PROCEEDINGS

of

1948 TURF CONFERENCE

Sponsored by the

G. O. Mott, Executive Sec.-Treas.

and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

MARCH, 1948

Table of Contents

ATTENDANCE

MIDWEST REGIONAL TURF FOUNDATION CONFERENCE

At Purdue

March 1 - 3, 1948

Name	Address	Country Club or Co.
Aarnick, Clifford	R. 2, Box 209, Terre Haute, Ind.	Terre Haute C.C.
Aarnick, D. F.	R. 1, Terre Haute, Indiana	Terre Haute C.C.
Anders, Ray	R.R. 4, Rockford, Ill.	Mauh-Nah-Tee C.C.
Aulbach, George	Amarillo, Texas	Amarillo C.C.
Baer, Virgil L.	Crown Point, Ind.	Youche C.C.
Bailey, H. S.	2015 Colfax St., Evanston, Ill.	Rep. Geo. A. Davis
Baker, A. S.	2529 Catalpa Dr., Dayton, Ohio	Jacobsen Mfg. Co.
Baker, C. I.	Chicago, Ill.	Chicago Park Dist.
Baker, Paul E.	Box 942, Portsmouth, Ohio	Elks C.C.
Barnhart, George E.	Box 434 R. 5, Evansville, Ind.	Muni Golf Course
Barrows, Robert J.	419 Kensington Dr., Madison 4, Wis.	Maple Bluff C.C.
Bennett, Wayne F.	R.R. 6, Box 39, Kokomo, Ind.	Kokomo C.C.
Bertucci, Elmer	345 Highwood Ave., Highwood, Ill.	Old Elm Golf C.
Biddulph, George	North Olmsted, Ohio	Spring Vale G.C.
Bidwell, Warren	2501 Bedford Ave., Cincinnati, Ohio	Cincinnati C.C.
Biggs, Floyd H.	Valparaiso, Indiana	Wauhoh Pk. G.C.
Bockoski, Chester	2701 N. Keystone, Indpls., Ind.	Willow Brook G.C.
Bond, R. R.	Box 350, Madison, Wisconsin	Old Orchard Turf Nurseries
Bobterbaugh, T. E.	Milwaukee, Wis.	Milwaukee C.C.
Boyd, Mavor S.	R.F.D. 1 Perry, Canton, Ohio	Parkersburg C.C., Parkersburg, W.Va.
Boyd, Taylor	Box 21, Cincinnati 27, Ohio	Kenwood C.C. & Camargo Club, Maderra, Ohio
Brandon, A. L.	St. Charles, Ill.	Greenkeepers Reporter
Brei, Henry	5501 Larcom Ave., Chicago, Ill.	Cook Ct. Forest Preserve, Edge-Brook G.C.
Bretzlaff, Carl	R.R. 16, Box 641, Indpls., Ind.	Meridian Hills CC
Buower, C. A.	Brook, Ind.	Hozelden C.C.
Brown, Carl R.	2035 N. Meridian St., Apt. 303, Indpls., Ind.	Mississenewa C.C. Peru, Indiana
Brundage, Robert	Copley, Ohio	Landscape
Butler, Albert	Michigan City, Indiana	Pottorwattomick C. C.
Cahill, Jim	Covington, Kentucky	Summit Hills
Canale, Joseph	Oglesby, Illinois	Deer Park G.C.
Chaplin, R. C.	R.F.D. 2, LaGrange, Ill.	Edgewood Valley C. C.
Chimelin, T. F.	River Grove, Ill.	Elmwood Cemetery Co.
Clarke, William	Box 431, Glenview, Ill.	Cook Ct. Forest Preserves & N.W. G. C.

Name	Address	Country Club or Co.
Clauss, Walter L.	529 Manguette Ave., Peoria, Ill.	Madison Park
Coble, Clem	54th & Kessler Blvd., Indpls., Ind.	Broadmoor C. C.
Conner, Edgar	Arthur, Illinois	Haskaskio Co. Club
Corlett, E. J.	28200 Kinsman Rd., Cleveland, Ohio	Beechmont C.C.
Cornwell, Ward	1015 Vernier Rd., Grosse Points Woods 30, Michigan	Lochmoor C.C.
Coval, Elmer	Lebanon, Indiana	Ulen C. C.
Coyne, Mike	Chicago Heights, Ill.	Lansing G.C.
Darrah, John	8700 So. Western Ave., Chicago, Ill.	Olympia Fields C.C.
Davidson, Ernie	Homewood, Ill.	Ravisloe C.C.
Davis, Ray	Prairie View, Ill.	Sky Crest C.C.
Davis, Raymond C.	Medinah, Ill.	Medinah C.C.
Davis, Richard	Lafayette, Indiana	Purdue University
Dearie, Ed B., Jr.	Oak Park, Ill.	Oak Park C.C.
Dearie, Gerald M.	Chicago, Ill.	Edgewater G.C.
DeBruyn, Leonard	Chicago, Ill.	Ridge C.C.
Didier, Ray	Chicago, Ill.	Tam O'Shanter C.C.
Dinelli, Frank J.	1302 Clavey Rd., Highland Pk., Ill.	Northmoor C.C.
Dinelli, Joe	Highland Park, Ill.	Northmoor C.C.
Dowell, Earl	Lafayette, Indiana	Lafayette C.C.
Dryfoos, Sidney L.	3108 Mayfield Rd., Cleveland, Ohio	Oakwood Club
Dunlap, Frank	Cleveland, Ohio	Cleveland C.C.
Dunn, Robert J.	Box 327, Crown Point, Ind.	Gary C.C.
Ebel, John C.	210 N. Hager Ave., Barrington, Ill.	Biltmore C.C.
Enfield, George H.	Dept of Agron., Purdue Univ. Lafayette, Ind.	Purdue University
Ermer, Frank W.	7506 Jameson Rd., Parma, Ohio	Ridgewood G.C.
Esterline, W. L.	Muncie, Ind.	Delaware C.C.
FauKerslay, D. R.	Frankfort, Indiana	Frankfort C.C.
Ferguson, Marvin H.	Beltsville, Maryland	USGA Green Section
Fifield, E.	1236 Rutledge St., Gary, Ind.	Gary Parks
Fontaine, L.L.	P.O. Box 636, Cherokee Station, Louisville 5, Ky.	Big Spring G.C.
Ford, O.C.	Fowler, Ind.	
Fortner, Jack	Indianapolis, Ind.	Speedway G.C.
Fox, O. P.	6549 Oxford Ave., Chicago, Ill.	Swift & Co. Plant Food Div.
French, Leo B.	440 W. Washington St., Chicago, Ill.	U.S. Rubber Co.
Gabriel, Sam J.	Cummings Sq., Harlem Ave. & Lake Ave., River Forest, Ill.	Cook Ct. Forest Preserve
Garmhausen, Wilbur G.	Columbus, Ohio	Ohio Highway Dept.
Garringer, C. E.	Indpls., Ind.	Speedway G.C.
Gerber, Ray	Glen Ellyn, Ill.	Supt. Glen Oak C.C.
Gillett, A. J.	1128 Rockton Ave., Rockford, Ill.	Forest Hills C.C.
Gilley, Angus	R.R. 6, Connersville, Ind.	Connersville, C.C.
Glos, E. H.	Bartlett, Ill.	Bartlett Hills G.C.
Glos, Walter H.	Bartlett, Ill.	Bartlett Hills G.C.
Godwin, H. F.	18261 Beowerland, Detroit, Mich.	Godwin Turf Nurseries
Goeke, Tony	811 So. 9th St., Richmond, Ind.	Elks C.C.
Graham, Paul	Edwardsburg, Mich.	Four Lakes C.C.
Graves, Stan	R.R. 17 Box 2, Indpls., Ind.	Municipal G.C.
Gridley, Owen	Lakeside, Michigan	Chikaming C.C.

Name	Address	Country Club or Co.
Griener, Clarence	43 So. Delaware St., Indpls., Ind.	C. E. Griener Co.
Grotti, Dominick	Northbrook, Ill.	Sunset Ridge C.C.
Hair, R. M.	Piqua, Ohio	City of Piqua
Halloran, Fred J.	Chicago, Ill.	George Davis, Inc.
Harasty,	Cleveland, Ohio	Caterburi C.C.
Hardy, Percy	R.R. 1, Box 431, Glen View, Ill.	Indian Boundary GC
Harker, J. W.	P. O. Box 636, Cherokee St. Louis. Ky.	Big Spring G.C.
Harris, Robert Bruce	Chicago, Ill.	Golf Course Architect
Harvey, Charles W.	3920 West 71st St., New Augusta, Ind.	Hillcrest C.C.
Herd, Bruce	Flossmoor, Ill.	Flossmoor C.C.
Heston, L.	Lafayette, Indiana	Purdue University
Hjart, Carl	Michigan City, Ind.	Long Beach C.C.
Hocker, Orville L.	1139 Pursell Ave., Dayton, Ohio	Supt. Pk. & Recreation
Hoffer, G. N.	Lafayette, Indiana	Purdue University
Holcomb, Stu	Lafayette, Indiana	Purdue University
Holt, Ethan	Lafayette, Indiana	Purdue University
Hopkins, Virgil C.	1527 So. Shairdin St., Elwood, Ind.	Elwood C.C.
House, Alvin	Indianapolis, Ind.	Meridian Hills C.C.
Hoyt, Walter	LaGrange, Ill.	Timber Trails G.C.
Hull, R.B.	Purdue University, Lafayette, Ind.	Landscape Architect
Husted, A. M.	522 Court House,Cincinnati, Ohio	Havillion Co. Pk.Dist.
Huter, J. G.	Louisville, Ky.	Big Spring G.C.
Isleib, H. T.	P. O. Box 677, Morristown, N. J.	Elks C.C., Richmond, Ind.
Johnson, Norman C.	43th & Brainard Ave., LaGrange, Ill.	LaGrange C.C.
Jones, Fred G.	6025 Guilford Ave., Indpls., Ind.	Sarah Shank G.C.
Kavanaugh, M.	Cincinnati, Ohio	Hamilton Co. Park District
Kiem, Wm.	Indpls., Ind.	Pleasant Run G.C.
Knox, George	1939 Miller Court, Homewood, Ill.	Calumet C.C.
Kohnke, Helmut	Lafayette, Indiana	Purdue University
Kohr, J. G.	R. R. 2, Box 504, South Bend, Ind.	South Bend C.C.
Kramer, H. H.	Lafayette, Indiana	Purdue University
Krantz, Frank	Owensville, Ohio	Camargo Club
Kress, Frank G.	3200 W. Grange Ave., Milwaukee, Wisc.	Tuckaway C.C.
Kuehl, Harry	Valparaiso, Ind.	Valparaiso G.C.
Kunek, Wm. E.	412 W. McClure, Peoria, Ill.	Northmoor G.C.
Lange, H.	Golf, Illinois	Glen View Club
Lankford, M. T.	301 W. Maryland St., Indpls., Ind.	Kenney Mach. Co.
Leahy, Gene	7609 Eberhart Ave., Chicago, Ill.	With Mr. Stewart
Lee, O. C.	Purdue University, Lafayette, Ind.	Weed Specialist
Lee, Owen	Muncie, Indiana	Delaware C. C.
Lehker, Glen	Purdue University, Lafayette, Ind.	Extension Entomologist
Lindenschmidt, Robt. L.	1513 Dana Ave., Cincinnati, Ohio	Hartwell Club
Linkogel, Albert	Clayton 5, Rt. 1, St. Louis Co., Missouri	Westwood C.C.
Lowe, Frank	Three Oaks, Michigan	Chickiming C.C.
Lyons, Wm. E.	1200 Firestone Parkway, Akron,Ohio	Firestone Tire & Rubber

Name	Address	Country Club or Co.
MacGregor, John	660 Euclid Ave., Glen Ellyn, Ill.	Worthington Mower Co.
McCawley, Roy F.	Mt. Prospect, Ill.	Mt. Prospect C.C.
McCoy, John	Columbus, Ohio	Ohio State Univ.
McCracken, C. H.	Columbus, Ohio	Ohio State Univ.
McDermott, Fred J.	R.R. 2, Leesburg, Indiana	Tippecanoe Lake CC
McDonald, Pat	Mt. Prospect, Ill.	Rob Roy G.C.
McIntosh, Dave	135th St. & 76th Ave., Orland Park, Illinois	Oak Hills G. C.
McIntosh, Drew	Fort Knox, Kentucky	Fort Knox C. C.
McIntosh, Jock	Palos Park, Illinois	Oak Hills G. C.
McLaughlin, J. W.	Lafayette, Indiana	Purdue University
Mackey, G. J.	Purdue University, Lafayette, Ind.	Dept. of Physical Ed.
Malteo, Michele	Hudson, Ohio	Lake Forest C. C.
Mann, Herbert A.	River Grove, Ill.	St. Joseph Cemetery
Marchi, Gene	3401 Salem Ave., Dayton, Ohio	Miami Valley G. C.
Marinello, M. J.	Chicago, Ill.	Chicago Park Dist.
Martin, James	Lafayette, Indiana	Purdue University
Mascaro, Tom	West Point, Penn.	West Point Lawn Products
Mashie, Emil	Lake Forest, Ill.	Onwentsia C. C.
Mendenhall, Chester	5301 E. State Line, Kansas City, Missouri	Mission Hills C. C.
Metz, T. K.	Michigan City, Ind.	Michigan City Municipal G. C.
Miller, R. S.	Dayton, Ohio	City of Dayton
Monical, Nelson	240 N. Portage Path, Akron, Ohio	Portage C. C.
Moore, Lowell	Purdue University, Lafayette, Ind.	Purdue University
Morrier, E. F.	Eastern State College, Charleston, Illinois	Charleston C. C.
Mott, G. O.	Purdue University, Lafayette, Ind.	Purdue University
Muller, Keith	Chicago, Ill.	U. S. Rubber Co.
Needham, A. A.	R.R. 2, Rockford, Ill.	Rockford C. C.
Newkirk, Edward	3235 Sutherland, Indpls., Ind.	Coffin G. C.
Nipple, Harold	R.R. 3, Box 650 Davis Ave., Terre Haute, Indiana	Rea Park
Noer, O. J.	P. O. Box 2079, Milwaukee, Wis.	Sewerage Comm.
Nowlin, O. H.	301 W. Maryland St., Indpls., Ind.	Kenney Mach. Co.
Nuessle, Fred	Flossmoor, Ill.	Flossmoor C. C.
Nugent, W. C.	Brook, Ind.	Hazelden C. C.
Oates, Wm. H.	Wheaton, Ill.	Arrowhead G.C.
Ohlrogge, Alvin	Lafayette, Indiana	Purdue University
Owens, R. E.	Peoria, Ill.	Peoria Park Dist.
Packer, Edward J.	7071 Clovernook Ave., N. C. Hill Cincinnati, Ohio	Wyoming G. C. Wyoming, Ohio
Parish, Lorn C.	Rt. 2, Parkersburg, W. Va.	Worthington G.C.
Parsons, M. M. Sr.	Indpls., Ind.	Highland G & C. C.
Parsons, M. M. Jr.	Indpls., Ind.	Highland G & C. C.
Petersen, C. A.	7059 So. Shore Drive, Chicago, Ill.	South Shore C. C.
Plein, Clarence	St. Louis, Mo.	Creve Creur G. C.
Popp, Paul	26th Desplaines Ave., Riverside, Ill.	Riverside G. C.
Purvey, Albert	McHenry, Ill.	McHenry C. C.

