insect pests.

12. Smoke-bush, Cotinus coggygria 20', pH 5.0-6.5, flowering-deciduous. This plant can be grown either as a large shrub or as a small tree. Guaranteed to add summer color to any golf course landscape. Depending on variety, the large purple or white flowers appear in mid summer and remain on the plant until early fall. The foliage of the purple flowering variety is purplish-green.

13. Cockspur Thorn, Crateagus cris-galli 36', pH 6.0-7.0, flowering-deciduous. Washington Hawthorn, Crataegus phaenopyrum 30', pH 6.0-7.0, flowering-deciduous. Because these trees develop 1 to 3 inch long thorns, they are seldom vandalized. Both species produce attractive clusters of white flowers in the spring and clusters of red berries in the fall. They have a rounded habit of growth with dense branching.

14. Cryptomeria, Cryptomeria japonica 150', pH 5.0-6.5, narrowleaf-evergreen. A narrow pyramidal tree with spreading whiplike branches. It is relatively free of diseases and insects and makes an excellent screen when grown in rows.

15. Dove Tree, Davidia involucrata 60', pH 5.5-6.5, flowering-deciduous. It has a broadly pyramidal habit of growth and produces dense shade. In mid May it produces a one inch ball of yellow stamens flanked by 2 bracts resembling a white dove. A very attractive tree when in flower; however, yearly flowering cannot be guaranteed.

16. Russian Olive, Eleagnus angustifolia 20', pH 5.0-6.5, deciduous. This wide spreading tree has an open habit of growth and attractive gray-green foliage. It is a very vigorous tree and will grow in a wide variety of soils. It can be grown either as a small tree or a large shrub. It is highly recommended because it is relatively maintenance free.

17. Green Ash, Fraxinus pensylvanica lanceolata 60', pH 6.0-7.0, deciduous. This tree has a dense-rounded habit of growth with lush greensummer foliage and brilliant yellow fall color. If given a choice, select the seedless varieties.

18. Ginkgo, Ginkgo biloba 120', pH 6.0-7.0, deciduous. Depending on the variety you select, the habit of growth may be rounded, fastigiate, or pendulus. Regardless which form you select only buy grafted male plants. Female plants produce fruit that is obnoxious and nauseating. Sexing of the seedlings cannot be done until the plants are 10 to 12 years old.

19. Common Honey-locust, Gleditsia triacanthos 135', pH 6.0-7.0, deciduous. There are approximately 12 varieties of Honey-locust available with shapes varying from rounded to fastigiate. All of the species are moderately fast growing and produce light summer shade. Most of the varieties have thorns except inermis.

20. Mountain Silverbell, Halesia monticola 90', pH 5.0-6.5, flowering deciduous. The Mountain Silverbell has small bell-shaped flowers that can be either white or pink depending on the variety. It has a pyramidal to rounded habit of growth with rather coarse, open foliage. There are no serious insects or diseases that affect this tree.

21. Chinese witch-hazel, Hamamelis mollis 30', pH 5.0-6.5 flowering-deciduous. Vernal Witch-hazel, Hamamelis vernalis 10', pH 5.0-6.5 flowering-deciduous. To provide winter color for those winter golfers, try growing some of these witch-hazels along the fairways. Depending on weather conditions, they often start blooming in December and continue until March. They will grow in either full sun or partial shade. They produce attractive summer foliage and are generally free of diseases and insects.

22. Idesia, Idesia polycarpa 45', pH 5.0-6.0, deciduous. A narrow pyramidal tree with interesting coarse leaves similar in appearance to Catalpa. Idesia is of special interest in the late fall and early winter with its large, loose grape-like clusters of bright red berries hanging from the ends of the branches.

23. Eastern red-cedar, Juniperus virginiana 90', pH 5.0-7.0, narrow-leaf evergreen. Our native red-cedar comes in a variety of shapes and colors. It can be used to make an excellent maintenance-free screen providing care is taken to select varieties that have natural resistance to bag-worms and spidermites. The habit of growth of red-cedar is from columnar to densely pyramidal. Its scale-like evergreen foliage can vary from dark-green to blue-green.

24. Golden-rain Tree. Koelreuteria pahiculata 30', pH 5.0-6.5, flowering-deciduous. Once established, the Golden-rain tree is a rather fast growing plant. It has a flat-topped habit of growth and produces large upright, pyramidal clusters of small, yellow flowers in early summer. This tree has absolutely no fall foliage color.

25. Crape-myrtle, Lagerstroemia indica 20', pH 5.5-6.5, flowering-deciduous. Grown either as a small tree or a large shrub, the Crape-myrtle has both summer and winter interest. Depending on varieties, the large lilac clusters can be white, pink, red and all shades of lavendar from mid summer to early fall. During the winter months, the exfoliating bark is of special interest. The only serious problem with this plant is powdery mildew during the last few weeks of flowering.

26. Tulip Tree, Liriodendron tulipifera 150', pH 5.5-6.5, deciduous. This broadly pyramidal tree developes massive branches and its leaves are uniquely shaped. In mid June it produces greenish-yellow tulip-shaped flowers which frequently go unseen. Once established it has a moderately fast rate of growth. Although aphids frequently infest this species in late summer, they appear to do little harm.

27. Star Magnolia, Magnolia stellata 20', pH 5.0-6.5, flowering-deciduous. Available in either white, pink or red, the flowers appear in mass over the entire plant in mid April. However, to avoid frost damage, locate the plants on the north-side of a wind varrier to delay flowering. It has a mounded to shrub like habit of growth with dense light-green summer foliage.

28. White, Norway, or Colorado spruce, Picea 90-'150', pH 4.5-5.5, narrowleaf-evergreen. Although spruce has been used extensively, there have been an increasing number of problems associated with them in recent years. Both spruce-gall aphids and spider mites have become yearly problems on these species and must be controlled if these plants are to remain healthy and attractive.

29. White, Red, Scotch or Japanese Black Pine, Pinus 75'-100', pH 5.5-6.5 narrowleaf evergreen. Pines have long been a favorite of landscapers. Their long evergreen needles are attractive the year-round and their habit of growth is different and interesting. However, in recent years there has been an increasing number of problems associated with pines. Air pollution has caused considerable damage to white pine near metropolitan areas and pine tip moth and pine shoot-moth have caused considerable damage to young growing pines. If pines are to be selected as a landscape plant every effort should be made to select species that are resistant to air pollution and to protect young plants from insect damage.

30. Plane Tree, Platanus occidentalis 90', pH 5.0-6.5, deciduous. Although our native plane tree can be seen growing along many of our highways, it is susceptible to a twig blight. Having a choice, select the Oriental Plane tree because it is resistant to twig blight and has the same attractive white, thick trunk and broad rounded habit of growth.

31. Higan cherry, Prunus subhirtella 30', pH 5.5-6.5, flowering-deciduous. There are two well known varieties of Higans cherry. The Autumn-Flowering cherry and the Weeping Higans cherry are the most popular. The Autumn-Flowering cherry produces pink flowers in the fall as well as in the spring, while the Weeping Higans cherry flowers only in the spring but has a weeping habit of growth. Both varieties are resistant to the flat-head peach borer.

32. Douglas-fir, Pseudotsuga menziesii 150', pH 4.5-6.0, narrowleaf evergreen. This densely pyramidal tree has just started to gain in popularity here in the east in recent years. It is slow in getting established, and when young it does not branch heavily without considerable pruning. However, time appears to correct many of these early difficulties.

33. Bradford Pear, Pyrus calleryana 'Bradford' 40', pH 5.5-6.5, flowering-deciduous. This has become one of the most popular street trees in the east. Its dense rounded habit of growth has made it ideal for planting beneath powerlines, and its heavy and long blooming period in the spring as well as its red to glossy scarlet fall foliage have helped to make it popular. However, this plant can only be propagated by budding and there has been some difficulties with the graft-union as the plant approaches maturity.

34. English Oak, Quercus robur 75', pH 4.5-5.5, deciduous. Most of the oaks have a history of being slow growing but long-lived. However, with regular fertilizing, the rate of oaks can be accelerated. One oak that would be ideal for dividing fairways with minimum space is the Fastigiate English oak. It has the same habit of growth as the Lombardy Poplar, grows rapidly when fertilized, and lives to a ripe-old-age.

35. Black Locust, Robinia pseudoacacia 75', pH 5.0-7.0, flowering-deciduous. A native plant frequently seen growing along the roadsides. It is an open upright tree. Its pendulous clusters of fragrant pea like flowers open in early June. However, in July and August, it frequently becomes infested with leafminers causing all of the leaves to turn brown.

Japanese Pagoda Tree, Sophora japonica 75', pH 5.5-7.0, flowering-deciduous. This tree is recommended because of its summer flowering habit. Its large pyramidal upright clusters of pea-like, white flowers appear in August. The tree itself has a rounded, wide-branching habit of growth. It is a moderately fast growing tree.

37. Little-leaf Linden, Tilia cordata 90', pH 5.5-6.5, deciduous. Usually a slow growing tree with a densely pyramidal habit of growth. The dense, compact dark green folige is striking when compared to other deciduous trees. There are 4 varieties available and all are resistant to most insects and disease.

38. Canada Hemlock, Tsuga canadensis 90', pH 4.5-5.5, narrowleaf-evergreen. An outstanding plant when used either as a specimen plant or planted in rows to form a screen. Because it is a shallow-rooted plant, it must be planted very shallow, and it will only thrive in well drained soils. Once it is well established it is resistant to most insects and diseases.

39. Augustine Elm, Ulmus americana 'Augustine', 100' pH 5.5-6.5, deciduous. This fast-growing columnar form of elm, has grown in popularity since the loss of our common american elm. Although it was thought to be resistant to the Dutch-Elm disease, there have been some indications that weak trees are susceptible. However, new disease resistant varieties are now being observed and should become available within a few years.

B. The following list of trees prefer growing in well drained soils but will tolerate growing in wet soils providing they are planted very shallow, to enable their roots to adapt to new and more difficult growing conditions.

1. Red or Swamp Maple, Acer rubrum 120', pH 5.5-6.5, deciduous. This tree developes a rounded to somewhat pyramidal habit of growth. It is a moderately fast growing tree once it becomes well established. Its fall foliage is a brilliant red.

2. River Birch, Betula nigra 90', pH 5.5-6.5, deciduous. Depending on the amount of competition from surrounding vegetation, the habit of growth will vary from pyramidal under crowded conditions to umbrella when grown in the open.

3. Leland False Cypress, Cupressocyparis leylandi 120', pH 5.0-6.5, narrowleaf-evergreen. A fast growing columnar evergreen with scale-like foliage. This plant forms a dense screen quickly and appears to be resistant to spider mites and bagworms. It is superior to the Lombardy Popular in appearance and hardiness, and when young it will grow up to 3 ft. per year under good growing conditions.

4. Franklin Tree, Franklinia alatamaha 30', pH 4.5-7.5, flowering-deciduous. Can be grown either as a small open pyramidal tree or as a large shrub. It produces large white flowers with yellow stamens in late summer and early fall. It will grow in a wide range of soil pH's. It also produces brilliant orange to red foliage in the fall. An excellent tree for fall floggers of golfballs.

5. American holly, Ilex opaca 45', pH 5.5-6.5, broadleaf evergreen. Foster #2 Holly, Ilex X 'Foster #2' 45', pH 5.5-6.5, broadleaf evergreen. Nellie R. Stevens, Ilex X 30', pH 5.5-6.5, broadleaf evergreen. Longstalk Holly, Ilex pedunculosa 30', pH 5.5-6.5, broadleaf evergreen. All of the above hollies produce red berries in the fall providing male pollinators are growing in the vicinity. Only the American hollies and Foster #2 are susceptible to the Holly Leafminer. The other 2 species are immune to this insect.

6. California Incense Cedar, Libocedrus decurrens 135', pH 5.0-6.5, narrowleaf-evergreen. Has a columnar habit of growth similar to the Leland False Cypress except that it has darker green foliage. This plant is also immune to most insects and diseases.

7. Sweet-gum, Liquidambar styraciflua 125', pH 6.0-7.0, deciduous. This broadly pyramidal tree has good-green summer foliage with attractive scarlet fall colors. It is rather insect and disease resistant providing the plants are not crowded. This is one tree that cannot tolerate competition.

8. Sweet Bay Magnolia, Magnolia virginiana 60', pH 5.0-6.5, flowering semi-evergreen. In the southern and coastal regions of the state, this plant is semi-evergreen, meaning that it looses its leaves in late winter. In the central and northern section it becomes deciduous. It produces very fragrant waxy white flowers in late spring. It is recommended here because it will grow well even in swampy soils.

9. Dawn Redwood, Metasequoia glyptostroboides 100', pH 4.5-6.0, deciduous. An upright pyramidal tree with a single straight trunk and grows rapidly. It produces light green summer foliage which turns a rust-color after the first frost.

10. Black Tupelo or Black Gum, Nyssa sylvatica 90', pH 5.5-6.5, deciduous. This dense branching pyramidal tree produces lustrous

leathery green leaves which turn a brilliant scarlet to orange in the fall. It is relatively free of disease or insect pests.

11. Bald Cypress, Taxodium distichum 150', pH 4.5-6.0, deciduous. This narrow-pyramidal tree is probably the last tree in the spring to develop its new leaves. Although it grows rather slowly, it thrives under swampy conditions.

BLUEGRASS AND RYEGRASS - STRENGTHS AND WEAKNESSES - KENTUCKY BLUEGRASS

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In recent years, there has been increased interest in the improved perennial ryegrasses in Maryland. There decreased leaf width and rapid germination has attracted many professional turfgrass managers. In spite of this upsurge in use of perennial ryegrass, the Kentucky bluegrasses remain the primary cool season turfgrass in the transition zone.

The University of Maryland Department of Agronomy currently conducts extensive variety trials at locations throughout Maryland. The variety trials conducted over the state contain over 65 individual cultivars and several combinations of cultivars. In the oldest trials, established in 1968 and containing 45 varieties, the top ten varieties after six years of evaluation are Warren's A-20, Warren's A-34, Merion, Georgetown, Birka, Fylking, NJE P-115, WK-412, Newport, and Sodco. These trials have been maintained at a 1½ inch mowing height and are evaluated for quality from April to November of each year. These same 45 varietieties have been maintained at a 2½ inch mowing height in another study and the top ten varieties out of 45 after six years of observation are Georgetown, Belturf, Vantage, K 8-146, Orion, K 8-144, Windsor, Sydsport, Warren's A-34 and Birka. Performance of Kentucky bluegrasses is influenced by mowing height.

These variety trials and extensive field observations provide us with information which makes it possible for the University of Maryland, Department of Agronomy, to provide general purpose turfgrass recommendations. The current recommendations are:

Kentucky Bluegrass

20-45% Certified Merion
20-45% Certified Kenblue or South Dakota Certified
20-40% Certified Adelphi, Certified Baron, Certified Birka, Certified Fylking, Certified Pennstar or Certified Sydsport

Creeping Red Fescue

10-50% Certified Pennlawn, Certified Jamestown

The Kentucky bluegrasses require a medium to medium-high intensity of culture including nitrogen fertilization ranging from 3 to 5 pounds nitrogen per 1000 sq. ft. per year. The most adequate mowing height in the transition zone is from 1 to 2 inches. Summer irrigation is often necessary on Kentucky bluegrass to prevent dormancy in the transition zone during the months of July and August.

The Kentucky bluegrasses exhibit several strengths in the transition zone which make them the most popular cool season turfgrass. Their medium texture and deep green color which maintains through the better part of the year is very desirable. They exhibit vigorous rhizome activity which

provides very high levels of recuperative potential. The Kentucky bluegrasses have a perennial root system which becomes more extensive with each year of proper management. They are apomictic which allows for reproduction without fertilization and makes possible their very uniform texture and growth habit. The Kentucky bluegrasses exhibit good low temperature hardiness and winter color and are capable of tolerating moderately wet soils.

Research being conducted at the University of Maryland is showing that the vigorous rhizome activity is essential to the divot healing capability of the Kentucky bluegrasses. In studies evaluating Kentucky bluegrasses and perennial ryegrasses for divot healing potential the Kentucky bluegrasses have provided two to three times the divot healing potential of the improved perennial ryegrasses. We have observed extreme drought tolerance in varieties of Kentucky bluegrass such as Merion, Vantage, Sodco, NJE P-59, combinations of Vantage and Victa, Parker Shirling No. 2, Kentucky 31 Tall Fescue, 90% Kentucky 31 Tall Fescue-10% South Dakota Certified, EVB 1036, 30% Merion-30% South Dakota Certified-30% Vantage-10% Jamestown and 30% Merion-30% South Dakota Certified-30% Fylking-10% Pennlawn Creeping Red Fescue. Exceptional resistance to Fusarium roseum has been observed in Vantage, Sodco, Parker Shirling No. 2, Kentucky 31 Tall Fescue, 90% Kentucky 31 Tall Fescue-10% South Dakota Certified, 30% Merion-30% Kenblue-30% Adelphi-10% Pennlawn Creeping Red Fescue, 30% Merion-30% South Dakota Certified-30% Victa-10% Pennlawn, 30% Merion-30% South Dakota Certified-30% Victa-10% Jamestown Creeping Red Fescue and combinations of 40% Victa and 60% Vantage.

The Kentucky bluegrasses have serious weaknesses in the transition zone which breeders are trying to improve through variety selection and hybridization. The establishment rate of the Kentucky bluegrasses is very slow compared to the improved perennial ryegrasses. Summer dormancy of the Kentucky bluegrasses necessitates irrigation in many instances to maintain good summer color. Relatively slow greenup rates for Kentucky bluegrass in the spring decrease the time when healing potential of these grasses can be provided. The Kentucky bluegrasses as a group of grasses generally lack shade tolerance. They have limited soil adaptation and are not tolerant of low soil pH. Fusarium susceptibility in the transition zone is a serious weakness of the Kentucky bluegrasses. The Kentucky bluegrasses have not been able to tolerate the lower mowing heights (less than 1 inch) quite as well as some of the improved perennial ryegrasses. Thatch buildup rates for some of the Kentucky bluegrasses have created extensive maintenance problems.

Although the Kentucky bluegrasses have severe shortcomings, they remain the primary cool season grass in the transition zone. There is currently no other grass capable of providing the levels of quality necessary for fairway turf at such a moderate maintenance cost.

"MY EXPERIENCES WITH BLUEGRASS AND RYEGRASS"

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I would like to take this opportunity to share with you some of my experiences with Kentucky bluegrasses and perennial ryegrasses.

First, I would like to provide you with some background about the Twin Shields Golf Course and its operation. It was designed and built by Messr's. Roy and Ray Shields who, own and operate the course as a semi-private club and as a profit-making business.

The course was built in the spring and summer of 1968 and seeded that fall. The tees, collars and fairways were seeded to: 40% Common Kentucky Bluegrass, 40% Merion Kentucky Bluegrass and 20% Pennlawn Red Fescue. The roughs were seeded to 60% K-31, 30% Common Blue and 10% Annual Rye. The course was opened for play in the spring of 1969 and we had few, if any, problems with our bluegrass that year.

By summer of 1970, we had a disease problem on our fairways. At first, I thought it was large Brown Patch Rhizoctonia solani, but Dr. A. J. Powell, from the University of Maryland identified the problem as Fusarium Roseum.

In 1971, the Fusarium was getting worse on the fairways and collars. We spot sprayed some areas, but had little success in controlling the Fusarium. That fall we spot seeded the most disease damaged areas with the 40% Common, 40% Merion and 20% Pennlawn seed mix utilizing a Rogers Overseeder.

In mid-June of 1972, we had the rainstorm associated with hurricane Agnes and the excessive heat that followed. By mid-July, 1972, the Fusarium was very bad. It was worse on some fairways than others. We spot sprayed some fairways with Tersan 1991 or Bennlate. We were also cooling the fairways with intermittant irrigation during mid-day. It is my opinion that extra water at night and cooling the Bluegrass during the day did help to slow the disease down.

We still were not controlling the disease by any means. Dr. Jack Hall looked at the Fusarium problem and in lieu of expensive spraying recommended continued water-cooling during mid-day and overseeding with Fusarium-resistant varieties such as Vantage in the fall.

That fall we did overseed the worse spots again with the same 40-40-20 mixture. We knew we weren't curing the problem by seeding these same bluegrasses back each year, but it was cheaper to seed than to spray 1991 at a heavy enough rate to control the Fusarium. Also I knew that a lot of work had been done on controlling Fusarium and I was hoping that a cheaper chemical would soon become available on the market.

By 1973 I thought we might be getting some relief. Dr. Jack Hall of the University of Maryland and Richard Schneider of O. M. Scott's had both asked if they could put out test plots to work on the Fusarium problem. The summer of 1973 was very hot and humid. Our Fusarium was extremely bad on all the bluegrass. O. M. Scott's had sodded 1800 sq. ft. test plots which included Vantage and other bluegrass varieties.

My conclusion from the test plots by that fall was that the Bennlate was still the only commercially available control of the Fusarium disease. So, in the fall of 1973 we decided to include some Manhattan Rye in our seed mixture which contained: 50% Manhattan Rye, 25% Common Kentucky Bluegrass and 25% Merion Bluegrass.

The new ryegrass amazed me in its fast germination and its ability to spread and cover the diseased scars on our bluegrass in such a short time. We still only spot seeded the worse diseased areas.

The Fusarium was not as bad in the summer of 1974 as it had been in 1973, but we still had two or three bad outbreaks during the summer. The Fusarium did not appear to affect the areas seeded with the ryegrass as bad as it had with the bluegrass mixture, but I did see some Pythium at times on the rye.

I still liked the bluegrass and not knowing which was worse, the Fusarium on the bluegrass or the Pythium on the ryegrass, I continued to put bluegrass in our fall seeding. I cut the percentage of rye to 1/3 of the seed mix by weight. We also switched to other varieties of bluegrass in the fall of 1974. The Bennlate was still the only noticeable control for the Fusarium.

By the 1975 season, and much to my dismay, the ryegrass had predominated over the bluegrass seed completely and made up at least 50% of the botanical composition of the turf where it had been seeded into pure stands of bluegrass.

During 1975, we had more of a silver crabgrass problem than a Fusarium problem. The late germinating crabgrass came in where the perennial ryegrass failed. But where there was no rye seeded into areas of bluegrass, the Fusarium still came out.

The rye had a considerable amount of Pythium especially in poorly drained areas. The Pythium thins the rye out considerably, but seems to still maintain a satisfactory, playable turf.

By the fall of 1975, I came to the conclusion that as far as a choice between the lesser of two evils-Fusarium or Pythium, I would fight the Pythium. The overseeding in the fall of 1975 contained 100% Manhattan Rye.

ADVANTAGES OF THE NEW IMPROVED PERENNIAL RYEGRASSES

1. Fast to germinate and establishes a thick, dense turf in a very short period of time.

2. Blends well with bluegrass and other cool season grasses when seeded in an overall area.

3. Much better competitor against poa annua than bluegrasses. I actually think it will smother poa out over a period of time.

4. With the exception of K-31, it is much more disease resistant than any other cool season grass.

5. More drought tolerant than most bluegrasses.

6. Requires a lower fertilization program than most bluegrasses.

7. Seems to stay a little greener during winter months than bluegrass.

8. Will withstand heavy golf cart traffic around greens and even in approach areas to and from cart paths.

9. Even though the ryegrasses don't produce stolons or rhizomes, I feel that it produces enough tillers to fill in small scars such as divots.

10. I don't think you need over 1-2 lbs of seed per 1000 sq. ft. in an overseeding situation.

DISADVANTAGES OF THE NEW IMPROVED PERENNIAL RYEGRASSES

1. When seeded with bluegrass in a high ratio or percentage by seed count, it may or can smother the bluegrass seedlings out, especially in a late fall seeding. I think the percent of rye should decrease as you get into late fall.

2. If spot seeded into bluegrass, it does not blend well during winter and early spring.

3. Does grow faster than bluegrasses and can require more frequent mowing.

4. Harder to mow and obtain a clean cut by the mowers.

5. Very susceptible to Pythium.

6. May not be as long-lived as bluegrasses.

SUMMARIZATION

This still leaves a lot of questions unanswered.

I especially agree with Holman Griffin's thoughts about the transition zone in his recent article in the "Golf Superintendent" magazine. He called this area the "badlands" of turf, crabgrass belt, the most difficult area to grow any type of turf. Also to date no one specific grass has been entirely successful for fairway turf.

I also agree that the ryegrasses may need to be overseeded from time to time, but not every year. They seem to hold up and make as good a playable turf for the dollars spent as any other type of turf we have to offer at the present time.

I feel there is still a great need for more research and cheaper chemicals in our transition zone.

MARYLAND TURFGRASS INSECT PESTS

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This guide is intended for the use of commercial sod producers and others engaged and trained in the commercial application of pesticides. Recommendations for home lawns and recreational areas are available in Entomology Leaflet No. 30, Home Lawn Insect Control. The author has assembled the most reliable control information available at the time of publication. However, due to both the continuous and rapid changes in pesticide registrations, individuals using these recommendations should always consult the label before applying any of these compounds.

Identification of Insect Pests

Turfgrasses provide food and protection to many insects and other arthropods. Fortunately, most insects encountered in turfgrasses are either non-destructive or beneficial species. So, it is very important to correctly determine which type of insect you have. Once you know their identity, you can learn what they feed on, what stages in their development are injurious and the number of generations that are expected during the season.

This guide provides control suggestions only for the most commonly encountered pest species. If you are unsure of the identity, there is no need to guess. You may get immediate help in identifying your turf pests by contacting the county Extension agent in your county, or by sending your specimens to John L. Hellman, Department of Entomology, University of Maryland, College Park, Maryland 20742.

Before considering the use of an insecticide, make sure the pest insects are present. Frequently, the damage or symptoms remain long after the actual feeding, and in many cases, a disease rather than an insect may be causing the damage. The accompanying chart will help you locate the injurious pests and help determine the need for applying an insecticide. Basically turf insects activity can be categorized into two groups: above-ground and below-ground.

Above Ground Pests

Chinch bugs Aphids Leafhoppers	suck plant juices
Sod webworms Armyworms & Cutworms Billbug adults	feed on leaves

Below Ground Pests

White grubs
Wireworms — feed on roots
Billbug grubs

Poa Beetle (Ataenius spretulus)

Description and Damage

Adults are black, about 3/16 inch long with very narrow shallow parallel grooves on the wings. The front of the head appears to be slightly indented or curved inward at the middle. Although the adults may be very abundant in the thatch, they are not known to cause any significant injury. The larval stage is almost identical to the japanese beetle grub, and can only be distinguished by its smaller mature size. The full grown poa grub is about 5/16 inch long when stretched out. These larvae may number 70 to 200 per sq. ft. in heavily infested annual bluegrass. Poa grubs are known to feed on the roots of the following grasses: Annual bluegrass, (preferred host), Bentgrass and Kentucky bluegrass.

Life Cycle and Habit

Adults overwinter near the turfgrass food source. This species has 2 generations in Maryland. The first generation begins in May or June. Adults normally fly onto golf fairway or greens in the late afternoon, usually 1-3 hours before dark. Warm, windless evenings are preferred periods for flight activities. Adults usually tunnel into the thatch and lay eggs. The larvae will complete development in July and the second generation will begin in late July or early August. The second generation adults are active in late August through September. These adults will then overwinter near the turfgrass areas. However, regardless of which material is used, all the insecticides must be flushed through the thatch layer into the soil.

Control and Management Practices

Any management practice that will eliminate or reduce the percentage of annual bluegrass in the turf or fairways are highly recommended since this species of grass is the preferred host. After destroying annual bluegrass, the grubs may feed on other grass types. Avoid using chlordane and dieldrin for poa grub control because this pest in many areas is highly resistant to these 2 compounds. To date the only insecticide that is legal to use in Maryland is Dylox at 8 lbs active ingredient/acre. Diazinon, Dasanit and Mocap are somewhat effective against this poa grub, however, these compounds are not presently labeled for this use.

CHINCH BUG (Blissus leucopterus hirtus)

Description and Damage

Adults are black, about 1/6 inch long. The immature nymphs are reddish or reddish-brown with white bands on their back. The adult differs from the nymph in having fully-developed wings which fold over and lie flat on the abdomen. The adults and nymphs can easily be confused with several beneficial bug species which also inhabit the thatch layer. However, chinchbugs produce a strong pungent odor when handled, unlike most of the beneficial species. Most of the damage is caused by the nymph's sucking the plant sap from the grass stems. This type of feeding will cause the grass to turn yellow before dying.

Life Cycle and Habits

Adults and older nymphs overwinter in the thatch or areas adjacent to the lawn that provide cover (leaf litter, bark mulches, etc.). Eggs are laid in the thatch or folds in the grass blades. Chinch Bugs require 30 to 40 days to complete their development. These generations generally overlap but in Maryland there are 3 or sometimes 4 generations between May and October.