Name	Address	Country Club or Co.
Quarandillo, Louie	Logansport, Indiana	Logansport C. C.
Randolph, W. H.	Charleston, Ill.	Charleston C. C.
Rees, James D. Jr.	4701 Keystone Ave., Indpls., Ind.	Willowbrook G. C.
Riley, William F.	2121 Madison Ave., Indpls., Ind.	Riley Lawn & Golf Equip.
Robellaz, Josephine	R.R. 2, Lafayette, Ind.	Edwood Glen G. C.
Rosset, Gabriel	Sunset Ridge Rd., Northbrook, Ill.	Green Acres C. C.
Rost, Bert	Park Ridge, Ill.	Park Ridge G. C.
Rowell, John	Kingston, Rhode Island	Plant Pathologist, R.I. Agr. Exp. Sta.
Runyan, C. C.	Station W, Cincinnati, Ohio	Cemetery of Spring Grove
Sage, Lois	Seymour, Indiana	Seymour C. C.
Schnitzius, H. J.	Indpls., Ind.	
Schroeder, Clarence	Appleton, Wis.	River Verre C. C.
Seaney, William L.	602 W. Main St., Crawfordsville, Ind.	Swift & Co.
Sellers, Everett	Glenview, Ill.	North Shore C. C.
Shahun, Albert	Coschocton, Ohio	Coshocton Town & CC
Sharvelle, Eric	Lafayette, Indiana	Purdue University
Shatwell, W. E.	Chicago, Ill.	Headquarters Fifth Army
Shock, Earl	2560 Berkley Dr., Dayton, Ohio	Community C. C.
Skrdla, Willis	Lafayette, Indiana	Purdue University
Siems, H. B.	Chicago, Ill.	Swift & Co.
Simmons, Howard E.	Cleveland, Ohio	Highland Pk. G. C.
Smith, Colin	Courtland Blvd., Cleveland, Ohio	Shaker Heights C.C.
Smith, Horton	Detroit, Michigan	Golf Professional
Sopko, Mike	Wickliffe, Ohio	Pineridge C. C.
Spangler, Wm. A.	1000 Greenlawn Ave., Columbus, Ohio	Green Lawn Cemetery Assoc.
Speights, Lafayette	764 W. 25th St., Indpls., Ind.	Douglas G.C.
Sprenger, Fred C.	709 Bigelow St., Peoria, Ill.	Peoria Park Board
Stanford, B. L.	16100 W. Eight Mile Rd., Detroit, Michigan	Irrigation Sales & Engr. Co.
Stanley, W. H.	Hoopeston, Ill.	Hubbard Trail C.C.
Stewart, C. E.	7658 Calumet Ave., Chicago, Ill.	Buckner Mfg. Co.
Strichter, Earl	Lafayette, Indiana	Purdue University
Strand, Donald G.	2601 Glenview Rd., Wilmette, Ill.	Westmoreland C.C.
Stupple, Wm. H.	Highland Park, Ill.	Exmoor C. C,
Sturgil, Cliff	Covington, Ky.	Devou Fields G.G.
Swezey, Burr	Lafayette, Indiana	Pres. Lafayette Nat'l. Bank
Thalheimer, Wilfrid	405 Western Ave., Batesville, Ind.	Hillcrest G. C.
Thode, Reuben H.	Chicago, Ill.	Chicago Park Dist.
Tiffany, H. M.	Chicago, Ill.	The Albert Dickinson Co.
Tilges, Ed.	P. O. Box 830, Evanston, Ill.	Evanston G. C.
Tyson, Dr. Jim	East Lansing, Mich.	Agronomist
Uebele, Herman	LaPorte, Indiana	Beechwood G. C.
Vail, F. E.	Dayton, Ohio	MacGregor G. C.
Vaughan, Ed.	P.O. Box 128, Park Ridge, Ill.	Park Ridge Dist.

Name	Address	Country Club or Co.
Vaughan, John L.	Chicago, Ill.	Vaughan's Seed Co.
Verhaalen, Lester	6200 W. Good Hope Rd., Milwaukee, Wis.	Brynwood G. & C. C.
Volk, N. J.	Lafayette, Indiana	Purdue University
Wakely, Ted	Toledo, Ohio	Chippewa C. C.
Warren, B. O.	Palos Park, Ill.	Warren Turf Nursery
Waters, H.	Cleveland, Ohio	Sherwin Williams Paint Co.
Way, J. H.	Cleveland, Ohio	Canterbury G. C.
Weber, D. R.	4021 W. Lake,Chicago, Ill.	
Welson, Leo	Indianapolis, Ind.	Speedway Golf Course
Welton, Kenneth	Lafayette, Ind.	Soil Conservation Service
Wendt, Donald	218 W. Russell St., Barrington, Ill.	Builtmore C. C.
Whitcomb, James E.	346 Pruitt St., Indpls., Ind.	Riverside G. C.
Whitmore, G. T. Jr.	607 Hanna Bldg., Cleveland, Ohio	Ridgewood G. C.
Wilson, Floyd D.	Noblesville, Ind.	Forest Park
Wittek, Stan	Crawfordsville, Ind.	Crawfordsville C. C.
Woehrle, Herman	Rt. 3, St. Anne, Ill.	Hieland Lodge
Wright, A. S.	Sharonville, Ohio	Hamilton Co.Pk,Dist.
Wright, D. C.	New Castle, Ind.	Westwood C. C.
Wright, L. A.	New Castle, Ind.	Westwood C. C.
Writ, James	Wheaton, Ill.	Arrowhead G. C.
Wyman, Allan	RR 2, Danville, Ill.	Danville C. C.
Yanaway, John F.	Charleston, Ill.	Charleston C. C.
Young, O. W.	4075 Southern Blvd., Dayton, Ohio	Moraine C. C.

INTRODUCTION TO TURF CONFERENCE

N. J. Volk

It is my privilege to welcome you to Purdue University again, and it is indeed a pleasure and an honor for me to welcome you to hold your Midwest Conference at this institution. I came to Purdue three years ago and at that particular conference we organized the Midwest Regional Turf Foundation. At least it was started at that time and was completed during the year. Since that time this organization and also the conference itself has grown strong and I believe the organization is here to stay. It hasn't grown quite as rapidly in some respects as we would like to have seen it grow but from the standpoint of these meetings, the organization certainly has developed more rapidly than I had ever anticipated it would. I believe that we have been having this type of meeting for something like ten years here at Purdue.

Now then, I just wonder if we have "repeats" at these meetings. I know we have because I have already shaken hands with a great many of you who have been here before. How many of you have been here to a meeting before? It looks like it's unanimous. How many of you have been to two meetings before? Well, that's about half, at least. How many have been to five meetings before? I didn't realize there were that many. Well, that certainly shows that you are getting something out of these meetings, and that ought to be an encouragement to the staff here at Purdue and also to the other speakers that have come here to talk to you, because when we have a lot of "repeats", then we are sure that we are putting across something that is worthwhile.

I wonder how many of you realize just how important turf is in this nation. It enters practically every phase of human life. First of all, I would mention recreation. Many of you are interested in golf courses, parks and similar recreational uses of turf. Recreation is a very important thing in the life of the individual, and turf plays a very important part in that particular phase of life.

Then we have health problems. If we had turf on all the bare spots in our cities we would have a lot healthier condition because in order to have turf on such areas, we would have to eliminate some of the dirt and filth that accumulates on them. The farmer that has a nice turf, a nice back yard, a nice front yard, probably has the healthiest condition around his premises. So we do have human health benefits associated with the use of turf.

Turf is important to government. If all the turf, and I include all sod crops in this case, disappeared in the United States, our democratic form of government would likely disappear and we would become a nation in which the government owned the land. I don't think there is any question about that. If turf disappeared, the only solution for the preservation of the land, would be for the government to take over the land and see to it that turf was put back on a certain percentage of it in order to maintain the land in a productive state and to save it from washing away. I think you'll find that countries that tend to cultivate practically all of their land and have a minimum of sod crops have gradually gone over to some type of dictatorship or non-democratic form of government.

Turf is very necessary for maximum food production. I'm speaking of turf in the broad sense now, not the kind of turf that some of you know only as you find it on the golf course or in somebody's front yard, I am speaking of the large area

of farm land that should be covered by grass or legumes. We cannot have maximum production on any given piece of land unless we have some kind of turf as sod brought into rotation for a certain specified length of time during each rotation. Sod or turf is essential to good soil structure and good soil structure is an important factor in maintaining food production in this nation.

Turf plays an important part in the conserving of our soil. It prevents the soil from washing down the rivers into the Gulf of Mexico or the Atlantic or the Pacific Ocean. Turf makes the soil absorptive of water, instead of letting it run off. We can put turf in our rotation, once every three or four years, or maybe more frequently than that if the land is steep and we can save that land and keep it on the farm, inside of the fence, instead of in the river. So it is very important to our nation that we have turf from the standpoint of conservation. It is just as important to the city man, the greenskeeper, the factory worker, and the preacher, as it is to the farmer that our soil be saved to produce crops and food now and for future generations.

From the standpoint of commerce, turf is important. Just think of the turf problems along our highways and in connection with our airfields. Without turf, I am sure that man would cease to exist and this nation would cease to be strong. So irrespective of whether you are interested in turf on a golf course, turf in a cemetery, turf on the roadside, grass in the front yard, or turf in the pasture, you should recognize that wherever you are working with turf, you are working with one of the most important crops affecting the life of man. The program that these men have worked up for you is one that I think you are going to enjoy and get a lot out of. Dr. Mott and his committee have done an excellent job in bringing together a group of good speakers. We will always be happy for any suggestions that you want to give to us, so that we can improve these conferences from year to year.

WHAT'S NEW IN TURF

Marvin Ferguson

During the war years many promises were showered on us regarding the wonders of the "postwar world". For the most part we have been disappointed. This is not the case, however, in the field of turf management. There are a number of new grasses, new machines, new disease, insect and weed control materials that make the growing of turf easier than it was before or during the war.

Probably the most significant new thing in turf is the machinery that has been set in motion for the purpose of discovering new facts. The research involved in the discovery of facts that will aid the cause of good turf means a lot of hard work on the part of some one. We do not know how much turf research is being done by other national organizations, but it may be well to outline the Green Section program as it fits into the nation-wide, decentralized, cooperative program of research and education.

Since August 1945, the Green Section has had research grants at Rhode Island, Pennsylvania, New Jersey, Georgia, Texas, Florida, and Oklahoma. These grants were usually in the amount of $300.00 each. All the money for research grants came from funds derived from Green Section subscriptions. In 1945 there was no money in the USGA treasury for reaearch. USGA memberships were at such a low ebb that there was not even enough money to support the Green Section office. It was therefore necessary to look elsewhere for funds for research and education. The answer was Green Section Subscriptions.

Green Section subscriptions are a means whereby commercial organizations, individuals, parks, cemeteries and schools, are enabled to contribute to the Green Section program and in turf receive the benefits of Green Section research and their publications. Rates for subscriptions are $30.00 a year. This was the same as the membership dues in the USGA until 1948 when USGA dues were raised to $35.00 a year.

Since August, 1945, the Green Section has placed research fellowships at Pennsylvania, Purdue, Michigan, and Georgia. More fellowships are planned and will be placed at Oklahoma, Texas, Maryland and Rhode Island. These fellowships are usually a joint effort with a cooperating group. Most of them have been made possible by contributions. A list of contributors was published in the December, 1947 issue of TIMELY TURF TOPICS. Some of the contributing organizations are: Detroit District Golf Association, Indiana Golf Association, Indianapolis District Golf Association, Southern Golf Association, Southern Turf Association and many others. The results of some of this work are now becoming usable data and are adding to our fund of basic knowledge of turf requirements. As this work increases there will be a "snow-balling" effect and soon a great many papers will be coming forth describing the results of turf research.

It is significant to note that a great many of the turf conference programs are entitled "2nd annual turf conference". These conferences are new and they are an indication of growing turf interests. In the development of turf programs through organizations such as turf associations or greenkeepers' associations it has been found that the "Turf Advisory Committee" is an indispensible cog in the wheel. The committee is a liaison between the experiment station and the turf interests of the state or the region.

Another thing that is new in turf is the fact that more people are realizing that others besides themselves are growing turf. It may be grown for a different purpose, but many of their basic problems are the same. A grass for roadside or

airfield use has the same general needs as a grass for tees or putting green use. The management and the use is difficult but the fundamental growth factors are the same.

It may be interesting here to outline the scope of turf in the United States.

15-16 million lawns	1 million acres
5,000 golf clubs	750,000 acres
38,000 athletic fields	150,000 acres
airfields	1,750,000 acres
Ground Force stations	2,000,000 acres
Parks	750,000 acres
Cemeteries	No figures available.
Roadsides	No figures available.

These figures have been compiled by the Turf Committee of the American Society of Agronomy.

Some examples of mutual benefits derived and mutual problems encountered in other phases of agriculture are:

1. The aerifier is now being used in pastures. It was designed for fairways and greens.
2. Blitzer mowers designed for airfields and golf course roughs are being used in pastures.
3. Efforts to grow 300 bushel yields of corn per acre have been stymied by problems of poor aeration and compaction. These are troubles that have confronted greenkeepers for many years in the maintenance of putting greens.
4. Homeowners, upon seeing a beautiful fairway, say, "I wish I had a lawn like that".

It has already been stated that the discovery of new facts through research involves a great deal of effort. These efforts cost money. There are several sources of money for the support of research. They are:

1. State legislatures can make appropriations to turf through the regular agricultural appropriations to the state experiment stations. This is the best and the soundest procedure. Turf has been recognized by the American Society of Agronomy as a legitimate part of agriculture and therefore it is only logical that a certain portion of funds for agricultural research be devoted to turf research. Turf groups must ask the experiment station to do this work. Experiment stations have no justification for developing information unless there is a demand for it. It is well to remember that "The squeaking wheel gets the grease".

   The recognition of turf by the American Society of Agronomy and the establishment of a Turf Committee within the Society is one of the "new" things in turf and it is a very significant step forward for the turf profession.

2. Commercial grants are another source of funds for research. We must invite industry to help us in turf research. They have valuable contributions to make, they are interested in our problems, and they feel that they have a big stake in the future of turf. Industry is to be congratulated on its independent research in the development of fungicides, insecticides, herbicides and machinery.

3. USGA grants are a source of revenue for turf research but they are limited because funds are limited. These limited funds can be made to go farther through cooperation with groups such as the Midwest Regional Turf Foundation and others. Other national groups are correlating their activities with ours and there is a pooling of interests.

A new book will be forthcoming in the near future. It is the USDA Yearbook of Agriculture for 1948, and it is entitled "Grass". A considerable portion of this book will be devoted to "Specialized Uses of Grass". The specialized uses of grass are mostly turf uses. The Yearbook should be a valuable contribution and beneficial to all those interested in the growing of turf.

Now let us consider some of the specific things that have recently come about. The "aerifier" is a machine designed to cultivate turf without severely disturbing the sod. The principal of cultivation and aeration is the same as that involved in the forking or spiking of greens. The sod is perforated allowing air, moisture, fertilizer and lime to get down into the soil where they are available to the grass roots. There are several machines now on the market which will aerate and cultivate the soil. No doubt there will be improvements upon these models. The principal involved is the important consideration and the development of machines to do the job is an important step forward and a valuable tool is furnished to the turf grower.