Control and Management Practices

Hot, dry weather and sunny locations are optimal for chunch bug development. Extended periods of rain or cool wet weather favor a fungus disease that will frequently control chinch bug populations.

When to treat: May 25 to June 15 (first generation): July 25 to August 10 (second generation). Apply treatments if nymph and adult counts exceed 20 per square foot or when yellowing or brown damage first appears.

Refer to Entomolgy Leaflets Nos. 75 or 30.

Chinch Bug Control Recommendations

Insecticide	Lbs. Active Ingredient/A	Chinch Bug Formulation	Rate to Apply per 1000 sq ft	Per A
Diazinon	5½ lbs	4 lbs/gal EC	4 oz.	5½ qts.
		14% G	15 oz.	40 lbs.
		50% WP	4 oz.	11 lbs.
Spectracide	6.8 lbs	25% EC	8 oz.	11 qts.
(Diazinon)	4.2 lbs	2% G	5 lbs.	218 lbs.
	4.4 lbs	5% G	2 lbs..	87 lbs.
Sevin	9 lbs.	4 lbs/gal F	7 oz.	9 qts.
		50% WP	7 oz.	18 lbs.
Aspon	7½ lbs.	6 lbs/gal EC	3.6 oz.	5 qts.
		5% G	3½ lbs.	152 lbs.
Dursban	1 lb	2 lbs/gal EC	1½ oz.	2 qts.
		4 lbs/gal EC	3/4 oz.	1 qt.
		½% G	5 lbs.	218 lbs.

BLUEGRASS BILLBUG (Sphenophorus parvulus)

Description and Damage

Adult: A weevil about $\frac{1}{4}$ inch long, black or dark brown with a long "snout". Injury caused by adults is much less important thanthat caused by the larval stage. Feeding injury appears as small puncture wounds in the grass stems or a "ragging" of the newly emerging grass blades.

Larva: A legless, white to cream colored grub with a brown head. Early season injury, caused by the small grub feeding inside the grass stem, will appear in the turf as small round, brown patches usually 1 to 4 inches in diameter. These dead patches are easily pulled out from the thatch. Young larvae feed inside the grass stems, hollowing out the stem and crown, leaving very fine sawdust-like excrement inside. Larger larvae feed on roots below the thatch layer. This type of feeding is identical to that caused by the Japanese beetle grub.

Life Cycle and Habits

In Maryland, there is usually one generation per year. The adult weevils overwinter in the thatch and become active between March and May. Eggs are laid inside the stems. The young larvae feed inside, killing stem, then exit through the crown into the soil during June. The greatest damage by the larvae occurs from early July to early September. Where grass is killed, the thatch appears loose and is easily lifted from the soil. The billbugs pupate from late August into September. The adults are active for a short period from September to the end of October.

Control and Management Practices

Adult: Control of this pest is difficult once the eggs have been laid inside the grass stems. Best time to apply controls is late April to late May to kill the overwintering adults before they lay eggs.

Grub: Application of insecticides for grub control during July, August and September may or may not provide good control. Optimum effectiveness is usually achieved only by following the insecticide application with 1 to 2 inches of water in order to flush the material into the top 2 to 3 inches of soil. If grub infestations are light to moderate (1 to 2 grubs per square foot), it is probably best not to apply an insecticide but only water and fertilize to stimulate new growth.

Refer to Entomology Leaflets Nos. 75 or 30.

Billbug Control Recommendations

Insecticide[1]	Lbs Active Ingredient/A	Formulation	Rate to Apply Per 1000 sq ft	Per A
Diazinon	$5\frac{1}{2}$ lbs	4 lbs/gal EC	4 oz	$5\frac{1}{2}$ qts.
		50% WP	4 oz	11 lbs.
		14% G	1 lb	44 lbs.
Spectracide	6.8 lbs	25% EC	8 oz	11 qts.
(Diazinon)	5.2 lbs	2% G	6 lbs	261 lbs.
	5.5 lbs	5% G	2.5 lbs	109 lbs.

[1] Sevin, Dursban and Baygon registered for sod webworm control are also effective against Adult billbugs. See sod webworm rates.

SOD WEBWORM (Crambus trisectus)

Description and Damage

Adult: Causes no injury to turf grasses; however, their abundance and flight activities can be used in predicting outbreaks.

Several species of webworms are present in Maryland, but the larger sod webworm appears to be one of the more important species. Adult moth is whitish or gray, about 5/8 inch long and characteristically rolls its wings around the abdomen.

Larva: The larval stage or caterpillar has several growth stages or instars. The mature caterpillar is about 3/4 to 1 inch long. Larva is light tan, usually spotted (black or reddish-brown spots). The caterpillar characteristically constructs a silken tube.

Life Cycle and Habits

The larger sod webworm has 3 generations per year. The caterpillars and eggs overwinter in the thatch. The larvae feed primarily at night and withdraw into their silken tubes during the day.

Control and Management Practices

When to treat: Apply controls when larval counts exceed one per square foot.

May 25 to June 10 (first generation). This generation rarely causes heavy damage and in most years does not require controls.

July 25 to August 20 (second generation). This generation is very important and, if not controlled, may cause severe injury or loss of sod.

September 5 to 20 (third generation). Damage by third generation larvae is frequently masked or mixed with the late, second generation injury. Thus, the potential for severe injury will continue until frost. When heavy adult flight activity is extended over a 7-week period in July and August, a spray in July and a second spray application in the last week of August or early September may be necessary for complete protection. Mow lawn before spraying and do not water for 3 days after treatment. Some varieties of turf grasses will recover from a heavy defoliation if watered and fertilized to stimulate new growth.

Refer to Entomology Leaflets Nos. 75 or 30.

Sod Webworm Control Recommendations

Insecticide	Lbs Active Ingredient/A	Formulation	Rate to Apply Per 1000 sq. ft.	Rate to Apply Per A
Sevin	9 lbs	4 lbs/gal F	7 oz.	9 qts.
		50% WP	7 oz.	18 lbs.
		80% S	4 oz.	11¼ lbs.

Insecticide	Lbs Active Ingredient/A	Formulation	Rate to Apply Per 1000 sq ft	Per A
Diazinon	5.5 lbs	4 lbs/gal EC	4 oz.	5½ qts.
		50% WP	4 oz.	11 lbs.
Sarolex (Diazinon)	5.5 lbs	4 lbs/gal EC	4 oz.	5½ qts.
Spectracide (Diazinon)	6.8 lbs	25% EC	8 oz.	11 qts.
Spectracide	4.2 lbs	2% G		217 lbs.
	4.4 lbs	5% G	2 lbs.	87 lbs.
Dursban	1 lb	2 lbs/gal EC	1½ oz.	2 qts.
		4 lbs/gal EC	3/4 oz.	1 qt.
		½% G	5 lbs	218 lbs.
Dylox or Proxol	8 lb	80% SP	3-3/4 oz.	10 lbs.
Dylox	8 lb	4 lbs/gal EC	6 oz.	8 qts.
Baygon	5.75 lbs	1.5 lbs/gal EC	11 oz.	3-3/4 gal.
		70% WP	2-3/4 oz.	7½ lbs.
Aspon	7.5 lbs	6 lbs/gal EC	3.6 oz.	5 qts.
		5% G	3½ lbs.	152 lbs.

JAPANESE BEETLE (Popillia japonica)

Description and Damage

Adult: An oval-shaped beetle about ½ inch in length. The head and body are metallic green; the wings are coppery-brown in color. The adults feed gregariously and can feed on more than 275 kinds of plants. The damaged foliage takes on a lacey appearance due to the adults consuming only the tissue between the veins.

Larva: A white C-shaped grub. The grub stage feeds on grass roots and causes the grass to dry out and die, leaving large brown dead patches of sod which can be rolled back from the soil.

Life Cycle and Habits

The entire cycle requires about one year. Peak emergence period for adults occurs in early July in Maryland. Beetles emerge and remain active for about 4 to 6 weeks. Most of the egg laying occurs in July and tapers off rapidly by the first week in August.

After emerging from the soil, females mate and feed for a few days. They then go back into the soil and lay 4 to 8 eggs before leaving to feed for several more days. Egg laying continues until a total of 40 to 60 eggs have been deposited. Eggs hatch in about 10 days. Root feeding by grubs during July, August and early September may be so extensive that the turf can be rolled back from the soil like a rug. By late September, the grubs (measuring about one inch in length) move down into the soil 6 to 18 inches. Here they remain inactive until the next spring. In late March or

early April, they again start their upward movement and feed on roots until late May. Then they change into a pupal stage and all feeding stops until they emerge as adults.

Control and Management Practices

Adult: Insecticides.

Grub: 1. Insecticides
2. Milky spore dust

Refer to Entomology Leaflet No. 78 for additional chemical controls.

Japanese Beetle Control Recommendations

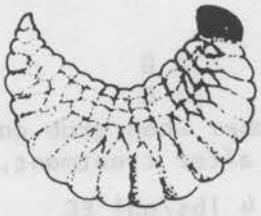
Insecticide	Lbs Active Ingredient/A	Formulation	Rate to Apply Per 1000 sq ft	Rate to Apply Per A
Chlordane*	10 lbs	8 lb/gal EC	4 oz.	5 qts.
	10 lbs	5% G	5 lbs.	200 lbs.
	10 lbs	40% WP	9 oz.	25 lbs.
Apply: Once every 3-4 years. March-November. Whenever ground is not frozen.				
Spectracide	5.2 lbs	2% G	6 lbs.	261 lbs.
(Diazinon)	5.5 lbs	5% G	2.5 lbs.	109 lbs.
Apply: Once, August-mid-September when grub counts exceed 3 sq. ft. Flush sprays into soil after treatment.				
Diazinon	5½ lbs	4 lbs/gal EC	4 oz.	5½ qts.
		14% G	1 lb.	44 lbs.
Apply: Once, August-mid-September when grub counts exceed 3 sq. ft. Flush sprays into soil after treatment.				
Dursban	3 lbs.	2 lbs/gal EC	4½ oz.	1½ gal.
Apply: Once, August-mid-September when grub counts exceed 3 sq. ft. Flush sprays into soil after treatment.				
Dylox or Proxol	8 lbs.	80% SP	3-3/4 oz.	10 lbs.
Apply: Once, August-mid-September when grub counts exceed 3 sq. ft. Flush sprays into soil after treatment.				
Milky Spore Disease "DOOM" OR "JAPIDEMIC" (Japanese beetles only)		Dust	4 oz. or 3 tsp/5 ft	10 lbs.
			Broadcast	20 lbs.
Apply: Whenever ground is not frozen.				

*Chlordane in Maryland is a restricted pesticide. When purchasing or using amounts over five pounds, a permit is required. Permits are available from: Division of Plant Industries
Pesticide Regulation
Room 2119, Symons Hall
Maryland Department of Agriculture
College Park, MD 20742

COMMON TURF INSECT PESTS

CHINCH BUG

ADULT BILLBUG

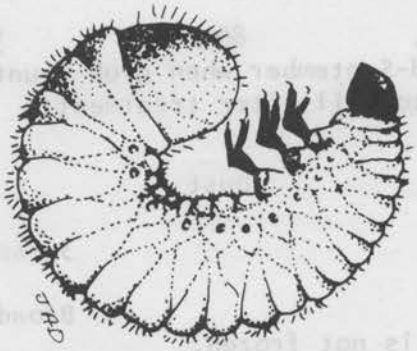


BILLBUG GRUB

SOD WEBWORM ADULT

SOD WEBWORM

JAPANESE BEETLE ADULT



WHITE GRUB

TURFGRASS RESEARCH UPDATE - MARYLAND

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The University of Maryland Department of Agronomy turfgrass research program includes variety and herbicide evaluation, management studies and basic research on air pollution damage and the mechanisms of disease resistance in Kentucky bluegrass.

The Department of Agronomy variety trials provide performance data on Kentucky bluegrasses, perennial ryegrasses and creeping red fescues. Observations made over the last seven years have provided important information about the persistance of individual turfgrass varieties under the climatic and edaphic conditions present in the transition zone. The strongest Kentucky bluegrass varieties observed over the last seven years have been: Merion, Warren's A-34 and A-20, Adelphi, Baron, Birka, Fylking, Sydsport, Pennstar and Vantage. General cool-season turfgrass recommendations in Maryland center around Kentucky bluegrass and the mixture should include approximately 10% creeping red fescue and at least three Kentucky bluegrasses.

Herbicide research at the University of Maryland has included extensive preemergence herbicide testing for crabgrass and goosegrass control in Kentucky bluegrass turf. Seven year studies investigating preemergence herbicides for control of crabgrass indicate that the most reliable material with the greatest residual is bensulide (Betasan). Over the seven year study bensulide was continually reliable. DCPA (Dacthal) and benefin (Balan) provided sporadic control of smooth crabgrass, however, split applications of these materials have considerably increased their effectiveness. This seven year study with several preemergence herbicides indicated that Bandane and Tricalcium arsonate seriously inhibited Kentucky bluegrass root growth at the three inch depth. Seven years of spring applications of bensulide, benefin and DCPA reduced root growth at the three inch depth approximately 30% (Table 1).

We are currently evaluating materials for goosegrass control in Kentucky bluegrass Poa annua mixtures. Oxadiazon, to be released as Ronstar, appears to be a very promising herbicide for preemergence control of goosegrass in cool season turf. Commercially available materials tested such as DCPA, Siduron, Tupersan, Bensulide and Benefin have not provided the level of control possible with Ronstar. Ronstar is not currently commercially available. However, it should be on the market within two years. Another experimental material that looks promising in split applications is butralin (Amex).

Research on selective control of yellow nutsedge in Kentucky bluegrass has shown that there are two materials capable of providing better control than the traditional methods of 2,4-D + disodium methane arsonate. In studies conducted in 1973-74 we were able to show that bentazon (basagran) was able to provide significantly better control of yellow nutsedge than 2,4-D + disodium methanearsonate (Table 2). A second material that appears promising for selective control of yellow nutsedge is Perfluidone (Destun). Neither of these materials are currently registered for turf at this time. However, it is expected that they will soon receive registration for use on turf.

Our research on control of Star of Bethlehem on the Eastern Shore indicates that a syngeristic combination containing $\frac{1}{2}$ pound active ingredient per acre 2,4-D + $\frac{1}{2}$ pound active ingredient per acre Silvex + 0.15 pound active ingredient per acre dicamba provides excellent control of Star of Bethlehem. Higher rates of any of these three materials applied alone have not provided equivalent control of Star of Bethlehem.