Among the new grasses for turf, the tall fescues, Alta and Kentucky 31, are probably the most important. These grasses are not really new. They have been grown for a number of years, but their use in turf is a new development. Some of the outstanding experimental plots are in existence here at Purdue where Alta fescue has withstood a 1/2 inch clipping height for two years. The tall fescues have a tremendously wide range of adaptation and are suitable for a number of turf purposes. The only objection to the tall fescues is a somewhat coarse texture. This feature is not significant if the service requirements of turf are kept uppermost in our minds. The wear resisting qualities are excellent. In tests at Michigan State College which were reported by Morrish and Harrison in the February, 1948 number of the Journal of the American Society of Agronomy, Alta fescue ranked near the top of the list in wear resistance. Alta fescue will do well on soils of low fertility, but it responds readily to high nitrogen fertilization.

There are several new red fescues that deserve consideration. At the Beltsville Turf Gardens, we have collected a group of red fescues and they are being grown for comparison. These trials include Oregon grown Chewings fescue, the Penn State Blend of Chewings fescue, Illahee creeping red fescue, Rainier creeping red fescue, Olds creeping red fescue, S-59 (a Welsh strain of creeping red fescue) Alta fescue and Kentucky 31 fescue. These have been under observation for a relatively short time and data that has been collected will have to be substantiated by further observation. Q-10 fescue is a strain that the Green Section is increasing because it is felt that this strain has characteristics of heat tolerance which are necessary in many parts of the country where red fescue is grown. This grass has been outstanding during the summer months at Beltsville.

The only bluegrass which shows exceptional promise is B-27. It is an interesting fact that most of the efforts toward the improvement of turf grasses have been expended on bluegrass, yet we have little to show for it. Much has been learned about the mode of reproduction and the hereditary characteristics of Kentucky bluegrass, but surprisingly few contributions have been made from the practical standpoint. B-27 is a low-growing, dark green grass which is resistant to Helminthosporium leafspot. Plans are under way to name this strain following further testing on a broad scale.

Perhaps Midwest greenkeepers are not too much interested in Bermuda grass, but we feel that it has a place in certain portions of the crabgrass belt. U-3 Bermuda is a strain that has been growing in the Green Section plots since 1938. During that time it has not winter-killed and it has stayed green more months of the year than any other Bermuda grass. It has survived the winters of State College, Pennsylvania, since it was planted there in 1940. Unfortunately, this strain of Bermuda is not available commercially. Much time and effort go into the testing and evaluation of grass strains before they are ready for commercial production. For tees, Bermuda grass is excellent. It can be mowed closely, it requires the minimum of irrigation, it forms a dense turf, it recovers rapidly, it crowds out crabgrass and goosegrass and it makes its best growth during the months of July, August, and September when the going is tough.

The Zoysias hold much promise for many turf uses. Zoysia matrella is adapted to the southern part of the United States and forms a very dense, fine-leaved turf. Zoysia japonica is more winter-hardy than Zoysia matrella but it has a somewhat coarser texture. These grasses are both more winter-hardy than Bermuda grass but they do not grow as rapidly as Bermuda. The Zoysias are not new grasses. They were introduced into the United States many years ago but they have not found wide use because of the fact that they were difficult to propagate vegetatively and no seed was available. Recent investigations by the Green Section and the Bureau of Plant Industry have disclosed the possibility of seed production as well as methods of treatment whereby germination of Zoysia seeds is much improved. These developments promise to place the Zoysia grasses on a commercial production basis. Zoysias will find a ready acceptance for many turf uses. One of the chief objections to Zoysia is its winter dormancy. Tests are in progress to determine whether cool-season grasses may be grown in association with Zoysia to provide color during the period when it is dormant.

The development of seed production will do much to encourage the use of Centipede grass in the Southeastern United States. Centipede is low-growing and forms a tough, dense turf. It is desirable for many uses and has a low fertility requirement.

In the improvement program on the bentgrasses, the emphasis has been placed on putting green bents. Several superior strains have been developed. Arlington bent (C-1) is particularly desirable from the standpoint of disease resistance. In plots at Rhode Island State College, the Arlington bent that was not treated for disease has been almost as good as the treated area. A great deal of attention is now being turned to the development of superior fairway bents. Golfers are demanding good lies on fairways. The answer seems to lie in the use of grasses that will form a dense turf under close mowing. Examples are bent, Bermuda, or Zoysia. The Green Section has a nursery consisting of approximately one hundred bents that have been collected from roughs and fairway areas from over a large part of the country. These bents have been chosen because of their hardiness in withstanding conditions of drought, low fertility and disease and insect resistance. We hope to find something superior to the bents now in general use on fairways. The Rhode Island Experiment Station has been carrying on an improvement program with the Colonial bents for a number of years. The Pennsylvania Experiment Station is conducting studies on seed production of creeping bents. It is quite likely that they may develop superior strains for fairway and lawn use.

The development of insecticides such as DDT, Chlordane, Benzene hexachloride and Thiophos 3422 have certainly been of tremendous benefit to turf growers. These developments have been paralleled by the advances in the field of herbicides and fungicides. 2,4-D has been a revolutionary tool in the control of weeds in turf. The new cadmium fungicides offer a solution to the dollarspot problem, one of the worst headaches with which the greenkeeper has had to contend.

THE PLANT FOOD SUPPLY SITUATION IN 1948

H. B. Siems

You probably realize that I wouldn't be talking about the plant food supply situation for 1948 if you could get all the plant food you want, which, unfortunately is not the case. But you know we've really come a long, long way in the manufacture of plant foods in relatively few years. From 1935 to 1939 the industry sold on an average of 7,300,000 tons annually. Last year it was pretty close to 16,000,000 tons. Now, that's a lot! Keep in mind that labor conditions were much more difficult than during the war. And in addition there was a production potential of 25% more that could not be utilized because of the scarcity of raw materials.

Nitrogen

Let's talk about the three major elements, Nitrogen, Phosphorus and Potassium. You have seen the exhibit at the entrance, showing what happens to plants when any one of these three is deficient. Now, what is the situation in regard to nitrogen? Nitrogen, gentlemen, is still scarce, yet since 1938 there has been an increase of nearly 100% in production. This year the International Emergency Food Council has allocated to the United States 873,000 tons of nitrogen. This, in terms of sulfate of ammonia, would be in the neighborhood of 4.5 million tons. Where does it come from? About 100,000 tons is imported from Chili as sodium nitrate of Chile saltpetre. Most of that is desinted for southern agriculture, which sorely needs it for side dressing cotton, corn and other crops. Then we import from Niagara Falls 15,000 tons of cyanamid. Most of that goes into orchards and for dusting cotton plants to remove the foliage at time of harvest. A small amount of sulfate of ammonia is imported from Trail, British, Columbia. So much for imported nitrogen -- a total of 137,000 tons. Our domestic production includes the following sources: In the manufacture of coke, coal is heated to a high temperature and the gases that are driven off are collected. One of these gases is ammonia, which is combined with sulfuric acid to form sulfate of ammonia. Production for the coming year of this material is estimated at 185,000 tons. About 150,000 tons of ammonium nitrate and 73,000 tons of synthetic sodium nitrate and uramon will be available. The industry uses various nitrogen solutions, all of them containing ammonia, some containing dissolved ammonium nitrate or urea. The nitrogen in these solutions amounts to 248,000 tons. Finally, there are 30,000 tons of organic nitrogen, derived from sewage sludge, cottonseed meal, tankage, etc. All told, that seems like a lot of nitrogen; now, why can't you get all you want? Well, 58,000 tons of this is to be exported to countries in Europe and Asia where there is a severe food shortage. So the reason for the nitrogen shortage is the food shortage. The American farmers are helping to alleviate that shortage through exports of vast quantities of food stuffs. And the amount of plant food the farmer uses is dependent upon the amount of money he makes. As you know, the farmers have been doing very well; they are spending more for plant food than ever before. Some of our midwestern states are using 30 times as much plant food as they were before the war. Now that there is a shortage of what the farmers want it is very difficult for industry to allocate much plant food for golf courses. The politicians would certainly raise Cain if it did. Gentlemen, that is the picture. We hope that next year some of the government-operated nitrogen plants, which are now exporting their total output, will sell it to our industry. This year the nitrogen situation is about 4% or 5% better than last, but the demand is still very, very great. So if you have a chance to obtain plant food containing nitrogen, by all means take advantage of it.

Phosphorus

Now, about phosphorus. Phosphates are needed in relatively large amounts since the soil minerals combine with them and the plants must compete with the minerals in order to have good growth and a vigorous root system. In order to assist plants in this competition much more phosphorus than is the crop requirement must be added to the soil. Phosphorus is the bright spot in the supply picture. A few years ago we used 5 or 6 million tons of superphosphate. This year, with the increased facilities for treble-superphosphate production and new phosphate rock mines opening, production should exceed the equivalent of 10 million tons of 18 per cent superphosphate. In addition, there are considerable quantities of phosphoric acid in the form of furnace treated phosphates, basic slag, various organic products and phosphate rock.

Potash

What about potash? This is another shortage in the raw material supply situation. It appears that potash production will be maintained at a slightly higher level than last year. The capacities of five principal operators are being pushed to the limit and no new production facility is in sight. All of these plants were built before the war and they have been unable to expand very much since. Although the potash producers deserve a lot of praise for their high production through increased efficiency and round-the-clock operations, the demand for potash is still far beyond the supply. In order to make mixed goods available to more consumers the industry has had to cut down on high-potash grades, mixing 2-12-6 rather than the recommended 3-12-12.

As far as the minor elements - manganese, zinc, boron and copper - are concerned, I think those elements will be available in adequate amounts. In most cases it is best to apply them in ready-made plant food mixtures, because it is an easy matter to apply toxic amounts of boron or manganese.

I wish that I could really have said something that you would like to hear, namely, that you could get all the plant food you need. But being put on the spot makes me feel like the spider who was spinning his web. He said, "This is going to take a lot out of me."

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Question: What is the outlook for completely soluble fertilizer?
Answer: It depends on what compounds you want. If you want nitrogen, the story is still that the nitrogen supply is very short, Now, the completely soluble nitrogen compounds of commerce are primarily ammonium sulfate, ammonium nitrate, sodium nitrate, ammonium phosphate and urea. I think those are the principal ones available at present. When it comes to phosphates that are completely soluble, the supply of them at this time is rather limited. All potash salts are soluble.
Question: Do the slowly available nitrogen compounds have commercial possibilities at this time?
Answer: As far as I know, no company is producing commercial quantities of slowly available nitrogen compounds made from urea and formaldehyde. Some of you may perhaps recall that I made a little of this material at last year's meeting. I poured two solutions together and in a very short time the mixture solidified. That product formed is still fairly scarce, for the reason that urea is still not available in sufficient quantity.
Question: What about the organic nitrogen carriers such as soybean meal, cottonseed meal, etc?
Answer: These materials are used as animal feeds. They are scarce even as such, hence there is a shortage.
Question: What is the source of potash?
Answer: Most of the potash used today comes largely from New Mexico potash mines. The potash is about 1000 feet below the surface. It is sandwiched in between layers of ordinary salt and is brought to the surface and purified. It contains, in the natural condition both the potash salts and common salts. Some potash comes from Utah, some from the salt lakes in California and a small amount from Europe.

WATER MANAGEMENT

O. J. Noer

As I look at the program I see the topic assigned to me is Water Management. Ken Welton is going to take the Drainage end of this mornings session.

I really prefer to talk about water usage rather than fertilizers because I think water management is the most important single factor in the maintenance of turf on a golf course. That fact can't be stressed too much. By recalling some of the headaches of 1947, from August on, I am sure you will agree with me, that fertilizer is frequently blamed for damage and injury that actually was caused by the faulty use of water. So you see everybody will be better off if water is used intelligently, and some of the summer time headaches will disappear. The water man is the key man in the golf course. He should be conscientious, dependable and well trained.

When I came in this morning and saw that little green cap on the front row, it reminded me of the days many years ago when I was a freshman at Wisconsin, I had the same shape and colored headgear, so hats off to you, Mr. Frosh.

A couple of years ago, I was in Toronto in the fall and went out to Mississagua with Blondy Wilson. It was a Sunday afternoon. We went over the golf course, and when we got down at the south end of the course, I said, "These greens are wilting, the grass is blue and is fairing badly. You had better get a little water on quickly". A new man was in charge who hadn't had too much experience taking care of greens. I was very much concerned, so we started to inspect all the greens. When we got to the north end of the course the greens looked as though they had been watered properly. So I gold the greenskeeper, "It looks to me as though you ought to check a little bit on the men who are doing your watering. Do you have just one, or do you have two?" He said, "Well, I've got two school boys. One man waters on the south end of the course and the other waters the north end". We decided that he had better check the man on the south end and when he did he found he came out to the club, set the sprinklers out, went to the club house and enjoyed a nights sleep and went off the job in the morning. It is not necessary to say more about the job of watering he did or to emphasize the necessity for having dependable well trained men to do the watering.

Before discussing the practical aspects, it might be well to review briefly the functions of water so far as turf growth is concerned.

A small amount of water is used to build plant structures, as was mentioned by Dr. Tyson yesterday, that is, the hydrogen and oxygen is used in the leaf as a raw food material to build sugar, which is the starting point for the elaboration of every other product in the plant. The amount used for this purpose is small and of little practical significance so far as the total quantity of water used by the plant is concerned. Water is also the vehicle of transport, that soupy stuff that George Enfield talked about. It carries the nutrients from the soil into the plant and is the vehicle of transport that moves the soil nutrients up into the different parts, where they are utilized and also carries the elaborated food made in the leaf, down to the other parts, including the roots. Transport is an important function of water.

By far the largest amount of water used by plants, is the transpirational water, or the water that is evaporated from the surfaces of the leaves. For the

last couple of years, Les Verhaalen, of Brynwood in Milwaukee has been good enough to weigh the clippings taken from one of the Washington bent greens on the course. A scale and a chart was provided by us so the clippings could be weighed and weights recorded on the chart whenever the green was moved. Each week a five pound sample of grass was collected and deposited in a box. At the end of the month the composite sample was collected and taken down to our laboratory where it was dried to a moisture free basis. In that way, we have been able to determine the amount of grass produced on the green during a growing season.

For rough calculation, the figure of 100 pounds of dry weight per thousand square feet is the amount of grass produced on a green in Milwaukee under the fertilizer and watering practices followed by Verhaalen. He uses approximately 1-1/4 pounds of nitrogen per thousand square feet per month and supplies ample phosphate and potash for growth. On the basis of a 100 pounds of dry matter, that means an average green of 5,000 square feet, produces 500 pounds of dry matter per year, or per five to six months which is the approximate good growing season in Wisconsin.

Plants evaporate from 300 to 1000 pounds of water per pound of dry matter produced. If 750 is taken as an average for turf on greens which Enfield agrees is a reasonable on an area where growth is fostered by constant watering and where conditions are made ideal for growth. He thinks it may be 1000 pounds.

So on the basis of 750 pounds the grass on an average green of 5,000 square feet will transpire, or evaporate, approximately 375,000 pounds of water during a growing season or about 47,000 gallons which is equivalent to 13 to 15 inches of water. Transpiration accounts for the largest use of water by plants. Additional losses from the soil occur due to direct evaporation, but where there is a dense turf, it is less than the amount that is transpired. If the grass is exceedingly thin and a great deal of surface soil is exposed, direct evaporation from the soil becomes an important factor. Drainage accounts for additional loss on porous soils with light textured sub soil.

The effect of water on character of growth is usually over-looked. Taking corn as an example those of you with farm experience in Wisconsin know that in the sandy area of the state, corn never grows tall, the leaves are always narrower and plants are smaller than they are on heavier soil. That is true even though the plant has all the plant food at its disposal that it can use during the growing season; and would also be true if there was ample rainfall. The reason for the difference in behavior is a matter of water. The sandy soils do not have the capacity to hold as much water, and therefore, growth is limited and the size of the plant is restricted as the result of a lesser quantity of water.

I presume the same is more or less true of grass. Copious watering with a high level of nitrogen makes grass of the same species a bit coarser than it would be under conditions of a more restricted quantity of water. Nitrogen and water are the things that stimulate vegetative growth. When there happens to be a bit too much nitrogen, rate of growth can be restricted somewhat by making water a partial limiting factor. The practice cannot be carried to the point where grass is going to wilt and die as a result of not having an adequate quantity of water. But by trying to limit the water partially, it is possible to overcome, in part, the bad effect of too much nitrogen.

The soil which is the main source of water for all plants is a mixture of a solid, a liquid and a gas, in a cubic foot of ideal soil, approximately 50% by volume, is solid matter consisting of mineral particles and organic matter. Also on a volume basis, about 90% is mineral and 10% is organic matter. Don't be

confused. Most of the recorded percentages of organic matter are by weight and not by volume. You all know that peat is much lighter than sand, therefore, on a weight basis the percentage of organic matter is much lower than when expressed on a volume relation as I mentioned above. The other 50% represents voids between the mineral particles which are occupied equally by a liquid and a gas. The liquid is water and the gas is air. They represent 25% each by volume. In such a well aerated soil it is possible to develop a deeper more extensive root system, than in one which is 50% solid and 50% water. In the latter case the interstices between the soil particles are filled completely with water and do not contain any air. Grass roots breathe just as you and I and when they are deprived of air or oxygen, they are bound to die. As I have often said stay under water for ten minutes and the undertaker is ready to dispose of you. Grass can stand the lack of oxygen somewhat longer, but it will be a dead duck, too, if there isn't air in the soil.

The soil contains three kinds of water, the hydroscopic water which is the moisture a dry soil absorbs when it is exposed to the air. In amount it is never more than a few percent, and is nothing more than of academic importance, to you. Then there is gravitational water, the water which is free to move under the influence of gravity. But we don't want gravitational water in any quantity in the soil because it simply fills up the voids and deprives the soil of air. I am going to dismiss further discussion of it because Ken Welton, who follows me, is going to talk on drainage.

The capillary water, or the film water, is of most importance for plants. It is the water that exists as a continuous film around the soil particles. The small feeder roots absorb moisture from the film, until it becomes so thin that the attraction of the soil particles for water is greater than the pull exerted by the root. Then the plant begins to wilt, and it wilts even though there is still capillary water in the soil. In other words, no plant can utilize all the capillary water in a soil.

In a sandy soil the particles are larger and, therefore, the surface exposed is less than in a fine textured clay soil. As a consequence, it takes less water to make thick films around the larger particles in the sand soil. This fact explains why grass revives quickly on sandy soil after a light shower, and the fact that it had rained cannot be seen by looking at the grass on heavy soil. The small amount of water can produce sufficiently thick films on the sandy soil so there is plenty of usable capillary water, whereas in the heavy soil with a large amount of exposed surface, the films are still so thin that the pull of the roots is not great enough to overcome the attraction of the soil particles for the water. This relationship about particle size and amount of available water is a good thing to remember. Peat and muck soils have a tremendous water holding capacity. They can retain many times their weight of water. Yet, they have an enormous attraction for water and plants will wilt when the peat may still contain 50 to 100 per cent of water by weight. Peat is an excellent source of organic matter but should never be used straight because of its high water holding capacity. During prolonged periods of continuous rains the soil is sure to become water-logged which is very detrimental to growth. Not to exceed 20 to 30 per cent of the soil mixture by volume should be peat or humus material.

Now we talk about the movement of capillary water is frequently stressed. The soil is said to move capillary water from the sub soil to furnish the plant with water and offset losses due to transpiration from the leaves and also from evaporation at the surface of the soil. Yet I can't help but think that capillary movement is really of less practical importance on golf greens than we lead you to believe. In other words, during hot weather and when there are winds, it

is doubtful whether soil can move water from the sub soil, up to the surface where most of the grass roots exist fast enough to prevent wilting. Many of you know the truth of that probable fact from experience. It would seem that a deep root system extending down six to eight inches or more if possible would simplify the problem. Then the grass would have a much larger reservoir of moisture to draw upon.

The principal reason for trouble this last year, was an excessively wet spring. It rained continuously, the greens became water-logged and stayed that way until mid-summer. What happened to the root system as a result? We just didn't have any. A few roots lived near the surface, but there were none underneath. More soil samples were received for testing this fall than in any two during the last ten years. Everybody wanted to know what could be done in the way of a fertilizer program to produce deeper roots. I believe it wasn't a matter of fertilizer, it was a matter of soil aeration. Even the best of soils didn't have good aeration because of the excessively wet spring. As a consequence, when August came and weather got hot the grass started to wilt and began to die soon afterwards unless it was watched, not 40 hours a week, but 7 days a week, Saturday and Sunday included, because grass doesn't work on a 40 hour week. During periods of that kind watering habits must be modified to meet the existing situation.

A few words about the practical aspects of water usage and I shall stop talking. I have just returned from Mexico City. The tendency there is to overwater the greens. It can be done there with more impurity than elsewhere. The climate is very dry; one's lips parch continuously in walking the golf course. There is no rain and temperatures are about 75°during the day time and drop to 60° at night. Climatic conditions are good for growing grass. The greens are over-watered continuously because the golfers think that is the way to have greens which will hold the ball. As a result the bent grass was quite thin, I could squeeze plenty water out of soil taken 2 inches below the surfaces even though greens had been watered about 6 or 8 hours earlier. The soil was too wet and when balls hit the green they would skid and make a deep scar. The greens were being over-watered without question and the soil being used was too heavy. It did not contain enough sand, or enough organic matter. But even so, the greens would have been much better had they followed different watering habits, because when grass is continuously over-watered, it is impossible to have a good thick dense turf. When conditions are reasonable satisfactory for growth, and the grass is not suffering for want of plant food, yet the turf is thin and of characteristic yellowish color it is evident that over-watering is practiced, because continuous over-watering tends to develop a thin open turf. Heavy watering makes the soil wet but in a dry atmosphere such as prevails in Mexico City, a couple hours after the greens are watered surfaces become hard and greens won't hold the ball because there is a thin surface skin of hard dry soil. Then greens are watered and the cycle repeated. The greens never improve because the turf stays thin. A thick turf helps the soil to hold water and helps stop the ball also.

I was in Tulsa in August a couple of years ago and I walked over the course with Alec Reppin. One of the players came along and said "Alec, the greens need some water. They are too dry". He looked at him and said, "The greens are all right, what you need to do is to go to your pro and learn how to play golf!" He was right, the greens would hold a properly played shot.

We generally say that it is best to water the greens thoroughly, several times a week or as infrequent as possible to maintain a good deep root system and a heavy turf. That is sensible practice. But in a season such as we just went through, with an exceedingly wet spring, there were no grass roots in August and a practice such as suggested above would be fatal so far as maintaining turf

is concerned. The greens could be watered at night and by 10:00 o'clock the next morning, the grass would wilt because the few roots were near the surface. When grass turns blue and starts to footprint and wilt badly, there is only one thing to do, namely to get out the hose and sprinklers and to syringe greens lightly with water to carry the grass through the day. Ted Booterbaugh at Milwaukee Country Club did that and had excellent greens, but had a little trouble with fairways because he did not have the labor to water lightly enough time during the daytime to stop wilting. A member of the club lives next to me and came over one Sunday morning. He said, "O.J. hasn't a big mistake been made in watering grass during the daytime at the country club. Isn't that why fairways have gone bad?" I said, "Howard, I hate to see you join the Monday morning quarterbacks". Then I queried, "What's the matter with the greens", he replied, "They are lovely, the best in the city", I said, "Well, they have been watered no less than three to four times every day". So if it was daytime watering that killed grass on the fairways why didn't the greens go bad as well.

In another case in Milwaukee, greens went bad because the turf was too thatched and heavily matted. The club was induced to sprinkle lightly in the daytime whenever grass showed wilt. On Thursday after Labor Day there was 3" of rain during the night. The next day turned warm and windy. About 2:00 o'clock I told Graham if anybody asks for me tell them I've gone out to North Hills. When I got there the turf was blue on the greens. Because the man in charge was up north, I located the foreman and said, "Get the sprinklers out and put a little water on the greens quickly. While you do that, I am going over to the country club house to see Father Kraus, and show him why I am telling you to water. Then he can confront the Monday morning quarterbacks when they start to criticize tomorrow afternoon and say 'How the hell can you expect any grass when it rains 3" at night and the next day at 2:00 o'clock they are out watering the greens'?". With the Noer profile sampler I showed him in a spot where the grass was still green but blue, that the soil underneath was bone dry. Father Kraus took one look and said, "Noer, if you hadn't showed me this, I wouldn't have believed it". In a situation of that kind in mid-summer there is no other alternative but to watch the greens 7 days a week, 24 hours a day, but principally from sun up to sun down. When grass starts to wilt, it is time to do something promptly. It is no time to think about a 40 hour week.

So far as the type of spray is concerned, everybody feels that a fine spray is better than a coarse one. Small droplets pick up more oxygen as they pass through the air than large ones. They introduce more oxygen into the soil to supplement the regular supply.

Time of watering is important unless practice is to over-water. Then it doesn't make any difference when water is applied. Where the correct amount of water is used, there is evidence, based on work done at Washington, to justify the statement that early morning is the best time of the day to water. The reason for advocating early morning watering, particularly in areas such as this where humidity is apt to be high is because it dries the grass off and thereby tends to reduce disease. In dry areas such as Mexico City at Amarillo the home of George Aulbauch who is in the audience, this question of night time or early morning watering is less important. Grass leaves never stay wet for long in a dry climate.

Some of the factors that affect the depth of roots are overlooked. Thatching or matting of grass on greens has become a phobia with me. It is not uncommon to see greens with a half inch to an inch of mat, yet supposedly the greens are being cut at a quarter inch. Actually they are being cut at a quarter inch above the mat but not a quarter inch above the soil. Such greens are not good for putting and the thatched turf is like putting a roof over the soil. As I have told many

of you Scotchmen, in Scotland they can't afford to buy shingles, so they put grass on their roofs, I have pictures showing the same thing in Mexico. Down there the peons use thick layers of cactus fronds on their roofs to keep the water out. The same thing happens when greens are allowed to become thickly matted. I question whether there is free movement of air into the soil on greens where the turf is thickly matted. Even though there is plenty of pore space in that soil, air cannot move down through the tremendous mat into the soil.

Layers of any kind, sand, peat or clay are bad. Sand layers when they are within two inches of the surface prevent deep rooting, especially in hot weather. The grass is sure to wilt and it will be hard to maintain turf on sand layered greens. The thing to do is to top dress such greens as much and as frequently as possible in order to build away from the sand layers and in addition to use a fork before top dressing to break-up the layers. I shall simply mention tree roots because I have talked too much about them. When I was at Guadalajara, Mexico, the other day I saw an instance for the first time where Bermuda grass had become thin as a result of tree roots in the green. I asked members if they had complained about this green, and remarked, "Doesn't it get awfully hard and fail to hold a ball?" They seemed rather surprised, that I could tell them the condition without being a golfer. Well, I could tell the minute I walked on the green that there were roots from the eucalyptus tree along side. An inch below the surface, I found all kinds of roots as big around as my thumb. Tree roots take water out of the soil and then it's impossible to restore it by watering from the top and then when hot weather comes there is no end of trouble.

As far as fairways are concerned, I'm not going to say a great deal because my time is running out. I'm going to confine my remarks to several statements. Grass can't live on water alone, it must have some of that soup diet of Enfields. Plants need food just as well as animals, including man, and they must have water too, but it takes the comgination of both for normal and healthy growth. I induced one of the clubs in Mexico to fertilize a strip across one of the fairways, about a month before I went down there. When I arrived the fairways were watered. The grass where there was no fertilizer was just as brown as it was in the rough, in spite of the fact that it was getting more water than it should need for good growth. Along side of it where the grass had been fertilized, the Bermuda was thick, it was green and was a very good turf from the playing standpoint. So on watered fairways, you will economize to a certain extent on the amount of water that is required by adding the plant food that the grass needs to make a decent growth. It's just folly to use water on a soil that is starved for nitrogen and expect the grass to turn green and start to grow. The soil gets water-logged, turf turns brown and looks worse than without the water.

So far as water systems are concerned, Scotty Stewart is going to tell you all about that subject, but I've got a chance to get in a word here ahead of him and I propose to do so. It seems to me water systems should be designed to take care of the maximum load or requirement for water on the particular area that is to be watered. Scotty says, an inch of water every week. There may be an occasional time when two inches of water is needed, but it is a short period so the grass will not die because it does not get the optimum amount of water. The system should have the capacity to furnish the maximum amount of water that is required at any one time. From the standpoint of use it is a matter of giving the grass enough water to keep it growing, to water thoroughly and at as infrequent intervals as possible. By doing that I am sure turf will be better provided it gets the amount of fertilizer that it needs. Such fairways will make a man like Horton Smith happier when he plays golf on them. This concludes my part of the program here. In an hour or so I shall join the goats, Enfield mentioned at the start of the program.

SOME THOUGHTS ON PUTTING GREEN DRAINAGE

Kenneth Welton

This talk probably should be entitled putting green drainage because in the short time allotted me I doubt if I will get past the putting green, the drainage of which is our main problem. I have no prepared paper and this is intentional on my part since I feel that a little philosophizing on the subject of draining putting greens will be of more help to you men than would the reading of a technical paper. Some may wonder why an engineer was not selected to speak on this subject rather than an agronomist. That's a fair question, but I think I can show you that the consideration of the sciences having to do with plant growth and soils may be more important than the actual mechanics of drainage.

In this connection, if this subject was to be assigned to an engineer you would probably agree it should be a drainage engineer. Yet an electrical or chemical engineer that happened to have farm background and some specialized knowledge of soils and crops might do a better job than a city bred civil engineer who had become known as a drainage engineer by virtue of some experience in highway drainage, or even in farm drainage, because that is also based on different problems than drainage for fine turf. Most drainage engineers are civil engineers that just simply started in with some drainage work and kept with it. I think the colleges nowadays are turning out agricultural engineers that are better qualified by training than anybody else for farm drainage work. That hasn't always been so, but I believe the agricultural engineers today are getting more plant physiology, soil science, and related soils and crops teaching than previously. The point I am making is that if an engineer is to make any improvements over the customary drainage practices now in effect he would have to know something about the particular plant or crop he's draining for.

For example, there are a number of good engineers working under my supervision in the state. They are farm drainage engineers, and yet I wouldn't ask any one of them to get up here today and speak because not one of them knows anything about the nature of golf course turf and the related problems you are up against. I know what would happen if one of those engineers would be given a drainage job in another part of the country where conditions or crops are different from where he's been working. The first thing he would do, because he's experienced and knows how to keep from getting his neck out too far, would be to go and chat with the county surveyor and the drainage contractors. He would find out how much drainage had been done around that section and how much of it was successful and how much of it failed, and why did it fail. Then having that information, he would visit some of these jobs and talk to the farmers. Well, the point is this -- the more I have to do with draingge, the more I feel that drainage of any particular area or for the growth of any particular crop, is not an exact science; it's more of an art.