Our research to determine the best methods for control of Fusarium roseum indicates that benomyl (Tersan 1991) and Methyl thiophanate (Fungo 50) are the only two commercially available systemic fungicides providing adequate control of Fusarium roseum in Kentucky bluegrass (Tables 3 and 4) turf. The best control with benomyl resulted from applying 4 oz. of product (2 oz. active ingredient) per 1000 sq. ft. two times at four week intervals, beginning at the time of Fusarium roseum activity. Ethyl thiophanate (Cleary's 3336) has not provided acceptable control of Fusarium roseum at 8 oz. per 1000 sq. ft. Baymeb 6447 an experimental fungicide, appears promising in its ability to control Fusarium roseum (Tables 3 and 4).

Our research using slow release fertilizers on Pencross creeping bentgrass greens indicates that single applications of milorganite, ureaformaldehyde and IBDU can provide turfgrass quality equivalent to that provided by several applications of urea (Tables 5 and 6). Under the conditions of this experiment milorganite increased the rooting depth and shoot density of the Pencross creeping bentgrass (Table 7).

Future research efforts will investigate the utilization of liquid sludge for turf fertilization. By the fall of 1976, approximately 50 acres of turf will be under observation utilizing liquid sludge and cake sludge for various phases of establishment and maintenance.

Other studies are being conducted on perennial ryegrass-Kentucky bluegrass mixtures for determining the relative competiveness of these grasses. Extensive variety trial evaluation will continue in future years in a continuing effort to provide turfgrass managers with improved varieties of turfgrass for the difficult transition zone.

Table 1. Residual effect of preemergence crabgrass control chemicals applied on April 18, 1972 upon root counts taken at a 3 and 6 inch depth on April 12, 1973[x], Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./A.)	Root Count/1.8 sq. inches 3 inch Depth (Number)	6 inch Depth (Number)
Bandane[x]	10 G[z]	35	5.5 a[y]	5.7 a
Benefin	2.5 G	2	22.0 bc	17.2 b
Ca_3AsO_4	48 G	187	15.0 ab	15.7 b
Bensulide	12.5 G	12.5	23.0 bc	14.2 ab
DCPA	75 WP	9	27.2 c	17.5 b
A-820	2.3 G	6	26.5 bc	17.0 b
Siduron	50 WP	12	32.7 c	21.0 b
Check		0	31.0 c	20.8 b

[x] Bandane, Benefin, Ca_3AsO_4, Bensulide, DCPA and Siduron were applied annually from 1966 through 1972 and A-820 only in 1972.

[y] Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[z] The abbreviations are G = granule and WP = wettable powder. The number in front of G and WP is % active ingredient.

Table 2. Effect of bentazon, perfluidone and 2,4-D plus disodium methanearsonate upon quality of the turfgrass on November 30, 1973 (99 days after treatment) and percent control of yellow nutsedge on September 10, 1974 (382 days after treatment).

Treatment		Turfgrass Quality Rating 11/30/73	Yellow nutsedge Control 10/10/74
Chemical	Rate lb ai/A	(rating)[x]	(%)
Bentazon	.75	4.6 a[y]	79 c[z]
	1.5	4.3 a	40 abc
Perfluidone	3.0	4.0 a	16 ab
	4.0	4.6 a	61 bc
2,4-D plus Disodium methanearsonate	1.0 + 5.0	6.3 a	30 abc
Check	0	6.6 a	0 a

[x] Turfgrass quality rating made on a 0-9 scale with 9=maximum turfgrass quality and 0=bare plot. A rating of 6 or greater is considered acceptable.

[y] Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range test.

[z] Total number of yellow nutsedge plants in each plot was determined and individual control values were calculated within each replicate.

Table 3. Treatment effect upon turfgrass quality and dollarspot damage on August 1, 1974 and number of fusarium colonies, percent of plot area dead and turfgrass quality on September 26, 1974. Treatments initiated on June 19, 1974.

Treatment	Rate (AI)/1000 sq ft	Number of Times Treatment Applied at 2 week interval	1 Aug 74		26 Sep 74		
			Quality Rating[x]	% Area infested by Dollar Spot	Fusarium colonies 400 sq ft (%)	Plot Area Dead[y]	Quality Rating
Ethyl thiophanate (G)	0.5 oz	4	5.2	16	63	16	4.2
	1.0 oz	4	5.5	14	31	6	5.2
Benomyl[z]	0.5 oz	4	5.5	10	46	12	4.2
	1.0 oz	4	5.5	9	70	17	4.0
Benomyl 50 (WP)	4.0 oz	1	6.5	6	33	8	5.0
	2.0 oz	2	7.0	1	18	4	5.5
	1.0 oz	4	5.2	14	24	5	5.7
	2.0 oz	1	5.7	10	26	4	5.4
Ethyl thiophanate (50 WP)	4.0 oz	1	5.6	14	58	14	4.2
Methyl thiophanate (50 WP)	4.0 oz	1	5.7	8	23	5	5.2
Seaweed (G)	5.8 lb	1	5.2	16	49	10	5.0
	13.7 lb	1	5.0	22	58	14	4.2
Seaweed (G & Liq)	6.8 lb + 2.5 oz	1 + 3	5.2	9	59	14	4.5
Seaweed (Liq)	2.5 oz	3	5.0	16	55	15	5.0
	5.0 oz	3	5.2	4	50	11	4.7
Icelandic Seaweed (G)	6.8 lb	1	5.2	10	54	12	4.5
Baymeb 6447 25 (WP)	2/1000 sq ft	1	6.7	1	12	3	6.2
Check		0	5.0	17	50	10	5.0
5% Bayes LSD			1.3	30.6	35.6	10.6	1.6

[x] Quality rating is on 0-9 scale where 9=maximum turfgrass quality, 0=bare ground. This evaluation was taken for use as fairway turf. G=acceptable quality.

[y] This rating reflects total stress created by treatments.

[z] Contains 28-0-7 fertilizer with nitrogen source 18.6% water soluble from urea and methylene ureas and 9.4% water unsoluble from methylene ureas. At the 0.5 AI/1000 sq ft rate this material provides 0.45 lb total nitrogen per 1000 sq ft.

Table 4. Treatment effects upon number of Fusarium colonies, percent of plot area and turfgrass quality on July 30 and September 5, 1975 following initiation of treatments on June 19, 1974 and June 19, 1975.

Treatment	Rate AI/1000 sq ft	Number of times treatment applied at 2 week interval	30 Jul 75 Fusarium colonies/ 400 sq ft	30 Jul 75 Quality[x] Rating	5 Sep 75 Fusarium colonies/ 400 sq ft	5 Sep 75 % Plot[y] Area Green	5 Sep 75 Quality Rating
Methyl thiophanate (1.15 G)	0.5 oz	4	27	4.7	114	52	3.2
	1.0 oz	4	33	5.2	110	62	3.5
Benomyl (1.95 G)[z]	0.5 oz	4	54	4.0	93	57	3.7
	1.0 oz	4	35	4.5	119	50	3.2
Benomyl (50 WP)	4.0 oz	1	41	4.5	89	69	3.7
	2.0 oz	2	18	6.0	66	77	4.5
	1.0 oz	4	28	5.7	88	70	4.2
	2.0 oz	1	44	5.0	88	69	4.0
Ethyl thiphonate + (50 WP)	4.0 oz	1	55	4.5	105	50	3.0
Methyl thiophanate (50 WP)	4.0 oz	1	25	5.2	87	69	4.5
Seaweed (G)	6.8 lb	1	48	4.0	99	60	3.7
	13.7 lb	1	54	4.0	130	49	3.0
Seaweed (G+Liq)	6.8 lb + 2.5 oz	1	66	3.5	110	46	2.5
Seaweed (Liq)	2.5 oz	3	40	4.7	106	60	3.7
	5.0 oz	3	44	4.2	129	45	3.0
Icelandic Seaweed (G)	6.8 lb	1	49	4.2	127	50	2.7
Baymeb 6447 25 WP	2.0 oz	1	8	7.2	79	76	4.7
Check	0	0	61	4.0	141	53	3.0
Bayes LSD			44	2.7	47	23	1.5

[x] Quality rating is on 0-9 scale where 9=maximum turfgrass quality. 0=bare ground. This evaluation was taken for use as fairway turf. G=acceptable quality.

[y] % Plot area green is a visual rating made on each plot which reflects the surface area of the plot that is covered with living green grass.

[z] 1.95 G is 1.95% active ingredient benomyl with 18.6% water soluble N from urea and methylene ureas and 9.4% water insoluble N from methylene ureas, soluble K_2O from potassium sulfate 7.0%.

Table 5. Sources of nitrogen and rates and times of application during 1972 for slow release nitrogen study conducted at Columbia, Maryland.

Nitrogen Source	Nitrogen Application Date						
	May 17	May 12	Jun 14	Jul 17	Aug 18	Sep 29	Oct 31
	lb N/1000 sq. ft.						
Urea	2	1	1	1	1	1½	1½
Urea formaldehyde	7					8	
Isobutylidene Urea	7					8	
Activated sludge	4	2			4	5	
TVA Sulfur-Urea	7					8	

Table 6. The effect of nitrogen sources, and timing and rate of nitrogenapplication upon the quality of Penncross Creeping bentgrass at various times. Dates and rates for nitrogen applications are in Table 5.

Nitrogen Source	Date						
	12 May 72	14 Jun 72	17 Jul 72	18 Aug 72	28 Sep 72	31 Oct 72	Ave.
	Quality Rating[a]						
Urea	5.7	6.3	7.3	6.3	8.0	4.7	7.0
Urea formaldehyde	5.3	5.7	6.7	6.0	7.0	6.0	6.1
Isobutylidene Urea	5.7	5.3	5.3	5.0	4.3	5.3	5.1
Activated Sludge	7.0	8.0	9.0	5.0	6.0	8.7	7.2
TVA Sulfur-Urea	5.3	5.3	4.7	5.8	4.7	3.3	4.7

[a] Quality rating made on a 1-9 scale with 9=maximum turfgrass quality and any value less than 6.0 is considered less than acceptable.

Table 7. The effect of nitrogen sources and timing and rate of nitrogen application upon the number of living tillers on August 18, 1972 and the maximum depth of roots on September 28, 1972. Timing and rates of nitrogen are noted in Table 5.

Nitrogen Source	Living tillers per 1.8 sq. in. 8/18/72	Maximum rooting depth 9/28/72
	number	inches
Urea	50	10.8
Urea formaldehyde	51	10.0
Isobutylidene Urea	41	10.2
Activated sludge	61	11.8
TVA Sulfur-Urea	45	9.7
Bayes 5% LSD	15	2.0

TURFGRASS RESEARCH UPDATE - ILLINOIS

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Sod production has become a highly sophisticated technology due to the development of better equipment, pesticides, turfgrass varieties, and production and handling techniques. However, many problems continue to plague sod growers including various weed species, diseases and other factors that reduce the quality and marketability of sod. The purpose of this paper is to explore several of these major problems and to report results from recent research at the University of Illinois on the production and subsequent use of sod.

ANNUAL BLUEGRASS CONTROL DURING ESTABLISHMENT

Annual bluegrass is a serious weed problem on some sod production sites. It germinates rapidly and is extremely vigorous and competitive with Kentucky bluegrass during cool seasons. Since preemergence herbicides that are effective in preventing annual bluegrass development from seed cannot be used safely in conjunction with seeding Kentucky bluegrass, studies were undertaken to evaluate their use with vegetative plantings. Results showed that application of a new herbicide - oxadiazon (Rhodia's Ronstar) - immediately after planting plugs of A-20 Kentucky bluegrass effectively controlled annual bluegrass and other annual weeds while allowing fairly rapid development of turf. However, tests employing 48 Kentucky bluegrasses showed that some varieties were highly susceptible to injury from oxadiazon while others were quite tolerant of this herbicide (Table 1). Results from other field studies showed that close plug spacing (ca. 6 in), moderate mowing heights (1.5-3.0 in), and adequate fertilization (0.5-1.0 lb Nitrogen/1000 sq ft/month) were important factors for encouraging rapid turfgrass establishment from plugs.

YELLOW NUTSEDGE CONTROL

Yellow nutsedge (Cyperus esculentus L.) is a perennial sedge that reproduces by seed, rhizomes and tubers. One surviving tuber can produce several nutsedge plants which can spread rapidly as a result of lateral growth and development of rhizomes. Extensive formation of tubers at rhizome terminals ensure regeneration of nutsedge plants in subsequent years. Results from research at the University of Illinois have shown that the success of yellow nutsedge as a weed in some turfs is inversely related to the competition from Kentucky bluegrass. Important factors for restricting the spread of nutsedge included: adequate fertilization (0.5 to 1.0 lb N/1000 sq ft/month), moderate mowing heights (1.5 to 3.0 in), adequate moisture to sustain growth of summer disease in turf. Chemical control of yellow nutsedge was highly variable; the best control from cyperquat and MAMA occurred on sites where intensive irrigation was practiced. This was believed to be due to the relationship between moisture and the absorption of the applied herbicides by the leaves. Plants sustained under high moisture have

relatively thin cuticles with continuous channels of water through the pores of the cuticle. Herbicide movement is facilitated by the water continuum between the spray droplet and the inside of the leaf. In contrast, plants subject to drouth typically have thicker cuticles with air-filled pores. Herbicide absorption is restricted in these plants and, consequently, efficacy is reduced.

PERENNIAL WEEDY GRASS CONTROL

Quackgrass, bentgrass, tall fescue and nimblewill are perennial grasses that can disrupt turfgrass quality and reduce the marketability of sod. Since there are no selective chemical controls for these weeds, nonselective herbicides have been used for spot-treating clumps and patches of undesirable perennial grasses. Dalapon and amitrole have been used for several years for this purpose; however, weed control has not always been satisfactory and the residual activity of these herbicides delays turfgrass recovery into treated areas. Recently, glyphosate (Monsanto's Roundup) has been shown to be effective in controlling perennial grasses while the lack of any residual activity following its use allows for rapid turfgrass growth into treated areas. Results from research have shown that treated sites can be reseeded soon after application of glyphosate. However, sufficient time should be allowed between chemical treatment and disc seeding to facilitate translocation of the herbicide within the plant; otherwise, the mechanical severing of stolons or rhizomes that accompanies disc seeding may interfere with herbicide translocation and, hence, control of the weed species.

SELECTION OF KENTUCKY BLUEGRASS VARIETIES

The intraspecific variability of Kentucky bluegrass has allowed the development of many varieties and experimental selections that differ widely in their color, texture, density, environmental adaptation, disease susceptibility, and other factors. The basis for these breeding efforts is that improvements in the characteristics and adaptation of a turfgrass reduce its dependency on cultural practices designed to compensate for specific weaknesses. Thus, turfgrass management is made simpler and higher turfgrass quality is obtainable with the use of improved varieties.

The diseases of principal importance have been Helminthosporium leaf spot, Sclerotinia dollar spot and Fusarium blight (Table 2). Those varieties showing the least injury from the diseases were: A-20, A-34, Adelphi, Baron, Bonnieblue, EVB-282, EVB-391, Galaxy, Glade, KI-131, KI-132, KI-143, KI-155, Majestic, Cheri, Monopoly, P-59, P-140, Parade, PSU-150, Sodco, Touchdown, Victa and Windsor. The summer quality data reflect both disease incidence and summer stress tolerance. Thatch development varied from 0.71 to 1.91 cm thick, depending upon variety. There is reason to believe that thatch has an important effect on summer stress tolerance since Nugget typically declines as summer temperatures rise while, at the Belleville site in southern Illinois, the absence of thatch in Nuggett is associated with substantially better summer quality.

The blends reflect disease and quality levels that represent compromises between the two component varieties. Considering the fact

that no variety is perfect, blending superior varieties allows for incorporating the desirable features of each component while reducing the impact of a specific weakness on general turfgrass quality. The Kentucky bluegrass (Fylking)-fine fescue mixtures have not produced good turf due to the poor adaptation and high disease susceptibility of the fine fescues. The Fylking-Pennfine (perennial ryegrass) mixture is predominantly perennial ryegrass and its quality through the season is similar to that of Pennfine alone.

SOIL-LESS (WASHED) SOD

A new and potentially important development by Warren's Turf Nursery is "soil-less" sod. Recently harvested sod is washed free of soil with a device that employs a steel conveyer belt, a series of water jets for washing, and a roller assembly to squeeze excess water from the sod. The resulting sod is lighter, easier to handle, and less costly to transport. Research results have shown that, under moderate climatic conditions, soil-less sod roots faster than conventional sod. Also, soil removal does not significantly reduce sod strength since the strength of a sod section is primarily due to the interlocking system of roots and rhizomes that remains with the washed sod. Another potential advantage of soil-less sod is the avoidance of an interface effect due to differences between soil types occurring at the sod production and transplant sites. One obvious concern with soil-less sod is the higher desiccation potential after planting, especially during stress conditions. Also, the nutrient requirements of soil-less soil that has been planted on very sandy media are higher than for conventional sod since little or no nutrients are carried with the sod after soil removal.

PROCESSED TURFGRASS CLIPPINGS

Mowing is one of the primary cultural practices necessary for sustaining turf. Clippings resulting from regular mowing are either picked up and discarded, or returned to the turf where they decompose. In view of the traditional use of grasses for forage, it is likely that turfgrass clippings could be successfully employed for feeding livestock and other animals. As turfgrass cultivars and cultural practices are substantially different from those employed in forage production, investigations were initiated this year to determine the relationship of turfgrass species, cultivars, mowing and fertilization to the nutritive value of clippings from these turfs. Lutein, a non-epoxide xanthophyll important as a pigmenting agent in poultry feeds, was found to occur in large quantities in Kentucky bluegrass clippings from sod farms in California. Clippings were collected from 20 Kentucky bluegrasses, four perennial ryegrasses and K-31 tall fescue in May and analyzed for lutein using an acetone extraction and thin-layer chromatographic separation of the pigments. Colorimetric determination of lutein was made from extracts from the TLC plates. Lutein levels ranged from a low of 72 mg/kg fresh weight in Vantage Kentucky bluegrass to a high of 350 mg/kg in Adelphi Kentucky bluegrass (Table 3). Thus, selection of a particular turfgrass cultivar substantially affects the lutein yield from the clippings. Clippings were also collected from Kentucky bluegrass fertilized with 0, 0.25,

0.5 or 1.0 kg N/are/mo. Results showed that lutein increases significantly from increasing nitrogen fertilization, but the increases were of a relatively low magnitude.

Turfgrass clippings offer a potentially important source of protein in animal feeds, especially for ruminants (sheep, cattle, etc.) which can digest the cellulose within the plant tissue. Crude protein levels were determined in dried clippings by Kjeldahl analysis for total nitrogen (X 6.25) in 53 Kentucky bluegrasses and 8 perennial ryegrasses. Within the Kentucky bluegrasses, crude protein levels ranged from 22 to nearly 33 percent depending upon cultivar (Table 4). The perennial ryegrasses ranged from 26.3 to 30.2 percent crude protein.

The dynamic nature of turfgrass technology and sod marketing conditions requires that sod growers keep abreast of new information from on-going research. Expanded results from scientific investigations provide important guides for selecting varieties and blends at planting, incorporating pesticides and other materials into production techniques, and modifying sod handling methods. The sod grower can no longer assume that what is considered satisfactory today will be adequate for tomorrow. At the same time, the challenges and opportunities that exist today can yield substantial gains for the sod grower who makes wise choices in light of new technical developments.

Table 1. Relative phytotoxicity from oxadiazon to field-planted plugs of Kentucky bluegrass varieties.

Phytotoxicity	Variety
Low	A-20, A-34, Ba 62-55, Baron, Brunswick, EVB-282, EVB-307, Galaxy, Geronimo, Glade, K1-131, K1-132, K1-133, K1-143, Majestic, Plush, PSU-150, PSU-169, PSU-197, RAM #1, RAM #2, Sodco, Vantage, Victa, Windsor.
Moderate	Adelphi, Ba 61-91, Bonnieblue, EVB-391, Fylking, K1-138, K1-155, Kenblue, Cheri, Monopoly, Nugget, P-140, PSU-190, Sydsport, Touchdown.
High	Campina, EVB-305, K1-157, Merion, P-59, Parade, Park, Pennstar.

Table 2. Performance of Kentucky bluegrass varieties, blends and mixtures in 1975 at the University of Illinois.

Variety	Spring Green-up[1]	Leaf Spot Disease[2]	Fusarium Blight[2]	Dollar Spot Disease[2]	Thatch Depth, cm.	Quality[1] 7/11/75	Quality[1] 8/15/75	Quality[1] 10/9/75
A-20 (seeded)	3.3	2.0	1.0	1.0	1.39	2.7	2.0	3.7
A-20 (veg)	4.0	2.0	1.0	1.0	1.24	3.7	2.3	2.7
A-34	3.0	2.7	1.3	1.0	1.11	5.0	2.3	3.0
A-20-6	4.0	2.0	1.0	1.0	0.99	2.7	2.0	2.0
Adelphi	2.7	2.0	1.0	1.0	1.25	4.0	2.3	3.0
Ba 61-91	4.3	2.7	2.0	1.3	1.05	3.7	3.7	4.7
Ba 62-55	4.0	2.3	1.3	2.0	1.50	3.3	3.3	3.3
Baron	5.3	2.7	1.3	1.0	1.37	3.7	3.0	3.0
Bonnieblue	3.0	2.3	1.3	1.0	1.01	3.7	2.3	3.3
Brunswick	2.0	3.0	2.3	1.7	1.54	2.3	3.7	4.7
Campina	2.3	7.0	1.0	1.3	1.06	4.0	3.3	3.3
Delft	2.3	3.7	5.0	1.0	1.04	3.7	5.7	6.3
EVB-282	3.3	3.0	1.0	1.0	1.14	2.7	2.7	3.0
EVB-305	4.7	2.0	4.3	1.3	1.52	5.3	4.3	5.7
EVB-307	3.7	2.0	2.0	1.7	1.19	4.0	4.0	4.3
EVB-391	5.7	2.7	1.3	1.0	1.26	4.0	3.0	3.0
Fylking	4.3	2.3	2.3	1.3	1.30	3.3	3.3	4.7
Galaxy	3.7	2.0	1.3	1.0	1.17	3.7	2.3	3.3
Geronimo	3.0	3.3	2.0	2.0	1.25	3.3	4.0	4.3
Glade	3.7	2.7	1.0	1.7	1.54	3.7	3.3	3.0
Kl-131	3.3	2.7	1.3	1.0	1.41	3.3	2.7	3.3
Kl-132	3.3	3.0	1.0	1.0	1.27	3.3	3.0	3.0
Kl-133	3.0	2.7	1.7	1.0	1.20	3.0	3.0	4.0
Kl-138	3.0	4.0	5.7	1.0	1.21	3.7	6.3	5.7
Kl-143	3.0	2.7	1.0	1.3	1.32	3.0	2.3	3.0
Kl-155	2.7	2.0	1.3	1.0	1.21	4.0	2.7	3.3
Kl-157	2.3	5.3	3.0	1.0	1.13	3.7	3.3	5.0
Kl-158	2.0	5.3	1.7	1.0	1.22	3.0	1.7	2.7
Kl-187	3.0	2.7	2.0	1.0	1.45	3.0	3.3	4.7
Kenblue	3.0	5.0	2.0	1.3	0.96	3.7	3.3	4.0
1L-3817	4.3	2.3	2.7	1.3	1.13	4.3	4.3	4.3
Majestic	2.7	2.0	1.0	1.0	1.41	4.0	2.3	2.7
Merion	3.0	2.0	1.7	1.3	1.02	2.3	3.0	4.0
MLM 18001	3.3	3.0	1.3	1.0	1.58	3.7	2.7	2.7
Monopoly	2.7	2.7	1.0	1.0	1.06	2.3	2.0	2.7
Nugget	7.7	1.0	2.7	3.3	1.52	4.7	5.3	5.3
P-59	2.0	2.3	1.0	1.0	1.33	4.7	2.7	2.7
P-140	2.3	2.7	1.0	1.7	1.76	2.3	2.3	2.7
Parade	2.3	2.3	1.3	1.7	1.01	4.3	3.0	2.7
Park	2.3	5.3	2.0	1.0	0.71	2.7	3.3	5.0
Pennstar	4.0	2.0	2.0	1.0	1.22	3.3	3.3	4.0
Plush	3.7	3.0	1.7	1.0	1.33	2.3	2.3	3.7
PSU-150	3.3	2.0	1.0	1.0	1.17	3.0	3.3	3.7
PSU-169	3.0	2.3	1.7	1.0	1.13	4.3	3.3	4.0
PSU-190	3.7	2.7	1.7	1.0	1.29	3.0	3.3	4.0
PSU-197	3.7	2.7	2.7	1.0	0.97	3.0	4.0	5.3
RAM #1	4.3	2.7	1.3	2.7	1.68	3.7	3.7	3.7
RAM #2	3.0	2.7	3.0	1.3	1.37	3.7	4.3	4.3
Sodco	3.0	3.0	1.0	1.0	1.37	3.0	2.7	2.3
Sydsport	4.0	2.0	1.7	1.0	1.22	5.0	3.0	3.0
Touchdown	3.3	2.3	1.0	1.0	1.91	4.3	3.0	2.7

Vantage	3.0	3.7	1.7	1.0	1.02	2.7	2.7	3.3
Victa	5.0	2.7	1.0	1.0	1.47	3.0	3.0	3.3
Windsor	3.0	3.0	1.0	1.0	1.22	2.7	2.0	3.0
..... Blends								
Merion+ Kenblue	3.0	3.0	1.7	1.0	1.22	3.0	3.3	4.3
Merion+ Pennstar	2.3	2.0	1.0	1.0	1.19	2.3	3.0	4.0
Merion + Baron	3.3	2.3	2.0	1.0	1.30	3.7	3.3	4.0
Nugget + Pennstar	7.0	1.3	2.0	1.0	1.28	4.3	4.0	4.3
Nugget + Park	3.0	2.3	3.7	1.0	1.10	3.7	5.0	6.0
Nugget + Glade	4.7	2.0	1.3	1.0	1.42	3.7	2.7	3.7
Nugget + Adelphi	4.3	1.7	1.3	1.0	1.27	4.3	2.7	3.3
Victa + Vantage	3.7	2.7	1.7	1.0	1.40	3.3	3.0	3.3
P-59 + Brunswick	2.3	2.7	3.3	1.0	1.41	3.3	4.3	5.3
Blend 38	3.3	3.0	1.7	1.0	1.51	3.3	3.0	3.3
..... Mixtures								
Fylking + Jamestown (RF)	4.0	2.3	5.0	1.0	1.36	4.7	4.3	6.0
Fylking + Pennlawn (RF)	3.3	2.3	5.3	1.0	1.24	3.7	5.7	6.0
Fylking + C-26 (HF)	3.7	2.0	3.3	1.3	1.31	3.7	4.3	5.7
Fylking + Pennfine (PR)	1.0	2.0	1.0	1.3	0.72	2.7	3.3	2.7

[1] Spring green-up and quality ratings were made using a scale of 1 through 9 with 1 representing best quality and 9 representing poorest quality.

[2] Disease ratings were made using a scale of 1 through 9 with 1 representing no disease and 9 representing complete blighting of the turf.

Table 3. Lutein content in fresh clippings of various turfgrasses.

Lutein	Cultivars
mg/kg fr wt	
360-300	Adelphi, A-34, Pennfine PR
299-250	Baron, Majestic, Pennstar, Merion, Fylking, Kenblue, Sydsport, Brunswick, Common PR, Manhattan PR, K-31 TF
249-200	Park, Windsor, A-20, Victa, Parade, Glade, Bonnieblue, NK-200 PR
199-150	Nugget, Touchdown
99-50	Vantage

Table 4. Crude protein content in dried clippings of various turfgrasses.

Protein	Cultivars
%	
35-30	Campina, Windsor, Majestic, Sodco, NK-101 PR
29-25	A-20, Parade, Adelphi, Bonnieblue, Brunswick, Merion, Plush, Vantage, Sydsport, Galaxy, Delft, Baron, Kenblue, Park, A-34, Nugget, Glade, Pennstar, Victa, Monopoly, NK-200 PR, Manhattan PR, NK-100 PR, Pennfine PR, Common PR
24-20	Fylking, Geronimo, Touchdown

TURFGRASS RESEARCH UPDATE - VIRGINIA

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I. Research with Perennial Ryegrasses

Around 20 new perennial ryegrasses, most recent commercial releases, are being compared with the common commercial variety Lynn. The objective is to obtain types that mow easily and "cleanly", persist under close mowing management, and are not aggressively competitive during the spring and autumn season. Ryegrass grows at lower temperatures than bluegrass, making it necessary to mow it more frequently, earlier in the spring and later in the autumn season than bluegrass.