On that basis, I don't see any reason why an agronomist, horticulturist or a soils man can't pick up enough of the mechanics of drainage to do as good a job of draining a putting green as an engineer who is unfamiliar with fine turf culture. And that lets me in, because I am an agronomist and also have had considerable experinece in drainage of the kind we're considering. One time, following the first world war, I was in business with Stan Thompson who is now quite a famous golf architect. We built or remodeled about 21 golf courses spread out across Canada and the north central states. Stan did the architecture and I followed along and supervised the construction work. Sometimes we would have as many as five or six jobs on at the same time. I often spent three or four nights a week sleeping on pullmans in those days. We had jobs from Halifax, Nova Scotia across to the Rockies and down through the states. At first we would hire engineers but it wasn't long before we learned the mechanics those engineers were using in laying out drainage

systems. So, I got my experience by trial and error, using all the facts and technical assistance I could get, and you are going to have to do the same in solving each drainage problem on your course. Use your imagination and experience, and with all the knowledge you have gained about the nature of the plant you are growing, you can design a drainage system for each particular problem on the course. The problems from green to green and spot to spot will be different. There is no book nor college course that will outline the exact procedure for a particular situation because there is too little known about the movement of water in soils, and then every soil reacts differently.

For example, here is a common prairie soil called Brookston, which is classified and described in soils literature. You might think we could get some specific information on draining Brookston for a particular crop. Yet, I can go right out here in the country and find one field of Brookston soil that weights 30 pounds to the cubic foot and another that weighs 66, and so on. This means the soil in one place has lost its porous structure more than the other and that changes the entire problem as far as drainage goes. The thing I'm saying is that there are so many variables that you men yourself are the best ones to eliminate them. So, I'll leave with you the results of some of my experience -- a few things that should be watched and taken into account in solving each individual putting green problem.

The first consideration is that you are growing a plant under extreme conditions. If the bent grass grew normally, it might grow a foot or more high and then its roots might reach almost that deep into the soil. But the plants are mowed to less than a half an inch in height. Grass cut so close cannot support a very deep root system. Most of the roots are concentrated within four inches of the surface. So, as O. J. Noer said, you've got a very small reservoir of water. The roots can only come in contact with what water is available in that shallow depth of soil. That means frequent watering at certain times to maintain the supply.

Then you've got to get rid of the surface water, first, because the players will insist on getting on with the game the minute the rain stops and they don't like pools on the greens. But more important, you must get rid of surface water before it weakens or drowns the plants. The time it takes to injure the plants depends on the conditions. For example, if the green is heavily fertilized and the weather is suitable for heavy growth, the grass will be using reserve nutrients and also oxygen to the limit of its capacity. A sudden shut-off of the oxygen supply might suffocate it in a few hours. On the other hand, grass growing under more natural conditions might survive several days of flooding. The air that the plant takes in through the leaves is not transported to the roots. The roots have to get their oxygen from the soil. There is a tremendous amount of energy used by the roots in pushing through the soil and transporting liquids and fertilizers up into the green part of the plant. You know a man uses a tremendous amount of oxygen as he works; so do the roots. You must have oxygen at the root zone or the plant will suffocate. When water fills the pore spaces in the soil the oxygen is crowded out.

Also, most putting surfaces will be ruined if they are trampled while soggy. The depressions left by players' heels will remain on some soils and leave a bumpy surface, and this will be especially true if you keep down the nap on the turf, which should be done for best putting conditions. But, since you cannot always keep players off of wet greens, the answer to a true putting surface is more dependent on proper soil structure and good internal drainage. I will come to that later.

There are also other reasons for adequate surface drainage and one is disease. If you have a saturated condition near the surface, you get high humidity close to the grass and in hot weather the conditions will be optimum for the growth of fungi and other disease causing organisms. So, you want to get that water away from the

surface quickly. Then, in the winter if the surface soil is saturated and there is a heavy freeze, you're going to get heaving and that will break the fibrous roots. Then, if a warm spell follows and the grass starts growing it will not have the roots to support the growth and will die. So, each green should be designed so that water will flow off the surface in case it can't get down to the sub-soil, due to some extreme condition.

Now, we come to the sub-drainage. I would say that the sub-drainage is much more important than the surface drainage. I don't want to see any water standing on a green, but if you have good sub-drainage the chances are that you will seldom have trouble from surface water. By sub-drainage I mean draining the water through or from the soil. And the water doesn't have to be drained from the green to a depth of four or five feet either. I think there's a lot of tile in greens that is unnecessary. When you build a golf green the contractor usually uses the material closest at hand for fill. If he uses sand, there will be no drainage problem. Twenty-five years ago I supervised the construction of a course in Halifax, Nova Scotia. The base of all the greens was field stones. We had to pick them off the fairways. We filled the crevices between the stones with gravel, coated the gravel with sand and finished with loamy soil. No tile were put in those greens and there was no drainage problem. But, ordinarily the contractor uses the silt or clay soils available from digging the traps, or from some waste area to make the fill for the greens. If this fill ever was of a permeable nature, the permeability will probably be destroyed before the contractor is through with it because it's moved, leveled and rolled with the equipment. So, there will be an impervious layer under whatever surface soil you finish with. Now the point there, is to finish the top of the fill with sufficient grade that the water which percolates through the open top soil of the green will gradually drain off to the sides of the green along the top of this sub-grade. To get this type of sub-drainage there should be a slope of, say four to five percent on the surface of the fill although the grade on the putting surface of the green will probably never be more than three percent. Perhaps Horton Smith will have something to say about that.

There are many comparatively small greens on well designed courses. It's stupid to build a green with eight to ten thousand square feet of surface on a hole that is designed so that a short iron approach shot is called for. On such an approach, accuracy is called for, hence a small green is adequate. On these small greens of, say, five or six thousand feet in area or less, the chances are no tile will be needed in the green. The surface and sub-grade drainage should take care of it. But, if you have to protect an area from surface water, which is often the case with greens fitted into hillsides, a shallow swail running around back of the green should be provided which will direct the surface water around the green to the side. Also, there will be cases where water seeps through the soil from higher elevations and keeps the sub-soil of the green saturated. In such cases a trench deep enough to catch this seepage should be dug and tiled. The back fill should be made with cinders and crushed rock up to a foot of the surface.

For larger greens with impervious fill, there is little doubt that a system of tile drainage should be provided; but here again my experience leads me to believe that there's been too much tile slapped in without very much thought of why. There's been more talk about whether you use a herringbone or a gridiron design in laying the tile than there has been on why and where the tile is needed. If you've got a big green with a good sub-grade, the higher portions at the back of the green will be well enough drained and there will be no need of running the tile to the rear, and the higher parts of the green. Catch all the isolated low spots and use the majority of the tile on the lower half. Lay the tile so as to protect the approach from seepage. A soft, soggy approach is a bad thing, both for the player and for the turf.

And now, I want to devote some time to soil structure. O. J. has covered some angles of that very well. The whole subject of putting green drainage is pretty well tied in with soil structure. The structure of the soil refers to the arrangement of the soil particles in relation to the voids or spaces between the particles. In some soils the particles cling together and form odd shaped crumbs or granules. These do not fit tightly and hence there is a correspondingly large area of space for air and also for entry and peroclation of water. On the other hand, the particles in some soils do not form crumbs or granules; the particles fit tightly together in a solid mass with a corresponding loss in pore space. These soils are more dense and have higher specific gravity than soils with proous structure. We must have a soil of a friable or porous nature to maintain healthy turf. The structure of the surface soil also has a considerable effect on the playability of the green. A soil that puddles and packs when wet will dry into a solid brick-like mass. A ball pitched to the green bounces and runs as if on a path. It will not hold the green. So the players kick and then the green must be watered to soften it. You can see that between the original lack of pore space in such a soil, even when dry, plus the super saturated condition it must be kept in to keep it from hardening, the grass has little chance and soon becomes thin and dies.

A soil may be of good structure under natural conditions but when it is spread on the surface of a putting green it is subjected to trampling and its structure may quickly be destroyed by puddling caused by the trampling of players on the green while it is wet. So, we must have a soil that will keep open and porous even under such adverse conditions. Of course, a sandy soil will stand trampling and remain porous because there is little or no clay and silt in it to cement the particles together. But pure sand will not hold moisture and plant food for long; it dries out too quickly. We must have more body in the soil. Our problem is, therefore, to get a loamy soil, one with enough wilt and clay in it, but one that still will not puddle and become dense. Organic matter, such a peat, is very porous and will not puddle and cement together. It is like sand in this connection. So we will have to add enough peat and sand to a loamy soil to hold the silt and clay particles apart.

It is best to test soils before using them as top soil on a green. If a soil when damp may be rolled into a marble which will hold its shape when tossed in the air and caught, or if it will form a worm when rolled between the hands, it is too plastic or putty-like. So, it will be necessary to add other materials to it to bring it to the correct composition.

The most effective material to break down the plasticity is organic matter. But if you get too much organic matter in a soil it will be spongy and it will be impossible to maintain a true firm putting surface. Also, although peats will take a lot of water, they will likewise hold water in the cells which the grass roots can't get, in which case even though the peaty soil seems moist the grass may wither for lack of moisture. So, we don't want too much organic matter in our putting green soil.

Now here is a good way to test soils and soil mixtures, both for building the surface on a green and as a mixture for top dressing. Use the soil that you have available as the base or bulk of all mixtures you will make. Possibly you have a bed you're cultivating to get rid of weeds. Sift this soil and then set aside one sample of the pure soil. Then to another sifted sample add about 1/8 by volume of good sedge, reed, or woody peat. German moss peat isn't fine enough unless you can grind it up some way. To another sample of soil add 1/8 of peat and 1/8 of coarse, clean sand. To another one add 1/4 peat and 1/8 of sand and to another one 1/4 of peat and 1/4 of sand. Well, that's five samples. Each sample should be 3 or 4 quarts in volume. Then put a sample in the bottom of a bucket, pour water in, stirring it until you get it to a consistency just short of where it will pour. A more exact check is to thin it to the place where you can draw your

finger through the top of the mud and that impression will still remain there until you tap the pail on the floor two or three times, when the surface will slick over again. Towards the end add water aparingly because the consistency will change very quickly. Do the same with each mixture and trowel each sample into a cigar box or some other container of at least 1¼ inches in depth. Make a record of the mixture in each sample and leave them for four or five days on the rafters or someplace in your shop where it is pretty dry and where they will dry uniformly. After the samples are dry, test them. You will probably find the pure soil, and perhaps one or more of the other mixtures, has dried so hard that you can't crush or crumble it in your hand. In order to have some uniformity in testing the force it takes to crumble them, use the same method on each. My experience in testing hundreds of samples has proven to my satisfaction that when you can't crumble a sample of 1¼ inches in thickness between the thumb and fingers of one hand, the mixture is too plastic for a green. So, test each dried sample in that manner and if you can break the sample of pure soil it's an exception, and you can use it. But, if not, continue from the mixture with the least peat and sand added, to the ones with more added, until you get one that crumbles as described, and that's a safe mixture.

Now, that's enough about soil structure. O. J. has talked about layering in greens. Remember, you cannot correct poor soil structure by putting on a layer of this and that, because layers stop capillary movement of water and the roots simply come down to the layer and stop. You can demonstrate that easily by putting, say, 6" of a certain soil in the bottom of a tube and then add a little sand or peat, say 1/4" thick, and put some more soil on top of that; then stand the tube in a jar of water and the water will come right up to the sand or peat and stop there. Of course, if you have the layer too close to the water, the water will force its way through, but if the layer is near the upper limit of capillary attraction, as it would frequently be in a green, the water will stop at the layer and the roots will just go down to that dry layer and stop. So, you get into a lot of trouble with layering. You can't go to extremes in nature; use a mixture.

Now, to go back to tile again, most greenkeepers want to know the depth, size and spacing of tile in putting greens. I'll take care of the size right away. I like a 4" tile. They are making a lot of 6" tile now, but that's a pretty big area to open up in a green and it is not necessary. If you can still buy 4" tile I think I would stick to them for putting greens. As to the depth and the spacing, that's where everyone does not agree with me. I like to keep the water table as high as possible in the green so that we get the greatest possible supply of capillary water. But some say that capillary moisture is relatively unimportant as a moisture supply in a putting green. However, since the major supply of water the turf uses is capillary water (the moisture that clings as a thin layer to the soil particles) rather than free water, I suspect they do not mean exactly what they say. In other words, if the grass does not depend upon capillary water than it must depend upon the only other type available which is free or gravitational water. Now, it is this free water that fills the pore space of the soil and excludes air, and is the kind we must drain off. Therefore, it is the capillary water we are most interested in. I expect what those who depreciate the importance of capillary moisture really mean, is that it is impossible to maintain an adequate supply of capillary moisture without frequent watering. That is true on too many putting greens. But, frequent watering is costly and always results in temporary, at least, saturation of the surface which presents certain problems while it lasts. Therefore, I feel it would be a move in the right direction if we would work towards maintaining as great a supply of capillary water from the water table as possible in order to cut down watering.

To provide a greater supply of capillary water it will be necessary to hold the top of the free water table as close to the surface as is consistent with good turf needs. Well, you cannot get the maximum use through capillary attraction of the

free water stored below if you put your tile too deep because you hold your water level below the efficient range of capillary movement. As far as I know, the highway engineers have done the most work on capillary movement of water in soils. Their researches show that the further you get away from the reservoir the slower the movement. Water will rise in peats 5½" in one day through capillary attraction. In sands, water will rise 11½" in a day. As the soil particles get finer, the water rises higher. In silt loams it will rise about 20" in a day and in some clays it will rise a little higher.

So there are the possibilities in three components of the proper top soils I have been discussing, peat, sand and silt or clay loam. When you have a mixture of these three we may expect the maximum supply of capillary water within 5½ - 20" from the top of the water table, which would be in turf controlled by the depth of the tile. Now, since turf roots do not go much deeper than 6" we could theoretically hold the water table that high; but that would hardly be practical, so let's lay the tile about 18" deep. This is not so shallow that super dry areas would appear immediately above the tile.

Now if we are going to put tile in at that depth, then the spacing should be fairly close -- I'd say 10 or 12 feet apart. It wouldn't make any great difference if you put them 4 or 5 feet apart, because the idea is to get the free water out. Drainage won't affect the capillary water. Some people like to put an inch of cinders or gravel in the bottom of the trench in which the tile is layed. It does facilitate laying of tile because you can move the tile around and get a true grade quickly. Some folks also like to cover the tile around the sides and over the top with cinders or gravel in order to keep the loose soil from running into the tile through the joints, and that's all right. But, do not carry the cinders to within closer than about a foot from the surface. Back fill the trench with the prepared surface soil.

I think possibly I have covered the situation sufficiently, and I hope you have followed my trend of thought. Briefly, I've tried to show you that drainage for any particular purpose is not an exact science; it is more of an art. Perfection in drainage does not depend upon engineering alone but also on soil physics, plant physiology, horticulture and agronomy. You fellows know your turf problems better than most engineers. So study each situation, and don't underestimate the importance of proper soil structure in the putting green.

IRRIGATION SYSTEMS

C. E. Stewart

The basic source of water supply for plant growth is precipitation, whether it falls naturally on the land during the growing season or on other portions of the earth's surface during earlier periods and is later brought by artificial methods to the irrigated areas by pumping or by gravity.

If all of the rainfall received annually on the earth's surface was evenly divided we could expect a yearly precipitation of 40 to 44 inches; unfortunately this division of rainfall is not evenly distributed and varies from as low as 4 inches per year at Yuma, Airzona to as high as 450 inches per year in parts of North-Eastern India. It is therefore obvious that the amount of irrigation water required must be based upon the deficiency of the rainfall required to produce healthy crops during the growing season.

Irrigation, which is the controlled application of water to land for agricultural purposes, is probably one of the oldest arts known to civilization. It is indicated that long before the time of Christ water from the River Nile was used to irrigate farm lands in Egypt. Even in prehistoric times the American Indians crudely practised irrigation, this appears to have been later improved upon by the Spaniards along the Rio Grande Valley; however the first approach to modern irrigation seems to have been made by the Mormons in Utah along about 1850.

The design of an irrigation system presents many problems, but the ultimate aim is to design the system of piping and pumping plant to produce and apply the necessary amount of precipitation in the most efficient and economical manner.

When the maximum amount of water to be carried through a pipe line in a given time is known the selection of the correct size of pipe should be based on costs, i.e. the cost of the pipe and the cost of the power. A small pipe costs less than a larger pipe, but the friction loss, or power loss, is greater in the small pipe and this increases the power bill. A larger pipe will in many instances save more in power bills than its additional cost over the small pipe; furthermore the large pipe may so reduce the total pump head that a smaller and lower priced pump may be used. It is not unusual to see a pipe line several sizes larger than the pump discharge connection. One approach to arriving at the economical size of pipe to use is given below.

A pump is to supply water at 100 g.p.m. through a discharge pipe 1000 feet in length over a level area. While the size and kind of pump will not be taken up here we will assume that the overall efficiency of the pump and motor is 70% and that electrical power costs 4 cents per kilowatt hour. The following table shows all the necessary figures.

1 Size	2 Cost of Pipe Installed	3 7% of Pipe Cost	4 Pipe Friction in feet of head	5 KWH per Year lost in Pipe Friction	6 Cost of Power per year at 4¢ per KWH	7 Total Cost per Year
2"	$620.00	$43.40	358	7715	$308.60	$352.00
2½"	780.00	54.60	120	2586	103.44	158.04
3"	880.00	61.60	49.6	1067	42.68	104.32
4"	1520.00	106.40	12.2	263	10.52	116.92

EXPLANATION

The cost of the pipe in column 2 includes all labor and all materials to put it in place in the ground and ready for use.

The 7% of pipe cost in column 3 includes the interest rate of 2½% on the amount invested plus ½% of the amount invested for maintenance, minor repairs etc., plus 4% of the amount invested for yearly depreciation; this latter figure is arrived at by estimating the life of the pipe to be 25 years, at the end of this time it must be replaced; consequently 4% per year must be put aside each year to take care of this depreciation. Thus a total of 2½, ½, 4, or 7%, must be paid out, or layed aside, each year, to pay for the use of the pipe.

The pipe friction in column 4 is computed in the usual way and is based on a friction co-efficient of 100.

The horsepower required to drive the pump against the head in column 4 is then computed, and in column 5 this is changed to kilowatt hours (KWH) by multiplying by 0.746 times the number of hours the pump is in operation each year, in this case it is taken at 100 days per year at 8 hours per day, or a total of 800 hours per year. Thus the figures in column 5 come from the following formula:--

$$KWH = \frac{\text{G.P.M. X Head in Feet}}{3960} \times \frac{I}{0.70\ (\text{efficiency})} \times 0.746 \times 800$$

which by further reduction is:--

$$\frac{\text{G.P.M. x HEAD in Feet}}{4.64}$$

With power costs at 4 cents per kilowatt hour (KWH) the figures in column 6 immediately follow. The total cost for the use of the pipe each year is the sum of column 3 and column 6, this total is shown in column 7.

For a complete picture of the costs of the job a pump and motor should be selected for each size of pipe, its costs found, and about 15% of its cost added to the totals in column 7 for the use of the pumping equipment. The lowest costs of these new totals would then give the size of the pipe and pumping equipment to buy, i.e. the lowest figure shown in column 7 indicates the economical size of pipe and pumping equipment.

HOW I MANAGE MY GREENS
on
AERATION, IRRIGATION AND DRAINAGE

Al Linkogel

Now, I am going back a few years to when I took over my present job as Superintendent of Westwood Country Club which was in the fall of 1931. There was not a good green left on the course, which, at that time, was 27 holes. All of the greens were built on heavy clay soil. All of them were tiled but the tile were 3 to 4 feet deep and backfilled with a heavy clay soil, so I knew I had a job on hand.

One of the first things I did was to purchase a 3-unit fairway spiker, mix up some good compost and top dress every two to three weeks, spiking before top dressing to try to build up a good topsoil. Of course, some of the really bad greens I tore up and laid new tile lines about 2 feet deep, backfilled with rock, and then covered the green with a good compost with plenty of course sand. These greens have never given me much trouble. I got along with the other greens pretty well until the second year. We had a wet spring, then it turned hot and humid. I had plenty of trouble. I purchased some tubler tine forks which I used fall and spring for tining the worst greens. In this way, I built up a pretty good root system but I still did not get perfect drainage. I tried to figure out a way to give a green good drainings without rebuilding, so I hit on the idea of a drainage machine, pictures of which you see laying back there on the table. This gave good results, and after playing with it a couple of years, I finally got it to work perfectly.

Now, one of the first things I do when grass starts to grow is to rake and brush my greens heavily to remove all the nap. I then go through all my greens with this drainage machine and then spike my greens before I top dress with fairway spiker so as to be sure that I will not form any layers, fertilize and top dress.

Last year I picked out one of my worst greens, used the drainage machine on part of it, tined forked another part, and left another part for a check. Well, you all probably remember what a year we had last year. I lost the check plot, had some spots go out on the tined part and where I used the drainage machine hald good grass.

I think a lot of tine forking my greens, especially if layers have formed but it is expensive to do this by hand. In the next couple of months, there is going to be a power spiker on the market which will spike a green in about 1½ hrs. which is going to be a great time saver.

My experience is that if you don't water properly, you cannot keep good greens no matter how much you spike. The way I do it is, in the spring of the year, I don't water until my greens show signs of suffering, to try to encourage the roots to go down for moisture. Of course, I get some complaints from the players once in a while about greens being dry. I water them with rotary sprinklers and, as soon as the cender or low spots are soaked up, I turf off sprinklers and check edges and high spots, then finish them by hand watering. I make all my men carry some pluggers made out of old golf shafts to test moisture in different parts of the green. I do all my watering in early morning and when we run into hot, humid weather, I have a man check all greens at noon time for dryness and especially on Saturdays and Sundays when play is heavy. I see a lot of grass lost yearly in the St. Louis District by not keeping men on the job on Sundays.

Now, I have four par 3 holes and all of them are in wooded, low areas, especially two of them. Although I have rebuilt them, they still give me trouble in hot, humid weather but after I removed underbrush and thinned out some trees to get some air circulation, they are now my best greens. Of course I spike them plenty and watch them closely.

A couple of years ago I fanned one of these greens. I used a 30-inch airplane type propeller on a gasoline motor and every morning I would start it up and let it fan the green for about two hours. That summer I only treated that green three times for brown patch in comparison with the green next to it that was not fanned, which I treated ten times. That's what air circulation means to a green.

HOW I MANAGE MY WATERED FAIRWAYS

Norman C. Johnson

Life is a one-way street. No matter how many detours you take, none of them lead back. Once you know and accept that, life becomes much simpler. Because then you know you must do the best you can with what you have and what you are and what you have become.

Most every golf course in the country have their specific problems, and these problems concerning course maintenance management have to be approached and solved in many different ways due to the variations of course design, topography, soil structure, irrigation, drainage, labor and club budgets. I believe these classifications about cover the basic problems that must be considered when one is formulating a maintenance program.

In order to illustrate my fairway management procedure a little clearer, it is important that some facts be explained briefly involving the physical and mechanical description of the project.

The terrain of our fairways at LaGrange Country Club, are slightly on the rolling side. The maintained fairway area involves approximately 45 acres. The range of soil type can be classified in general, as a medium loam to rather heavy clay. The fairway permanent vegetative cover consists of mixed bent strains, with some isolated areas of blue grass which has still survived the close mowing practices. In addition to the permanent fairway grasses, we are also confronted with an ever increasing problem of steady encroachment in our fairways by poa annua and chickweed.

The over-all drainage system is just fair. A man made creek bi-sects part of the golf course, and some of the sub-drainage is disposed into this creek. The balance of the drainage disposal, is either discharged on the ground surface or into the village storm sewer system. During the past several years, drainage corrections have been accomplished when time permits. In most instances, the system is still considered a temporary function.

Our source of water supply is taken from a well. A deep well turbine (Peerless) type pump is used for pumping water from the well into a pond, located adjacent to the pump house. Capacity of the well from seasonal tests, is 260 to 350 GPM. The turbine pump is operated by a 20 horse power electric motor, and is designed for 350 GPM. Two Allis Chalmers booster pumps are maintained for the purpose of pumping water out of the pond, and into the irrigation pipe lines. These pumps are designed for 200 GPM each, against a pressure of 90 pounds. The booster pumps are so arranged, that they can be used separately, as the occasion may require.

The fairway water pipe system are placed down the center of each hole at an approximate depth of 18 inches. The size of pipe lines ranges from 4 inch to 1½ inch. The present system is not a circulation layout consequently there are many deadend lines. There are a total of 96 one inch Skinner valves which are spaced at 120 foot intervals throughout the fairway system. The pressure at valve outlets, varies from 75 pounds to 15 pounds which is considered by irrigation engineers, a low pressure system. Due to the conditions, it is necessary to use 50 foot of 1 inch hose with the sprinkler to assure a maximum coverage between valve outlets.

Major equipment we use in the maintenance of our fairways consists of the following:

Two (2) Toro Trojan gang mowers
Two (2) Toro Tractors
One (1) Farmall A Tractor
One (1) Ford Pick-Up Truck
One (1) Bean Power Sprayer (15 GPM) (200 gal. tank)
One (1) International 8' fertilizer distributor
One (1) " 7' seed drill
One (1) West Point Aerifier

Fairway Management:

Fertilization. During the growing season, we have been making from two to three fertilizer applications. The first applications are made in April, after fairways have been lightly rolled. The material used for the initial application has been an inorganic fertilizer with a high nitrogen content. During the past several seasons, the analysis has been a 10-8-6, applied at the rate of 400 pounds per acre. When using a material of this type, the turf is permitted to dry out before making the application. A light drag is attached to the distrivutor for the purpose of knocking off fertilizer material from the grass blade itself. This procedure is common practice whenever fertilizer is being applied.

The second fertilizer application is made during the latter part of June, and the material used, is an activated sludge (Milorganite) applied at the rate of 1000 pounds per acre. Because this material releases its plant food properties in a rather slow and uniform manner, it is felt that our plant food requirements are satisfactorily taken care of during the mid-summer period.

Our final fertilizer application is made in September. We have been using a commercial fertilizer, its analysis, 5-10-5, applied at the rate of 500 pounds per acre.

Mowing. Our mowing operations start as soon as grasses indicate good growth. With exception of periods when grasses are semi-dormant, we cut fairway turf not less than twice a week, and sometimes it becomes necessary to cut a third time when turf responds vigorously from fertilizer applications. From my own practical experience and observation, it does appear that the frequency of cut plays a major part in the establishment of a dense turf.

When seasonal play is intensive, two gangs of mowers are in operation which helps to eliminate any interference on our part, with membership play. Three different patterns of mowing are observed during the week. For example; Monday, clockwise. Wednesday, cross-wise. Friday, counter-clockwise. In order to lessen the problem of tractor compaction when mowing either clockwise or counter-clockwise, tractor and mowing units are moved over towards the rough demarkation line on the first round, allowing one unit, with gear clutch disengated, to travel over the rough area. This practice is done every second week of the season.

Before daily mowing is initiated, it has been the general rule, to allow the fairway turf to dry which makes cutting easier and a much neater looking fairway, especially wherever bent grass is the predominating cover. A low speed cutting is maintained at all times averaging about 6 miles per hour. We have maintained a height of cut of approximately 3/4 inch, throughout the season.

Watering. As already mentioned, our fairway irrigation system is a low pressure layout with 1 inch snap-on valves located in the center of each watered

fairway. The number of valve outlets per fairway are measured by the length of the area to be watered. In view of the low pressure, it is necessary to use 50 feet of 1 inch hose with each sprinkler to assure a satisfactory coverage between valve outlets. In order to accomplish a uniform distribution of water around the valve area, it takes from 3 to 4 sprinkler settings. After much experimental and pressure readings throughout the system, with various numbers of sprinklers and different size nozzles, we have found that 8 sprinklers, using 3/8 inch nozzle on the outersweep arm is our limitation. One man with a light truck can handle this job, although it means covering the entire course due to method of distributing sprinklers to equalize the prevailing pressure. A skip system is observed at all times because it is known that some areas retain adequate moisture much longer than others, and furthermore we have to watch our water supply, it is not the best. Our policy on watering, is to stay a little on the dry side, and in most instances, our limited supply takes care of that worry. During very dry periods, there are times when it becomes necessary to do some spot watering in the daytime but it is not a good practice when players are on the course, nor when the humidity is high. More turf is lost from over-watering than from under-watering.

Weed Control. We have treated fairways twice since the introduction of 2,4D. Considerable effort and thought has been given to the type of material best suited for our specific problem. After some trial and error work, a sodium salt 70%, 2,4D was selected for our weed control program. A power Bean sprayer is used for this work. It is a trailer type, 15 GPM, 200 gallon tank. The boom is a tri-nozzle affair, with the three nozzles spaced at 2 foot intervals. The swivel joint attachment to nozzles makes it easy to adjust for any desired angle of spray. The over-all width of boom is 4 feet which is mounted in front of the tractor, and suspended 18 inches above the ground level. The type of nozzle I use, is called a Teejet without strainers. ($\frac{1}{4}$ inch-T9540) The sodium salt 2,4D applied with water, is calculated at approximately 1 pound of actual 2,4D per acre, or $1\frac{1}{2}$ to $1\frac{1}{4}$ pounds of the complete material. Operating our sprayer at full capacity with the pressure gauge reading 100 pounds, and the forward motion at 3 miles per hour, it is figured that the sprayer is delivering about 50 gallons of water per acre, in the mixed solution. The coverage of the spray boom has been measured at 28 feet, with satisfactory killing effect at 25 feet. The best time to destroy designated weeds, is when they are quite active. This time does vary, so it is up to the individual to closely observe these indications. DON'T just send the rigging out whenever the mood strikes you.

Aeration. Up until the invention of some new aeration machinery, our fairways have been renovated by a common practice of discing in a straing-away manner which does not turf the turf. The mat formation on our bent fairways has been quite a problem, especially during the mid-summer when water would not penetrate the heavy and stemy mat condition. In time, these areas would turn brown, and no matter how much water one would pour on, it just seemed to shed it, like water on a duck's back. Since our slicing operation, we have obtained some relief. Last fall, one of these new turf renovators was purchased, and from all the reports that come drifting by, it now appears that our aeration problems are going to be licked.

It reminds me what the sieve said to the needle, "You have a hole in your head." So it looks like my fairways will have a great many holes in them this season, and they won't be all divots.