Perennial ryegrasses are desirable because they blend well with bluegrasses; using ryegrasses with bluegrass is a way to establish a vegetative cover quickly as the ryegrasses germinate and grow much faster than do bluegrasses. It appears that some of the ryegrasses are more tolerant of shade and drought than the bluegrasses.

The varieties Manhattan and Pennfine are persistent but they are susceptible to red thread (Corticium) which can be overcome by irrigation and nitrogen fertilization, but this aggravates mowing management.

II. Overseeding Bermudagrass with Cool Season Grasses

The research with bermudagrass putting greens has essentially been discontinued since most putting greens in Virginia are now bentgrass. However, overseeding of bermudagrass tees and fairways is very important.

Thus, some of the new perennial ryegrasses are being tested in Southeastern Virginia under a warm humid summer environment and at Blacksburg at a cool, rather high elevation and less humid climate. Perennial ryegrasses are especially desirable for overseeding bermudagrasses because of their prolonged persistence making the transition during the spring months almost unnoticeable. The ideal would be adapted perennial ryegrasses that would persist year after year to reduce or negate annual seeding of ryegrasses.

III. Experiments with Fine Fescues

Various varieties and species of creeping red (Festuca rubra) and chewings fescue (Festuca rubra var. commutata) and hard fescue (F. Ovina var duriuscula) are being evaluated with mowing management and nitrogen fertilization. Most of the fine leaved fescues do not maintain dense turf but they are rather persistent under shaded conditions.

In highway research programs in Virginia and West Virginia red fescue can be seeded later than Ky 31 tall fescue in the autumn for obtaining suitable stands. It appears that red fescue is also more satisfactory than Ky 31 fescue for dormant winter seedings on highway slopes.

IV. Tall Fescues

Various varieties and new releases of Kentucky 31 Tall fescue are being evaluated. There is a critical need for a dwarf and highly rhizomatous tall fescue. It is known that such morphological characteristics are present in this species but combinations of these characteristics have not yet been fixed.

Ky 31 Tall fescue is the best variety as it is very persistent and stays greener during the winter months than other types. Tall fescues are also being compared in mixtures with varieties of bluegrass.

V. Research with Bluegrasses

Many varieties of Kentucky bluegrass are being compared for persistence under different mowing and nitrogen regimes. Their rooting behavior at various seasons is being investigated to find types that are more persistent under warm climate conditions. Research is under way in the breeding area where crosses are being made and morphological types from various environments are being brought to Blacksburg to test their adaptation. One bluegrass selected out of a bent green near Blacksburg appears very tolerant of close clipping and well adapted. Dr. Lincoln Taylor now has some seed of this strain.

Other work with bluegrass blends continues. We established our first experiment with such blends in 1959 predicated on the idea that there was no one satisfactory strain of bluegrass; hence, bluegrass blends would compromise for the weaknesses in the various varieties and provide higher quality turf under variable management and environmental conditions. This concept seems to be sound and may now be referred to as a good principle in designing seed mixtures.

VI. Semitropical or Warm Season Grasses

The major problem with bermudagrass is poor winter survival. It is postulated that warm days in February break dormancy of bermudagrass thereby making them very susceptible to winter damage by subsequent severe cold spells. One of the graduate students is placing genotypes in a greenhouse for a few days after which they are submitted to freezing conditions to test their persistence. Persistence is being associated with rhizomes and other morphological characteristics. Presently, it is sure that certain of the medium-coarse types such as Tufcote and Mid-Iron are more persistent than fine leaved putting green types.

There is considerable interest in centepede and St. Augustine grasses for low maintenance turf areas. These strains are surprisingly persistent in eastern Virginia and require very low fertility and infrequent mowing as compared with bermudagrasses.

VII. Nitrogen and Iron Fertilization Interrelationships

For the temperate grasses, nitrogen fertilization begins with autumn (September-October) nitrogen fertilization followed with light applications in November and December where it is desirable to maintain green color. Only soluble sources of N or those that release nitrogen without bacteria activity are satisfactory for obtaining green color during the winter. IBDU releases nitrogen during the winter months but caution must be exercised against using too much of it so as to avoid too much spring growth.

After applying nitrogen, iron fertilization enhances color especially during cold and high temperature periods, when iron absorption is slow. Foliar applications of chelated iron are taken up more slowly than iron sulfate. Chelated iron generally inhibits growth during the favorable growing season as in spring. This also tends to inhibit root growth. When applied during the spring season, iron sulfate is less inhibitory than chelated iron, especially if N is also applied in the spring.

VIII. Growth Regulators

Dr. Schmidt talked to you about using growth regulators last year and there is little change except that some of the growth regulators inhibit roots the year after they are applied. Thus, the research indicates that using growth regulators year after year would inhibit root development and vigor or grasses.

IX. Weed Herbicides

Research with weed herbicides is in cooperation with Dr. Wayne Bingham. Ronstar manufactured by the Rhodia Company is excellent for controlling goosegrass as a pre-emergence spray in April. However, this material should not be used on golf greens as bentgrass is injured by it. It may be used with bermudagrass and bluegrass.

For crabgrass control with pre-emergence materials it is best to apply two applications, the first application being made in April, and the second in June.

X. Sandy Greens

It has become fairly common to use sand as a substrate for golf course putting greens. Research has been initiated to study the sandy soil-turf growth-moisture interrelationships. Some data are being obtained on water budgets and turfgrass wear.

XI. Highway Turf Research

Research is being continued with establishing vegetation quickly that shifts to persistent types of vegetation requiring little or no maintenance. For cuts, serrate grading or loose rough surfaces it is very important to establish vegetation quickly and encourage a persistent leguminous growth. For fills allowing materials to fall naturally leaving stones and rock in place has increased water infiltration, reduced erosion, and stimulated the development of temporary and persistent vegetative cover. For medians, rough and loose surfaces have given phenomenal improvement for establishing vegetative cover. The preparing of rough loose surfaces creates many microenvironments, greatly improving the chances of seedling establisment with variable environmental conditions. Runoff is reduced because there is more water infiltration. As compared with the conventional hard smooth surface grading, seeds germinate quickly and grow rapidly because some "natural' seed and fertilizer coverage is obtained to stimulate growth with rough loose surfaces.

Altering seed mixtures with different seasons of seeding makes it rather simple to establish vegetation during March through November. The winter months are the critical months for establishing vegetation but erosion is controlled by using special mulching and tacking techniques. Tacking straw with woodfiber is superior to the chemical tackfinders that have been available to date. The information in Virginia has been compiled into a special handbook and is available upon request.

IRRIGATION RENOVATION

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I. Reasons for Renovation

Our problems at the Sparrows Point Country Club with the old irrigation system were many. The deterioration which was occuring in most of the system was of a continuous nature and we could foresee the absolute failure which would result in heavy turf loss. Much of the original piping installed in 1953-54 was causing us a great deal of problems in labor and repairs. Piping installed in 1959 and again in 1964 was also becoming thin walled and extremely poor. We knew that the soil conditions existing on our facility were reacting on the exterior surfaces of the pipe and that the rust and oxide slur in the older pipe was acting more or less as a catalyst for further deterioration. The newer pipe was also in bad shape. For many years we have been using copper sulfate in our irrigation lakes for aquatic weed control and I feel the use of this material has added to the deterioration of our system.

In order to come up with an adequate and workable solution to our problems we considered several propositions that could be undertaken to update the existing system. 1. Replace the pipe only and retain a manual system. This was rejected for several reasons; labor, cost and inadequate application of moisture. 2. Use the system as it was, watering only those areas needing water. Rejection of this alternative was based upon the same reasoning as item 1.; availability of competent manpower, cost, moisture control, availability or facility and a step backward. 3. Our final proposal was to replace all existing piping with PVC, install new updated type sprinkler heads, remote control valves and control mechanisms to provide a completely automatic irrigation system. The benefits expected from such a system were: 1. Replacement of the present piping in order to prevent turf failure as the result of a major breakdown in the old system 2. elimination of necessary overtime labor to operate the manual system; 3. elimination of the time and materials needed to repair the old system; 4. elimination of time and materials associated with replacing lost turf; 5. better overall turf condition and vigor as a result of scheduled and timed application of moisture. 6. increased availability of facilities in early spring and late fall when it would be possible to syringe frost from the courses rather than waiting for it to melt; 7. reduced interference with play as the automated system would operate during the hours of darkness; 8. reduction of total water usage.

II. General Objectives Desired

1. Secure a local supplier/contractor.
2. Install automated system designed to water at night with no one in attendance.
3. Be able to vary amounts of moisture for any section of the facility.
4. Be able to perform all maintenance or sprinkler heads (exclusive of controls) from above the ground.
5. Minimum number or type (models) or heads.
6. "Turnkey" installation from one supplier/contractor.
7. Maintenance of system able to be performed by golf course personnel.
8. Flexibility to:

    a. water and syringe greens and tees separate from fairways.
    b. change moisture application easily and at will.
    c. manually override any or all parts of the system.
    d. rain cut off.

9. Make water supply to lakes independent of the irrigation system.

III. Choice of Systems

We chose to look at 3 different systems and from the 3 pick the package that would enable us to attain the end results proposed in our objectives. There are many and varied irrigation systems on the market, many of which are excellent, functional units. We narrowed our choice to the Moody Rainmaster, the Johns-Manville Binar, and the Toro Systems. The people concerned with these systems were asked to furnish the following detailed information.

1. Design criteria.
2. Number of controllers, master control and remote.
3. Number and type of additional controls, if any.
4. Number of sprinkler heads by model.
5. Fairway spacing of heads.
6. Pipe manufacturer and type as to class, schedule, type joints, etc.
7. Depth of pipe cover.
8. Type or wire.
9. Modifications of additional units necessary for existing pumping equipment.
10. Breakdown of material vs. labor.
11. If awarded a contract complete and detailed as-built drawings.

The Greens Chairman, our golf course superintendent and 6 other men representing various departments of the Sparrows Point Division of the Bethlehem Steel Corporation were assigned the responsibility of evaluating all of this information and deciding which unit would do the job for our facility. The installation chosen was the Johns-Mansville Binar. Demarco Turf Irrigation Contractors, Incorporated were selected to install the system and Hill's Irrigation was his source of supply for the Johns-Manville Materials.

IV. Installation

Installation was begun March 1975 and in order to proceed with pulling the $1\frac{1}{2}$" and 2" pipe and wire it was decided to continue working on greens and tees while the ground conditions remained good. This operation included installation of necessary sprinkler heads and decoders. In order to eliminate wire splices remote control stations were installed at pre-selected sights as the operation progressed. When the greens and tees were finished the contractor started at our No. 2 pumping station and began trenching and installing the 6, 4 and 3 inch ring-tite pvc lines. The pump systems had been redesigned and changed over at an earlier date so that the Demarco Company was able to turn sections of the new system on as they progressed. During the months of installation we were only without water in certain areas about 1 week. During this period we had to water a few greens with our 300 gallon spray unit. At our No. 1 pumping station a $7\frac{1}{2}$ h.p. vertical pump was installed to be used as a jockey pump in order to maintain constant pressure on the system at all times. Each pump station had a 6" - 92 G clayton valve placed in the main line. The other equipment that was used to complete the 27-hole system was as follows: 199 Buckner, 8570 valve in head sprinklers with 29 volt L.P. Solenoids, 218-8550 sprinklers equipped the same as the 8570 units, 418 L.P.D. Decoders, 3 DS 4 disconnect switches, 1 portable operator and DC converter pack and 12 Binar CP-1 controllers. The banks or CP-1 units and the DS-4's are located in our office where they are easily checked for operation.

The system is warranted against defects for 1 year and was winterized this season by Demarco. J-M warrants all functional components for the same period of time.

V. Conclusion

We have had a few bugs to eliminate in operation of the system and are awaiting the coming season to initiate a full schedule for watering our facility. It will take us a while to make our system function properly for the particular needs of our courses.

GOLF COURSE CONSTRUCTION

Robert Orazi
Golf Course Superintendent
Hunt Valley Golf Course
Hunt Valley, MD

Golf course construction is very much a part of golf course maintenance. Sooner or later many of you will either be renovating your course or undertaking a construction project of some magnitude. There is always the problem of that one green that lays low on your course and inevitably by July 4th weekend you just watch helplessly as it goes through its annual "summer kill" period. Under this situation you know what the problem is but correcting it may take years of convincing your greens committee to undertake a rebuilding project with the necessary funds.

Then one morning you unexpectedly receive a phone call informing you that the Board of Directors has finally decided that the number 14 green does need rebuilding after all! And so after trying for years to live with this situation you are now faced with the problem of constructing a new green. A dream come true - or is it just another headache for you! Assuming that the necessary funds have been made available it can be a rewarding experience for you providing you know how to go about it. And so you begin your construction project be it one green or an additional 9 holes.

Working With The Golf Course Architect:

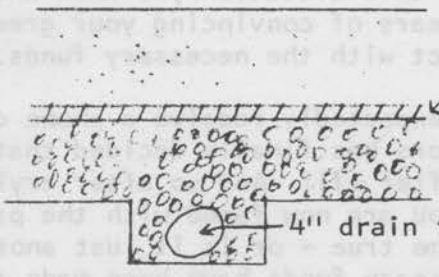
One of your first contacts is with the golf course architect. In too many instances the golf course superintendent is not included in any meetings with the architect; and yet no one is more qualified than the superintendent in helping the architect select specifications for tee, fairway, rough and green construction.

Many so called "problem areas" found on a golf course can generally be related to poor construction practices. In many instances these oversights may have been prevented if consultation with the superintendent were made in the beginning. You have all seen the course that is less than 10 years old where inconsistencies exist and greens do not drain properly due to the poor selection of sand particle size. Many times irrigation systems are installed that require constant modification. Going back and correcting these mistakes can be very costly and more importantly will interfere with the original purpose of the golf course - - to provide uninterrupted play!

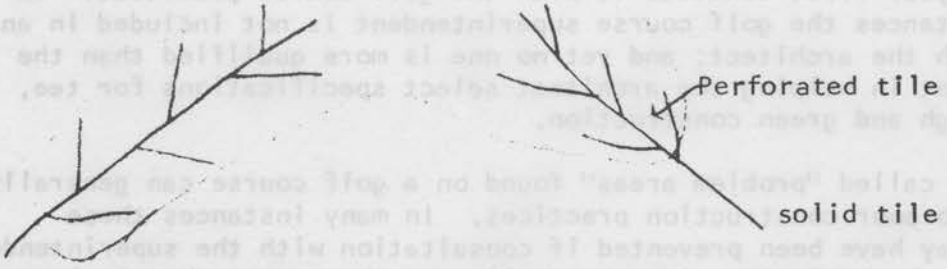
When selection of the architect has been made sit down with him especially if he is foreign to your area and discuss such things as the type of greens construction to be used and the selection of grasses before specifications are written up for contract bidding. Go to the various sand suppliers in your area and obtain samples to be tested. In Maryland we are fortunate to have a wide range of sands to choose from. Similarly check the new site for what type and amount of top soil is available. Check for the availability of humus and obtain samples for testing. Once you have obtained all three materials for testing send them to an independent soil testing lab for testing. The cost of this

service is minimal compared to what the cost of using the wrong sand could mean. Generally when you get the results of the test you will have several materials to choose from. In my opinion this is the only way to go in selecting the proper greens mixture.