HOW TO OBTAIN QUICK ESTABLISHMENT OF STOLON BENTS

R. R. Bond

More interest has been shown in the past two years in establishing new bent greens than for many years. In analyzing this we have reached the conclusion that many new men have and are entering the greenkeeping profession. When you consider that we have just come through ten years of depression and four years of war during which time very few new golf courses were constructed and not many old greens rejuvenated, we think this is understandable. During this time many old greenkeepers have passed away, many have retired, quite a few quit their jobs and entered war factories. Some did not return from the war and in the meanwhile the new men coming into the field found established greens where there is no necessity to learn or practice the art of planting and establishing new greens. So here we have a period where many greenkeepers who have been in this business two, five ten and even fifteen years, have never had to plant a new green until recently. Dr. Mott, Prof Lantz,&Mr. Anderson are aware of this condition and have asked me to lead this discussion.

There seems to be as many ways and methods of planting and bringing a green to maturity as there are greenkeepers. We recall a green that took seventeen months, months - not weeks, before it was ready for play. On the other hand Mr. Ray Whitlow, greenkeeper Topeka Country Club, Topeka, Kansas, reported that he played on his new greens five weeks after planting. These are the two extremes but in between there is a vast difference in time that it takes greenkeepers to produce a playable green. One large golf club in Ohio stated they could not change over their old greens this spring because it would tie up their golf course all season. I know of a green that was planted last August and up to freezing time last November had not once been mowed or topdressed. Another green planted in early September, in the same condition. In these two cases the greenkeepers were failing to make sod and, of course, they will lose all of their long stolons by freezing and must start from the roots again this spring. I know of another set of greens that were mowed each week after the third week and the stolons were removed and neatly piled on the side of the green instead of being left on the green where they belonged.

But if I don't quit stalling we'll never get our greens planted. To begin with I am assuming that the greens are ready to be planted, that you have a good porous foundation composed of coarse, sharp sand, small gravel and dirt, so as to have a quick natural drainage, not only downward but sideward. If not, and you have considerable clay in the sub-soil you had better tile to save yourself many a headache in future years. I am assuming that you have at least six or seven inches of good top-soil over your foundation, composed of about 20% peat, 30% coarse sharp sand and 50% of rich corn land dirt. That this mixture has been well worked together with a disc or a roto-tiller. That the green has been worked over and over again from all angles with a roller and raked so as to smooth out all sharp undulations and hills. This does not mean that a green must lie perfectly flat and smooth, you can have your undulations and knells but they must be so graduated that a mower can be run over the green from any angle without scalping. I am assuming that the green is sloping in at least two or three different directions as a natural drain for quick drainage in case of ever-watering or heavy rains. You will note here that I lay considerable emphasis upon drainage. To my mind there are three very important phases in building and maintaining perfect greens. The first is drainage, the second is DRAINAGE, and the third is D-R-A-I-N-A-G-E. And I am also assuming that the green is well settled. If you have neglected to do any of these operations your greens are not ready to plant, and you had better correct them before planting to save yourself a lot of hard work and misery for years to come.

Presuming that all these operations are taken care of we are now ready to plant the green. Please bear in mind our objective toward which we are striving is to establish perfect bent greens as fast as we can help nature grow the grass and I believe a program can be laid out which has been tried and tested for many years, in which playable greens can be established in eight weeks or sooner, and perfect greens in nine weeks. To obtain this goal we must have a fast and continuous growth of grass.

But let's get going with our planting. A week before we plant spread over the green dry ammonia sulfate at the rate of 5 or 6 lbs. per 1,000 sq. ft., either by hand or by spreader. If it does not rain during the week gently rake it in and wet down the night before planting. If the green is not well packed or solid and is apt to show heel prints it is best to work on wide boards. We like to run a line of boards the full length of a green, from the apron to the back, and in about the middle of the green. Then we lay two rows of boards about a foot apart, starting the first board two feet from the very edge of the green. These two rows of boards are laid vertical to the boards running down the middle to form a large letter T. In this way you work from the front of the green with all your materials in front near the apron. The materials needed depends upon the help available. One man, of course, can plant a green, we use eight men because it is a complete planting unit and eight men can plant nine medium greens in one day. For these eight men we need one wheelbarrow, four bushel baskets, four tin pails, two rakes, one fairly heavy roller - about 250 lbs., and a hose with an extra fine spray nozzle, about ten wide boards, 10 or 12 ft. long and a cubic yard of ready mixed, sieved top-dressing, composed of 50% sand, 30% fine cultivated peat and 20% good dirt. We also mix in with this top-dressing 200 lbs. of Milorganite and throw in a few handsfull of potash, or if available, some old well-rotted manure at least four or five years old, if you are fortunate enough to obtain it. The manure can take the place of the Milorganite as well as the peat. This additional fertilizer disintegrates slowly and is a continuous feed for the young roots as they are growing down. You will note here that our first top dressing is very friable. The object is to have it so porous that a newly sprouted node can come through the soil wherever it sprouts instead of crawling along under a crust until it finds a crack through the soil for an opening. One quick way to check to find out if the top dressing is friable enough is to place in your hand 1½ teaspoons full of peat, 2½ teaspoons of the coarse sand and 1 tsp. of dirt. Mix this all together and dampen, squeeze your fist together tightly and open. If it crumbles or cracks the top dressing is about right but if it stays into a tight ball either there is too much clay in the soil or you do not have enough sand in it.

Now for the actual planting. First rake the part of the green between the first row of boards and the end of the green is about ¼ inch deep. Spreading the chopped stolons through your fingers at the rate of 10 bushels per thousand square feet. Roll these stolons down and top dress to no more thanl/8 inch and roll again. The object is to have the stolons packed between two layers of dirt much as the gardener would pack down the soil after planting seeds. About 1/3 to 1/4 of these stolons will show above ground. This is as it should be, because the nodes that are above ground will sprout into leaves and new stolons, while the nodes under ground will sprout into roots. It is very true you can have quicker greens by not using any top dressing at all. Simply roll the stolons into dampened soil but they are very apt to blow away before the tiny roots can adhere to the ground. Now move the first layer of boards back about one foot past the second layer of boards. This will give you a planting area of about two feet in width which is about all the average man reaches while stooping down planting and proceed as stated before. First rake then plant then roll, then top dress and then roll again. It is very important that these stolons are scattered evenly. We suggest they be planted to a thickness of ten bushels per thousand square feet. At this rate the green will thicken out very rapidly

and before the weeds get a chance. You may save a little money at first by planting the stolons at the rate of eight or even six bushels per thousand square feet but it alows up the green and gives the weeds a chance and any of you fellows who have had the experience of hand picking a green know of the work and the expense involved.

To get the correct thickness take a bushel of the chopped stolons and spread it evenly over a plot 10 x 10 which is 100 sq. ft. or at the rate of ten bushels per thousand square feet. After getting the knack of planting this area with this amount of stolons you could go ahead and plant all your greens feeling pretty sure you are planting to the correct thickness.

Now if the day is a windy or warm or sunshiny day better start spraying even before the green is 1/3 planted. This spray is an extremely fine mist one through which rainbows can be seen. It isn't the amount of water which is put on the green that counts but the frequentness of the moisture, because after all you do not have to water over a depth of 1/4 inch and at no time must the top layer of this soil become dry, not even for an hour, and must be kept moist for a period of at least four days. This is so important that your best man on your force should be given the task of doing the spraying. By this time new shoots will be showing all over the green. We generally leave one man to spray on the first green while we are planting the second green and then he can divide his time between the two greens until the third green is ready. One man can take care of the spraying of three greens by just making the rounds. The first four days tells the story and is the most important. Because if this top layer of soil becomes dry and the tiny roots dry up you lose your green. None after the first four days of constant and continuous spraying from before sunrise until after sunset you can slow up the spraying to about every hour or so depending upon the winds and the hot sun. If the weather is cool or the sky overcast it is natural that the ground would not dry out so quickly and you will not have to spray as often.

There is nothing much to do for the next three weeks except, of course, spray. Watch your greens carefully and whenever the new stolons become an inch or two long it is ready for another shot of ammonia sulfate at the rate of 5 or 6 lbs per thousand square feet generally dry or mixed with damp sand and wash the blades off. Whenever the stolons grow to be three or four inches long they are ready for the first mowing. This may be three or four weeks after planting depending upon warm, growing nights and days.

Now before mowing roll the green so as to force as many of the stolons into the soil as possible and then mow, first with an ordinary mower following it up with a putting green mower to a height of 1/4 inch. Leave the clippings fall where they may, scattering some of the stolons that may be too thick over the places that are too thin. Then roll the clippings down and top dress with the same mixture of top dressing as stated before, and not over 1/8 inch. Do this once a week for four weeks. This is what we call "building sod." After this remove the clippings with a carrier and your green is ready to play upon. The program outlined is an eight week schedule but it may be slowed up a week or two or advanced a week or two, depending upon the warm growing days and nights.

From here on in we lower our mower to 3/16 of an inch and change the top dressing to a mixture of 20 to 25% sharp couarse sand, 20 to 25% cultivated peat and the balance of good rich dirt from the compost heatp. No one can tell you just what the mixture should be in every instance and locality. It depends upon your soil. You will have to decide this for yourself after having your soil analyzed or by the old hand test stated before. But when you do decide on a good mixture, stay with it.

You can plant a green any time during growing season. Up in our country we have planted as late as November 17th, and the greens were played upon by the first part of June but we prefer the late summer or early fall planting to the spring because the heat is down in the ground while in the spring the ground is generally cold to a depth of several feet and the greenkeeper has more time to work on his old greens in the spring while by fall most of this work is over.

We prefer chopped stolons to uncut stolons as they flat on the ground and do not need nearly as much top dressing to hold them down until the roots take hold. The more top dressing put on the stolons the slower the start of the growth. It is true that chopped stolons will "bleed" a little more but nature has a way of closing these pores which is the reason florists must trim the ends of cut flower stems daily so moisture can reach the blossom.

You may plant a green any time during the growing seaen, presumably from April first to November fifteenth, depending, of course, upon your locality. We prefer the late summer or early fall as at these times the greenkeepers have more time to work on new greens and besides the ground is still warm for several feet down, while in the early spring the ground is cold for the same depth and this cold must rise to the surface which slows up the growth.

THE FUNDAMENTALS OF GOLF COURSE DESIGN

Robert Bruce Harris

In going around the country and looking over many existing clubs one of the things that amazes me a great deal is that very frequently the wrong site is selected for the golf course. In the design of the golf course, the selection of the site is extremely important. One of the fundamental errors that's made often, in selecting a site that is too small. I don't know why it is, but early in the game in this country, through publicity, etc., the idea got around that you could build a good 9 hole golf course on 60 acres or that you could build a good 18 hole course on 120 acres. That is very far from the truth; it may be that on sites of that size you can have some outstanding holes, but the relation from one hole to another will always be bad because on that size tract you just don't have enough space between the fairways. Also on a site of that size you will get into a layout where perhaps the first nine holes will go right around the outside of the property and then the second nine will have holes that will go straight back and forth which makes a very dull golf course indeed, and it often makes a dangerous one. So, it would be a good idea to get the thought before the public or the laymen not to choose a site that is too small. On courses that we design we always like to have a minimum of 80 acres for 9 holes, or 160 for 18, and if possible we like to have more than that. Very often on a proposed golf course site there will be natural features such as a swamp or lake or deep ravines that will prevent you from using all of the property, and on a small site it results in a tight golf course.

After considering the size, another very important factor in selecting the golf site is to have it the right shape. A short time ago, I was called in on a job in which the property was a square 160 acres. There were no natural features, no trees or anything like that, and I thought it was quite a dull golf site although the soil was very good. The change of grade was very small and it had no existing features of any kind. Right near our property was an adjoining farm site on which there was a ravine and some trees and it was really quite a nice piece of golf property, but not very good farm property. In looking it all over, we suggested to our client that it might be possible to trade part of our original land for some of the farmer's land. As a result, we offered the farmer 40 acres out of our 160 acres and suggested that he give us 40 acres in exchange. It so happened the farmer was glad to get rid of this because it wasn't very good farm property, but it was excellent golf property, so we made the trade and it resulted in a site that had an irregular shape, with the north and south dimension longer than the east and west one. You all know that playing around a course in which the shape of the property is very regular often makes an uninteresting course.

Sometimes we are called in on a piece of property where the long dimension may be a mile in an east and west direction, and the north and south direction may be only a quarter of a mile long. You can't avoid having a great many sun shots on this kind of site, plus the fact that you develop a layout in which you create a race around the outside of the property. The shape is quite an important factor although it is often overlooked because the real estate agent or someone in the proposed club has a piece of property and he wants to get rid of it, and the club takes it just as it is. This studying and selecting the right site is very easy to achieve in the beginning and it results in a much better golf course at no additional cost.

After considering the shape, the next step is not to get a piece of property that is too rugged. Back in the days just before the first World War and perhaps

for ten years after that, there were more mistakes made along that line in the selection of golf sites than in any other way. Almost everyone thought that in order to have a good golf course it had to be extremely sporty, and their idea was that the way to have it sporty was to have a lot of steep hills and to play up and down those hills. It is good to have an undulating piece of property but not too rolling because the average membership includes all ages, sexes and physical condition and they just can't stand that severe up and down climbing. Consequently, it is better to have a gently rolling site than one that is very rugged. In addition to that, before the site is purchased, the soil should be analyzed and considered thoroughly. I have been called in on property where there should never have been a golf course built because the expense of hauling in soil and fertilizer, etc., was much too great. At the same time, in selecting the site, the drainage of the property should be considered and also the location of the water supply because the location of the water supply sourde has a lot to do with the size and amount of the pipe that is to be used.

After the site has been selected then it is a very good idea to get an aerial survey of the property, plus a detailed topographical survey. Our purpose is that in addition to studying the site on the ground these surveys make it easier to figure out a number of layouts for the property. In designing the general layout of the course, much imagination is necessary and also a lot of trial and error. Part of that study involves the working with the card of the course and it is amazing how often that card is botched up in the golf course layout. I was called in on a job the other day to remodel a club, and in looking at the card which was a standard par 72, I found that on the par 3 holes, of which there were four, one of them was 185 yards and the other 3 were all between 200 and 240 yards.

It should be evident to anyone that that is not good golf because one of the refreshing and variable things about a par 3 hole is using an iron club off the tee. When a wooden club is used on a par 3 hole there is no change from the same club that is used on the par four or par five holes.

That studying the card of the coutse is quite an important thing and in most cases it hasn't been done enough. I'm going to refer to a few facts about the card of the course. Taking what we call a standard 18 hole course with a par 72, that does not necessarily mean that every course has to be 72, although that is more or less of a tradition today. In that sort of a layout we have four par 3s, 10 par 4s, and four par 5s. The way those holes are mixed up is very important. It is very evident that to have any two par 3s succeed themselves or any two par 5s is very bad and if you can avoid it, do not have any par 4s succeed themselves. Although if you have a par 4 that is 360 yards and then have another hole following it that is 420 yards, you will have plenty of variety. But taking the standard layout it is very possible to work it out so you don't have any pars succeeding themselves, such as this.

Have your first hole a 4, your next one a 5 and then a 4 and then a 3 and then a 4 and then a 5, and then a 4 and then a 3 and then a 4. You see you have a 4, a 5, a 4, a 3, a 4, a 5, a 4, a 3, a 4. In other words, there are no two holes in succession that have the same par. Sometimes because of peculiarities of the site you cannot always do that, but it is a good objective because it starts out the course with variety. Taking two nines of par 36 each and if we were figuring to have a good comfortable course we might plan the par 3s this way: we would have one of 135, another of 150, another of 165 and another of 180. Then taking our fours, we might start with 340, then another one at 350, 360, 370, 380, 390, 400, 410, 420 and 430. There we have the ten par 4s all spaced ten yards apart.