What type of greens construction will you be using? Are you going to use the Purr Wick System or follow the recommendations of the U.S.G.A. Here I feel that the opinion of the architect is most important. He has had the experience of seeing each type of construction and knows pretty well the capabilities of most contractors. For practical purposes we will be using internally drained sand greens at Hunt Valley's new addition.



The thing to keep in mind when installing internal drainage is that you do not want water to move more than 10 inches in order to enter a drain tile. Another consideration to keep in mind is that perforated pipe is used to pick up water and solid pipe is used to transport water.



The selection of grasses, on the other hand, should be made by the golf superintendent. Here you're dealing with many different opinions and experiences as well as your own local conditions. The turf specialist at your local university can be very helpful in telling you some of the blends and varieties that have been tested and provide you with the results of these tests. However; the final selection should still be yours because you know what will work under your conditions. Ideally if you have a year or two to make up your mind you can set up a series of test plots on location and observe the results. George Gumm did this at the Ocean City Golf Club several years back and was able to select a blend that

was suited to his own conditions. What works for one superintendent may not necessarily work for another. Whatever the selection, manage it the best you know how and remember that you reserve the right to change your mind. There are varied opinions as to whether the answer is ryegrass, bluegrass or the warm season grasses in the Mid Atlantic Area.

Selection of the Builder

After everyone concerned is satisfied with the set of plans and specifications the architect has prepared it is time to select the man who is going to make the architect's dream a reality - the artist, the sculptor, the man who can transform the thoughts and ideas of the architect from paper to the land.

There are a couple of important points to consider in selecting the builder. After reviewing the architects plans and specifications each contractor being considered should be asked to submit a sealed bid and visit the site. Select the contractor of choice and have him perform his work on a time and materials basis.

Sealed Bids

In accepting a sealed bid the criteria the architect has provided in his plans and specifications pretty well dictate that the project is in complete control of the architect. Any changes from the original plans will generally be handled on a "cost plus" basis. This is fine as long as the architect is able to visit the site frequently while the course is under construction.

Costs and timing are more controllable because each phase has to be completed on or about a certain date to insure partial payment. Penalities are generally included in the contract if these deadlines are not met. Most experienced golf course contractors are familiar with this type of contract and prefer this type of arrangement for scheduling purposes. They know how long their equipment will be tied up and can program their work accordingly.

The responsibilities of the golf course superintendent under this type of contract are to see that the plans and specifications provided are adhered to by the contractor. Any suggestions or changes during construction will have to be approved by the people financing the project.

Time and Material Contract

In the case of the job being done on a time and materials basis, more of the golf course superintendents time and judgement are involved. This is especially true if the contractor does not have his superintendent on the job site at all times. Changes can readily be made in the field under this type of contract. If a certain drainage problem is noticed or additional clearing is necessary these can be corrected immediately without

loss of time. Attempting to satisfy an inspector representing the soil conservation service can be handled more discretely when the owner has to meet specifications because more frequently than not sedimentation laws will vary from county to county and state to state.

Whatever the contract, the builder should be experienced in golf course construction and be reputable. Generally a list of previous jobs and references will be provided upon request. If he is a member of the Golf Course Builders Association of America you know that he must adhere to a certain code of ethics.

In summery I hope I have shown you that the golf course superintendent must indeed be diversified in handling a construction project. The time you spend in the planning stages and out in the field will reward you later as the course matures with fewer maintenance problems and more time to consider other construction projects.

TENNIS COURT MAINTENANCE

Robert C. Miller
Golf Course Superintendent
Suburban Country Club
Pikesville, Maryland

Fast-dri tennis courts - what are they? - How are they built and what is the daily maintenance that should be done to insure a good playing surface?

What are fast-dri tennis courts? Some commercial names for fast-dri courts are Har-Tru, Green Marble, Greenrock Valite green, Rubico-green surfacing and Vel-play. Most of the basic composition material is a fine ground green stone that looks and feels like sand. The surface materials usually are ground to the following mesh screenings:

14 mesh	1 - 5% retained
20 mesh	15 - 25%
28 mesh	15 - 25%
35 mesh	10 - 15%
65 mesh	12 - 20%
100 mesh	2 - 8%
passing 100 mesh	23 - 33%

In building tennis courts pick a location that is well drained and free of trees and undergrowth including roots. Get a reputable tennis court builder to come to your club or organization and talk to the officials and superintendent. Have them estimate a price and write a construction contract for the amount of courts to be built. After plans and a contract are signed by both parties the superintendent should assign his tennis court maintenance man to observe the builder during the construction. At Suburban Country Club we have been fortunate to have Donald Fleet doing the tennis maintenance work for the past 23 years. Donald is the most sincere person about his job that I have met in the golf course or tennis business. He has trained 5 other people that take care of tennis courts in the Baltimore area. He has given me a tremendous amount of information about tennis courts.

While the builder is building you tennis courts give him as much cooperation as possible. There are always little things you can do for him that will insure you a better built tennis court.

The sub-grade for the courts should be at least 3 feet outside the fence line. Area should be graded in a place with a slope of 1" for every 24 feet. After the sub grade is complete, install your irrigation system. I would recommend putting in a system that eliminates as much hand watering as possible.

Again have the builder or an irrigation installer put in your system unless you have adequate equipment and materials to install it yourself (see table 1). The heads of the system should rise above the finished court and then be lowered after the final construction of the court. After the irrigation system is completed a brick curb should be placed around the court battery. These are single bricks laid flat end to end imbedded in cement on a stone base. This type curb is designed to float with frost and should last indefinitely. The finished curb elevation should be $\frac{1}{2}$" below the finished grade level and the court surface should be tapered from 18 inches out to meet it. The purpose of the curb is to keep the fast-dri material from spreading and act as a buffer for grass or weed encroachment.

After the brick curb is in place start to work on the stone base. The base of a fast-dri tennis court is designed for two functions: First, it must be as stable as a water bound macadam to support the surfacing layer. Materials that tend to shift or crawl when rolled, or move when subjected to freezing and thawing should be avoided. Secondly, the base must be porous to asorb excess water from the playing surface to allow play immediately after a rain. This absorbed water is later evaporated back to the surface, keeping it moist for best play. The stone base should be a crushed stone but other materials such as cinder, slag, pit gravel or washed lime rock are sometime used. The stone base should be 4" thick. The stone base should be put on top of the sub-grade in rows 12 ft. wide on 6 ft. centers. Use 1" X 3" X 14 ft. screed strips nailed flush to top of the grade stakes. Stone is then hauled or wheeled in and placed in the rows to the top of the screed strips. A straight edge is then pulled in a straight forward movement, striking off the stone level with the screed strips. Extra care should be taken not to displace the screed strips. After finishing a section of the stone base then roll with a 600 to 1000 lb roller and repeat this process in the next base section until the whole court or the battery of courts are done.

When the complete base is done and has been rolled, watered and re-rolled, the next step is to lay the Har-Tru or fast-dri material. Since your stone base was placed to grade, lay off your court or battery of courts in strips 12 ft. wide in either direction. Using redwood strips start 12" inside the brick curb, tamp the strips lightly to firm them. Lay a bag of material on the end of each strip to keep them from sliding. Then place 7 bags of surface material inside the strips. Bust open the bags with a metal rake and smooth the material until it is level with the top of the strips. After doing 10 to 15 ft. take the straightedge and pull forward to get a true level where the material is smooth. Fill in all low areas or impressions with a shovel of material and repull the straightedge over the same area. When the complete 12 ft. wide area is completed repeat the same procedure in the next 12 ft. area. When the 12 ft. bay is done water this area thoroughly. When puddles appear you know sufficient water has been applied. When the surface material is semi-dry roll the area with a 600 lb roller. In doing the adjoining bays remove the screed strips and use a thin strip of metal (16 gauge) 6" wide and 20 ft. long on top of the surface material on the area just

completed. This will serve as a height level for the straightedge when leveling the rest of the court.

Net post foundations are now installed. The foundations should be 30" X 18" X 30" with a clear distance between posts of 42 ft. The net post sleeve should be a $3\frac{1}{4}$" piece of pipe imbedded in the foundation hole in cement level with the top surface of the court.

The court can then be marked off and tapes nailed to surface. A diagram for this procedure is at the end of this text.

Erect your net posts and nets and the tennis court is now ready for play.

In a short review basically a tennis court is built along the same lines and procedures as a United States Golf Association green. It contains sub-grade and a stone base which serves both as drainage and a water reservoir to keep the top material moist and in good shape.

Daily maintenance on fast-dri courts - include watering every day and brushing or brooming daily. Roll the courts at least once a week with a 1000 lb roller and then use line brooms or line brushes every day. When the service line areas become low take up the tape and rebuild the area with more material. The following pages give a more detailed method. There are no hard and fast methods as different people do jobs with different styles but hopefully the following suggestions will be a help.

General Maintenance

The following suggestions for maintaining a Har-Tru fast-drying tennis court are simply basic guide lines - not hard, fast rules. Local climate, soil conditions and court layout will require the establishment of different maintenance procedures, using our guide lines in conjunction with its own requirements and capabilities.

Brushing

The court should be brushed by pulling the brush over the entire surface of the court at the end of each day's play. In addition, if the court is in continuous use, it is recommended to brush midway during the day's play. Brushing keeps the surface level and the granules evenly distributed at all times. Brushing, which only takes a minimum of time, is very definitely an important item of court maintenance.

Brushing should be done in different directions as much as possible to prevent build-ups of material.

Watering

A green Har-Tru fast-drying tennis court plays best when slightly damp (dark green color). When the court surface tends to become grayish

in color, it is an indication that the court needs watering. A sprinkler system is recommended for watering whenever possible. This will save many hours of labor and will pay for itself in a matter of months. However, when watering by hand, the nozzle of the hose should not be pointed down toward the surface but should be held at waist level and directed horizontally so that the water will fall in a shallow arc.

The best judge of how much water to put on the court is the difference between the amount needed to keep the surface damp, during playing time, and the amount believed to be in the court at the time of watering. The correct amount of time for watering will be found by trial and error and experience. The recommended time for watering is at night after the court has been brushed.

Rolling

A newly-constructed court should receive one or two consecutive rollings - lengthwise and crosswise - each day for a minimum period of one week. Rolling is best effected when the court surface is in a damp or semi-damp condition. A 600 pound power roller will provide best results. Following this initial maintenance the court should be rolled at least three times per month, in addition to rolling after every appreciable rainfall.

Rolling an absolutely dry or extremely wet court is not recommended. If the court surface adheres to the roller surface and/or tends to move or shift when rolling, rolling should be stopped and the court allowed to dry sufficiently to prevent damage to the court. Once the court has dried to the point that the previous condition no longer exists, rolling can be continued. The more rolling a court receives the firmer the surface, resulting in a faster playing court.

Patching

If a hole or small indentation appears in the surface, it should be repaired immediately, because failure to do so can cause more extensive and difficult repair work later on. For example, if a small depression appears near the base line and does not disappear with ordinary maintenance, then the area should be patched. Using a hand trowel, square end shovel or like instrument, cut out the area down to the stone base material. Replace the removed area with regular Har-Tru surfacing material. The Har-Tru should be applied dry, compacted and leveled to the surrounding area. The material is easily leveled with a straightedge piece of wood drawn across the area in a manner similar to concrete floating. After the area is leveled apply enough water to soak the patch. When the water disappears the patch should be firm and ready to play on. These instructions apply to all sizes of patches.

Spring and Winter Maintenance

General

The Winter maintenance required for Har-Tru Fast-Drying Tennis Courts is largely determined by the geographical location and the local weather conditions of the installation. Thorough consideration to cover the court should be given when the playing season is limited to three to four months. The owner or caretaker can best determine if and when the court should be protected. If there is a probability of the courts drying out during the non-playing season, accompanied by strong winds, it is recommended that the court be covered to prevent loss of surface material.

During the Winter, the tapes will generally rise above the surface and have to be reset in the Spring. The tapes can be removed and stored in the Fall and relaid in the Spring. If the tapes are not removed, it is recommended that boards be laid on the lines to keep them in place. Also, some added weight such as bricks or stones will help keep them down.

For older courts with a cinder base, substantially fewer cinders will appear due to frost action if the court is covered. When cinders come to the surface they must be removed in the Spring.

Covering

Polyethylene plastic is recommended for covering the courts. The plastic is laid with the first piece at the low side of the court and each successive piece should overlap the adjacent one four to six inches. It is good practice to lay two by fours on the laps to get the plastic to conform to the surface of the courts. Also bricks or stones should be placed on the boards to prevent wind or other unnatural disturbance of the plastic covering. In the Spring the covering material should be removed, and after watering, brushing and rolling sufficiently, the court will be ready for play.

Reconditioning and Top Dressing

Clean the surface of any debris and, if there are stones or foreign materials on the surface, these should be picked up and removed. If there appears to be excess loose, coarse or dead granules on the court surface, these may be gathered into small piles by using a lute (a straightedge scraper) and removed with a shovel. Once the court is cleaned it should then be thoroughly rolled to compact the surface. If more than one ton of new material is to be applied, the tapes should be removed to prevent them from becoming too low.

The regular green Har-Tru surfacing material is usually the most satisfactory material for reconditioning a Har-Tru court. The surface must be dry before any new material is applied. If there is any doubt as to whether or not the court is dry enough, one should sprinkle a

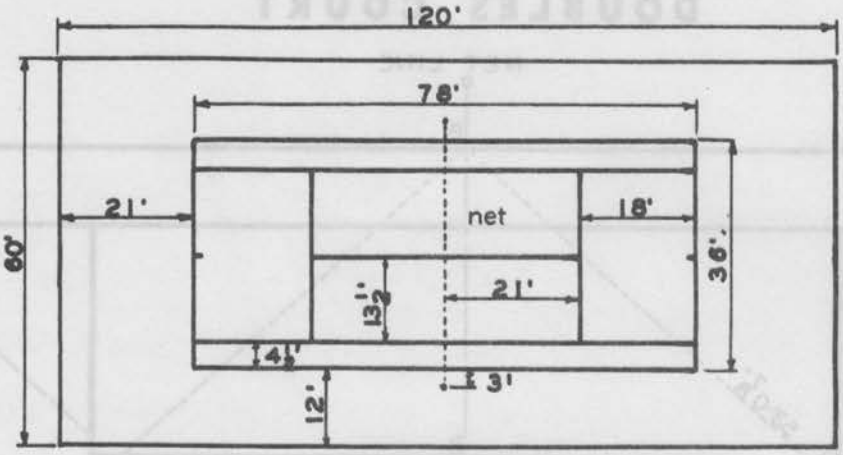
handful of new dry material on the surface and step on it lightly. If the material tends to stick to the shoe, the court surface is too damp for the application of material.

Apply the new material as evenly as possible, by using a lawn type spreader set to the widest opening. If this is not available, it can be broadcast by using a shovel.

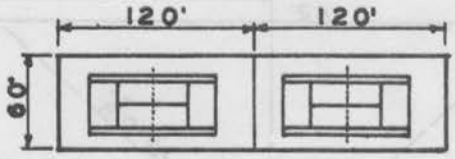
After the new surfacing material has been applied, the court should be brushed in two directions. The tapes should be brushed and water applied in a very fine spray until the court is wet. Care should be taken that too much water does not fall on any one spot to cause a hole or the material to wash out. The court should then be allowed to absorb the water. When the surface is dry (no evidence of water on the surface) the court should be brushed again. Then the court should be rolled at least once in each direction with a 600 lb. roller. This rolling should be continued, as well as the brushing, until the court is firm enough for play.

CORRECT TENNIS COURT LAYOUT

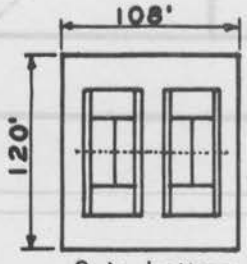
SINGLE UNIT AND IN BATTERY



LAYOUT FOR 1 COURT

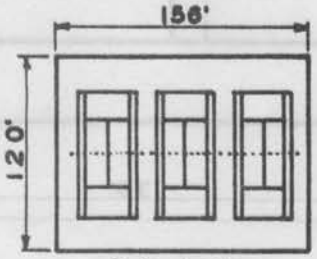


2 end to end

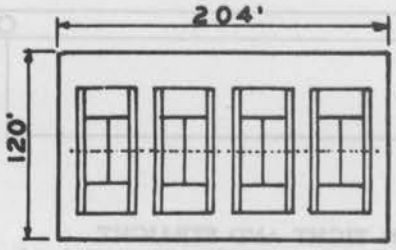


2 in battery

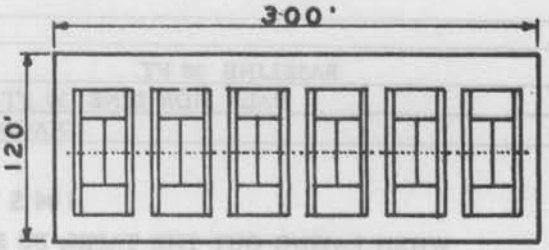
NOTE
WHEN IN BATTERIES ALLEY
BETWEEN COURTS IS 12'



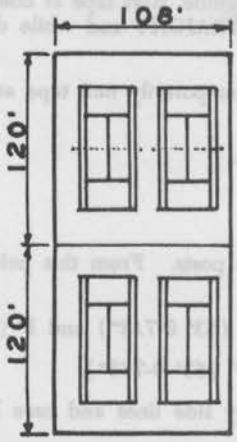
3 in battery



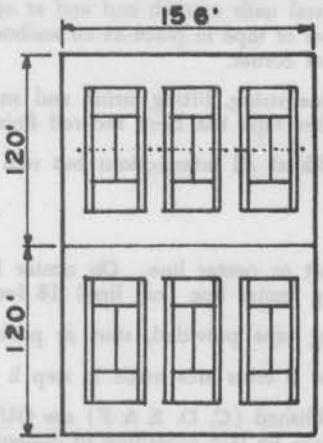
4 in battery



6 in battery



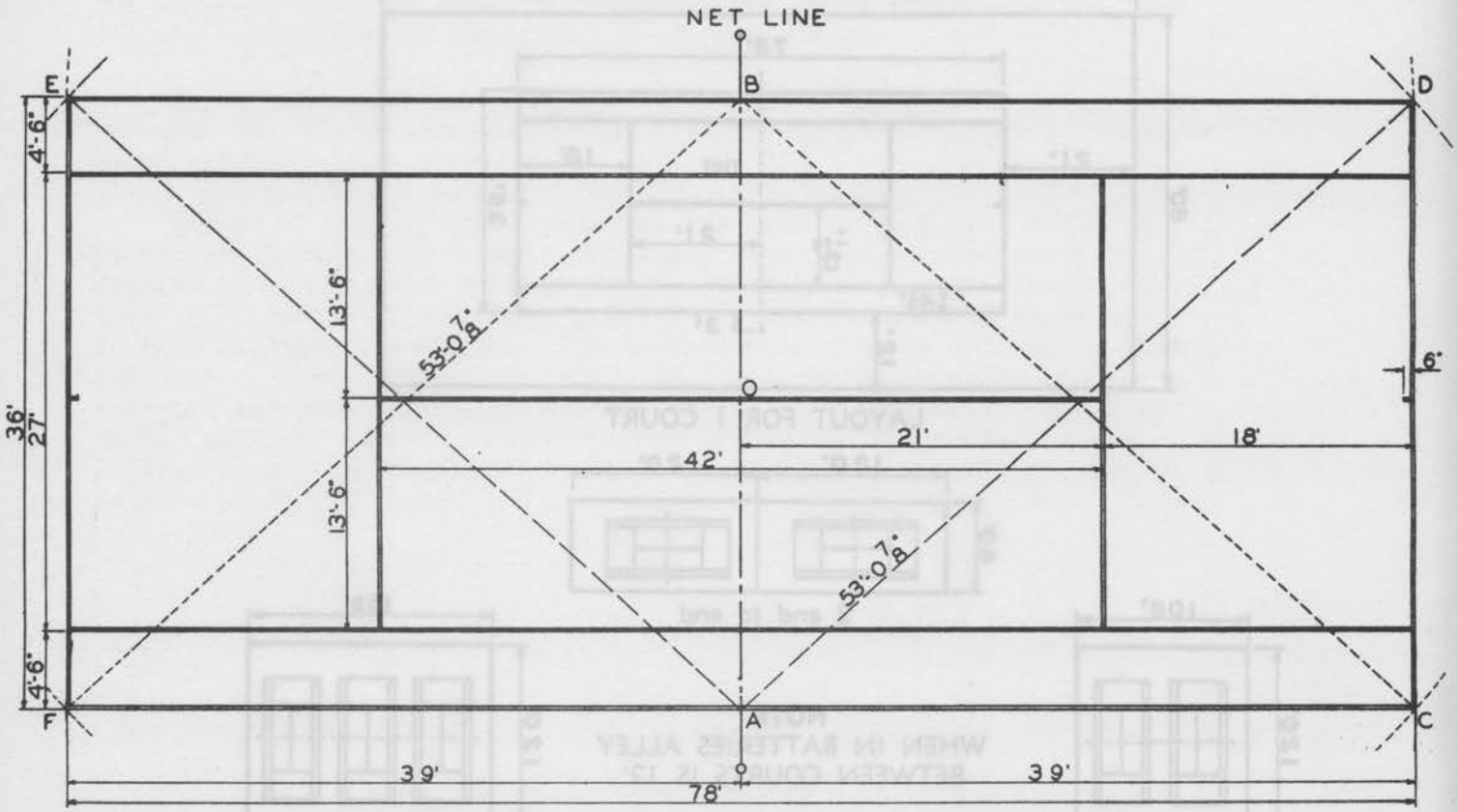
2 batteries of 2 end to end



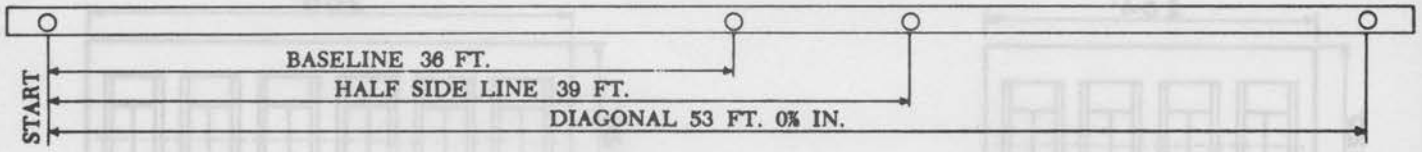
2 batteries of 3 end to end

INSTRUCTIONS FOR LAYING LEADED FABRIC TAPES

DOUBLES COURT



MEASURING TAPE



INSTRUCTIONS

WHEN LAYING OUT THE TAPES, BE SURE THE TAPES ARE DRAWN TIGHT AND STRAIGHT.

This can be accomplished after stretching a string (mason's line) along the court line to be laid. The string should be pulled tight and anchored with several nails at each end and at approximately 20 foot intervals. Using this line as a guide, start tape at one corner and nail about three feet of tape in place as an anchor. From opposite corner pull tape TIGHT AND STRAIGHT and while drawn tight, anchor with nails at corner.

Align tape with line string, lifting string and snapping it occasionally to avoid misalignment, and temporarily nail tape at about two foot intervals. After tape has been secured finish nailing in holes provided at three inch centers.

Lap tape full width at all intersections but nail thru both layers at the four outside corners only.

1. Establish the net or center line. On center line find center point ○ half way between the net posts. From this point measure both ways along center line (net line) 18 feet and establish points A and B.
2. Using measuring tape provided, start at point A and swing arc at C (39'), D (53' 0-7/8"), E (53' 0-7/8") and F (39').
3. Starting at point B cross arcs made in step 2 at points C (53' 0-7/8"), D (39'), E (39') and F (53' 0-7/8").
4. The points established (C, D. E & F) are OUTSIDE corners of the court. From these points lay side lines and base lines. The interior lines can then be laid according to dimensions in diagram.

Table 1. Standard Amounts of Materials Needed for Courts in One Battery

Brick	570	725	875	1025	1150	1300
Sand - Cu. Yds.	1 cu.yd.	1½ cu.yd.	2	2½	3	3½
Cement - Bags	8	12	16	20	24	26
Stone 3/4" - tons	130	210	300	400	500	600
Screening - tons	20	40	60	80	100	120
TCM - tons	40	72	104	136	168	200
Nails aluminum - lbs.	12	24	36	48	60	72
Concrete for posts - Cu. Yds.	3/4 yd.	1½	2	2½	3	3½

HORTICULTURAL PLANTINGS ON GOLF COURSES

J. P. Barefoot
Golf Course Superintendent
United States Soldiers Home
Washington, D.C.

The aesthetic value of flower beds has many faces. You can utilize them to call attention to areas, dress up otherwise dull areas, break the sterility of square corners and walls, or just plant them because they are pretty.

Unless you have a greenhouse operation like ours it is pretty difficult and at times more expensive to grow your own annuals. Seed germination temperatures and incubation climates vary with the seeds to be sown so all can not be accomodated in one small greenhouse.

When selecting your bedding plants, be sure to buy more than you need so you can hold replacements for any that might die. It is not necessary to plant a sculptured or formal bed such as EMBROIDERY masses of many different kinds of annuals. Embroidery beds uses SANTOLINA, ALTERANTHERIA, and MARIGOLDS and many other types of flowers. The santolina foliage is the show part of this plant and it is available in several colors. Santolina is especially good for display beds where you want to outline numbers, letters, or figures such as a liberty bell or club crest.

Containers are often very effective to brighten areas, and are relatively easy to maintain. Cascade petunias can be used to soften the corners of many types of planters. A simple red geranium in a bucket, tub, washboiler, kettle, or even an old commode, wagon or wheelbarrow, can be used effectively to set at the base of a signpost, the edges of steps, next to gates or doors, or at junctions of walks where people tend to take shortcuts making paths in the turf.

Marigolds, impatiens, hens & chickens or any other annual that will adapt planted in a strawberry jar can create an interesting display.

In recent years IMPATIENS have become increasingly popular. They do equally well in shade or sun. We are using Impatiens in many beds where we previously planted Petunias, since the impatiens are much hardier and less prone to damage from temperature and moisture extremes, insects, and disease. We often border impatiens with LIRIOPE. The banana plant can add interest to the flower bed - and the banana benefits from its summer in the sun.

In order to have the beds as full as possible early in the season, we plant closer than the seed book recommendations. We work in 5-10-5 when preparing the beds, along with manure or peat moss, Milorganite, lime or bone meal, and Perlite. The beds are fed through the growing season with a liquid soluble fertilizer about once a month. The vases

and boxes are fed every two weeks, the feeding being stopped if the plants show signs of legginess. We have found that Calypso petunias, harmony marigolds, and dusty miller blend very well.

Marigolds with Salvia, are quite prolific and easy to grow. Their problem of susceptibility to rust, and powdery mildew can be controlled by occasional spraying of Tersan 1991. Another interesting plant is the Celosia or commonly called Cockscomb. It is available in many varieties and colors and provides an interesting and unusual display either in groups or alone.

Begonias do well in the shade, and if they are heavily fertilized fill in rapidly in a full sun situation.

Caladiums, their show coming primarily from foliage, make a bed that is attractive early in the season, and are an excellent centerpiece for begonias or impatiens or can be successfully bordered with LIRIOPE.

Once established, a perennial/biennial garden can add variety to your beds, they have a wide range of blooming periods, and many can be used for cut flowers. Ornamental cabbage provides an interesting cover for a tulip bed in the winter. It is showy, hardy, and will prevent erosion of the soil.

With tulips, I prefer a massing of single colors as much as possible. Care should be taken to select heights and time of blooming that are compatible when mixing varieties.

Planting of mums after your annuals have shown weakening in the fall will add color for an extra month or two. They can be removed at tulip planting time to a holding area where you can keep them pinched from the start of the growing season until mid-July and brought back in the beds the following fall.

Annual vinca covers rapidly and does well in temperature or moisture extremes and is a very hardy plant. Canna lillies are used where a tall plant is needed - along walls, along fences, or as a centerpiece for a bed, stepping down to geraniums, then ageratum then alyssum.

We have been using Treflan as our weed preventer for the past five or six years with excellent results. Watering should be done as needed, although overwatering should be avoided.