In taking the par 5s, in order to have variety, we could start out with one 430, another 500, the next 520, and the longest 540. Adding up these par 3, par 4 and par 5 holes makes a total of 6520 yards. That is probably a tougher golf course than most people like, but in having large tees or alternate tees, it is very easy, by taking 10 yards off each one of these holes to reduce that by 180 yards, which brings it down to 6340 yards, which is just a comfortable golf course. If you want to add 180 to the 6520, this brings it up to 7600 yards which is good championship length.

In working out a new layout in which it is possible to use the above holes, we could make our first hole 420 yards, the next one could be 520 yards, the third one could be 370, the fourth one would be a par 3 of 165 yards, the next one would be 400 yards, the following one would be 500, the next one 340, the next one 135 and the finish hole 410. The finished layout for the first and second nines would be like this:

HOLE	YARDS	PAR
1	420	4
2	520	5
3	370	4
4	165	3
5	400	4
6	500	5
7	340	4
8	135	3
9	410	4
Out	3260	36
10	380	4
11	480	5
12	350	4
13	150	3
14	390	4
15	540	5
16	360	4
17	180	3
18	430	4
In	3260	36
Out	3260	36
Total	6520	72

There you have all those holes with a different par and none of them approaching the same yardage.

When we start to design the layout of the course we first do it by working up many sketches and using yards like this. It isn't always possible to do that because of peculiarities of the site, but if you start with that idea in mind you get a better layout. In designing new layouts we generally make 10 or 15 preliminary plans of the course before we decide on 3 or 5 and then we boil those down to one. In doing that, there are many things to be considered. One of them is the location of the clubhouse. There are a lot of good golf courses ruined by locating the clubhouse first and then designing the golf course afterwards. The two should be designed together because sometimes locating the clubhouse in the wrong place makes a very bad golf course. In figuring out our general layout we generally try to avoid having our holes run right around the outside of the property first, and then having them run back and forth inside. We may have one boundary hole and then another one inside the course and so on, but never several in a row paralleling the boundary. In fact, the more variety you can get in the

holes, the more interesting the golf course will be.

In designing the course, we try to maintain as much of the natural beauty of the property as possible as that is always very pleasant to the golfer. We also try to put a premium on good golf and we design the course so that it constantly improves the skill of the golfer, yet at the same time it will always be pleasant to all classes of players. In this general design of the golf course and after we figure the rotation of the holes and the general layout there is another very fundamental factor which influences that design and that is the amount of money that is available to build the golf course.

I am going to read you a paragraph from a book that I happened to be reading coming down on the train. Perhaps some of you are acquainted with the late Horace Hutchinson who was a golf writer in England about the turn of the century and the name of this book is "Golf Green and Greenkeeping." I was interested in the cost of golf courses at that time. I'll just read you what he says about the cost of building a golf course. He said "The cost of making a nine hole course should be about as follows: For 9 approaches, 15 pounds, 15 shillings, for 2 level greens - 20 pounds, for seven natural greens - 28 pounds, for top dressing for greens - 3 pounds, seven shillings, for nine tees, - 2 pounds, for chemical manure - 4 pounds, making a total cost for building the entire golf course of 73 pounds." For those of you who were not acquainted with English money at the turn of the century, a pound was worth about $5.00, making a cost of building a nine hole golf course about $365.00. We have come a long way since those days as I suppose that would be about the cost of 7 tons of fertilizer today. I know that I remodelled one green last fall and it wasn't a very elaborate green and it cost a little over $3,000.00.

So the cost is a very fundamental factor in building a golf course. In fact it is also a factor in the maintenance because it is very easy for us, for example to design a golf course and to plan a certain kind of water system and to plan to build greens in a particular way and of a certain size, but if the funds are not available it just can't be done. That is one of the thoughts whereby you men can help the game of golf by educating your members to the fact that good installation work which saves money on maintenance cannot be done for a low sum of money.

In designing our greens, we generally proportion the size of the putting surface in relation to the length of the approach shot. In other words, on a standard 18 hole course, we will plan our smallest green for the hole that has the shortest and least difficult approach shot, and we will plan the largest green for the one that has the longest and most difficult approach shot, and the other greens would be in proportion to the length of the approach shot.

That is a very easy thing to do but suppose we decided to have our greens average 7000 sq. ft. putting surface. That might mean that your smallest green might be 4500 feet and your largest green might be 9500. But in building those greens, it might be that your average area that would be graded might be 15,000 or 20,000 feet because of the slope outside of the putting surface.

It used to be that in building the green, the dirt was scooped out of sand traps alongside the green and then piled up with a covering of top soil. On this bent was planted and then the greenkeeper suffered for a good many years with tight greens and poor drainage and very expensive maintenance.

A much better way to build the green, but a much more expensive way is to have the top 8 inches a mixture of 3 parts of coarsesand, 3 parts of top soil and 2 parts of peat. Beneath this, have an 8 inch layer of gravel and at the

bottom of this gravel, have lines of 4 or 6 inch tile spaced 15 feet apart. Below this have ordinary clay fill. This is one of many good ways to build a green, but you do not do that sort of thing for just a small amount of money. The education which you can give people who are just starting to build a new golf course is invaluable if you tell them not to just throw up the existing soil which might be a heavy clay or something like that, and expect to get a good green which is going to be easy to maintain. It just can't be done and it can't be done for a small sum of money.

The same thing applies in regard to tees. I think you have all seen the old fashioned tees that have been built in a manner in which the ground would rise up a few feet in a sharp rectangular plateau and the slope had to be mowed by hand. The tee was so small that soon there would be a large hole develop in the front of the tee. That sort of thing is very easy to avoid by building big tees, and in addition to having only one big tee, it is often desirable to have several per hole. This means that if your play is heavy, the birdies can be changed often and the turf that is under repair can then have enough time to become sturdy.

Large tees also make a much more interesting course, as the length of the holes can be varied by moving the birdies. It makes a much different golf course for the player who is playing the back of that tee, or the middle or the front and where you have those large tees or several alternate ones, it makes a much more interesting golf course and one that is easier to maintain.

Another thing that influences the cost of the golf course and the cost in turf influences the design, is the way the traps are built. At one time, it was customary for almost all traps to be built by scooping up some of the ground and throwing it up into a mound and then placing some sand in the excavated part. That is the easy way of building a trap, but often in building that kind of trap it may be on very heavy soil and it becomes a receptacle for water and it is a very difficult place to drain. Very often a better method is to build the entire trap above the existing surface of the ground, as it is easier to drain and is much more visable to the players. On a flat piece of property where the soil is heavy and where there isn't much fall for a drainage outlet this often makes a much better trap but it costs more money than the other kind because you have to haul in soil to do it. But in the end it is a better trap and easier to maintain.

Another part of golf course design which had been neglected lately, is the rough. During the war, due to golf ball shortage, labor, etc., there was a lot of rough eliminated on courses and in many cases it spoiled the golf holes. I, myself think the old fashioned rough that was like a hay field was too difficult and it is not good to have. On most courses it ties up the play too long. Some rough is a very good thing for determining a good golf hole. Most golf holes with no rough are very dull and uninteresting, and do not promote the skill of the golfer, as there is no challenge at all. Yet the same hole with the same length and topography can be made interesting by outlining the rough in a strategic manner. This promotes accuracy and skill and helps the golfer to improve his game. The reason I bring this out to you Gentlemen is because most of you are in charge of the outline of fairways and many a good golf course has been spoiled by careless mowing of the outline of the rough.

Another element of golf course design that is often overlooked is the planting of trees on the golf course. I consider the planting of trees just as much a fundamental part of the design of a golf hole as the placing of sand traps or the outlining of the fairway. In my opinion, there should be no shrubs on the golf course itself. As you all know, the scale of the golf course is large. The view is much different than one in your back yard or when you are looking at the

front of a house with some shrubs massed against it.

Planting small shrubs or even large shrubs between fairways is out of scale with the distance involved and they are irritating from the standpoint of appearance, playing and maintenance. I don't think that there should be anything smaller out on the golf course than trees the size of the Hawthorns and Crabs. Anything smaller than that is out of scale and out of place. Around the boundaries of the property or around the clubhouse you can use shrubs but they don't belong of the golf course.

The planting of the trees themselves is a very important factor in the design of the course, and in determining the outline of the holes and I don't think that any trees should be planted on the golf course without the recommendation of the golf course architect. I have seen too many cases where every new green chairman coming in has a favorite tree or shrub planted on the course and in the end you have a very chaotic looking landscape.

The most amazing thing to me about Pinehurst isn't their superb golf courses, but the fact that almost all of the pines were planted. Today, I venture to say that 99 out of 100 people think that they are playing through a natural pine forest. There is one point that I want to bring out to all of you about that planting, however. In planting that club, they only used one kind of plant material, long leaf yellow pine. It was native to that country and they didn't use any other varieties. That resulted in a most outstanding job. When you do any planting on your own course, remember the results will be much better if you keep the planting simple. Don't use a lot of variety.

Golf course architecture and construction has been going through a period of transition or evolution and we have no control over it. For example, we don't have very much labor to maintain a golf course today and so maintenance has been developed so that it is almost entirely done by maintenance machinery. I think that influence has been an excellent thing on the design of a golf course, for it has made golf course design more streamlined and more beautiful and made the courses easier and more economical to maintain.

FOR THE GOLF PRO

Horton Smith

O. J. and Gentlemen. I think that this very flattering introduction calls for a little story----"you can always judge the quality of the soft soap by the amount of lye in it." I think that Purdue University and all of you fellows who are connected with the development of this Conference here should be congratulated. As one who has had a lot of fun in playing golf and one who is interested in making more and happier golfers, I think this is not only a constructive thing but perhaps today a necessity. I'm sure that golfers as well as the general public are expecting more for their money progressively in these times. I think they're going to be harder to please. I think, from my professional position, that conferences of this sort are very necessary to bring about not only better understanding among those interested in the various phases of golf but to give that golfer you might say, more for his money, which I am convinced they are going to demand more and more. I was a little disappointed of course that some of the clubs dropped out from the membership in this organization and I think that is another indication that we have to do more and more to promote these things that we feel are essential for golf. I realize the clubs are more or less solicited rather generally, there's the U.S.G.A., there's the Western Golf Assn. and Michigan Golf Assn. Of course, we have our Michigan State Turf & Greens Work in the Detroit District. However, I think that in time that some of these organizations are going to assort themselves as outstanding in their various phases. I look upon the U.S.G.A. of course, as being the prime legislative body of golf as they should be. They can do some other things of course in addition to that, promoting the Greens Section, etc. I suggest that since we have the advantage of a fine affiliation with a splendid University like Purdue that we should further all the gain here and at other places such as Michigan State where they're doing progressive work. My principle point here is that I do feel that such conferences and research are very essential for general education and general improvement of everybody who's interested in any phase of golf. I know from personal experience that there are far too many people in golf posing as experts for the ill effect of the game. I also know at the various clubs I've been connected with, that some fellows who have made a half-million dollars and he suddenly thinks that he knows how to run the golf course. Sometimes that leads to very poor conditions and unpleasant golf and you might say the near failure of the club. I feel that all of us interested in the various phases of golf must coordinate better and better. We've got to consider you might say, how the course looks and how ti plays. We've got to consider the aspects of rules because rules have a very definite bearing on the success and pleasure of the game of golf so I suggest that we should all bear in mind that there are several important phases in the game of golf and we must coordinate them for the success of the thing that we're all interested in and that's the welfare of golf.

I feel that during the war there was a tendency to distort a lot of values of golf. Many of them were perhaps necessary and very justifiable. Now the time has come, I think, when all of us from the standpoint of playing qualities, from rules and maintenance, etc., we've got to begin to reestablish many of those true values of golf that we feel are essential to the welfare of the game of golf.

I know in the professional ranks they developed sort of a "ballyhoo" golf during the war period when the rough was cut down to nothing, which favored the power hitters who weren't penalized at all if they drove far enough that they could use a lofted iron to play the green. There was a tendency to water many of the greens to the extent that any shot would hold whether played from off line, from over traps or from the center of the fairway or what not. This lowered the scores and brought forth spectacular publicity but I think it has questionable value in the future. I think, unfortunately, professional golf is now receiving

a boomerang of ill effects and has almost become the target of bad publicity because they devaluated some of these things that I consider rather essential to the real game of golf. Certainly most of the old timers considered it. There is a tendency to declare all roads as ground under repair and give a "free lift" and many of those things that may be small, but I think may have some bearing on the true value of golf. The professionals, of course, should do everything they can to uphold the standard of rules and etiquett, etc., as many of those things do have a bearing on the welfare of golf. Naturally, if there were not enough laborers on the course to condition the roads, well the professional would probably say, "Well, they can't take care of the roads, and they can't take care of other things just right, so water the greens so any pitch shot will hold, cut down the rough, etc. Then there would be no premium on skillful players and such disturbs and devaluates some of the standards of the game.

I think that you get the idea that I am driving at, and that requires the coordination of the greenskeeper, and the pro, and the greens chairman, and the rules committee, and the games committee and all of those people. I do feel that professional tournament golf has harmed itself a little bit by devaluating or disturbing the true values of some of the rules and thus some of the precedents and scoring records. In other words, they got so that if the fairways were not perfect, they would say, Well, we'd better "tee up". Too much rules tampering is an unjustified distortion, and under such distortions they shot some low scores which tended to destroy the value of old time records, etc., and almost ridicule precedent. I've heard some of the younger fellows say, "Could Walter Hagen and Bobby Jones ever play, or was it just in those days that nobody else could play and they had to come out first. That is a very extreme example though of a continued devaluation of some of the fine principles of the game, and it's such groups as these represented here that can coordinate matters toward a fine healthy, future game of golf.

Some of you know, particularly some of you professionals here, realize that some of the kids don't have respect for the rules and ethics and the real principles of the game. I think in time such as this will lead to a very unhealthy condition, and none of us want that. Whatever phase of golf we are interested in, we are interested in having a real high class sport that can be played either for championships or played for fun, and we've got to adjust ourselves accordingly. Sure there will be times at our club when we should play winter rules and should make special rules to take care of conditions. But again we should all coordinate so that we know what we are doing and for a purpose and we don't want to have any friction between the pros and the greenskeepers and the other people interested in golf. One reason why I like a Conference of this type is that more people will be better informed and they will all be more intelligent in carrying on toward a better game.

As I suggested, a lot of members, who had good luck with their lawn begin to feel they are an expert of fairways also. If all of us are well informed regarding our jobs, I think we'll each do our jobs very well toward a very successful conclusion--and that will be more golfers and happy golfers, as well as good ones who appreciate the true values of good scores: good condition, good ethics and proper traditions.

Now getting a little bit more on to my topic, I feel that due to circumstances and lack of distant imagination, perhaps, parking facilities seem to have been neglected in the olden days, but we know that all like to arrive at a golf course and bd able to park conveniently and near to the locker room and have a well located golf shop and a caddy situation if possible, so that there would be a minimum amount of lugging clubs and looking for caddies. In other words, a good coordinated plan of parking, locker room, golf shop and caddy headquarters. It would be nice

if these could be coordinated.

Then, of course, in my case, I would like to have a course where there would be ample facilities for practice. I would like to hit some short shots perhaps to a practice green which wouldn't have to be in putting condition. I would like to have a fairway strip of ample length for hitting full tee shots and I would like to have a practice green that I could play some short chips or pitches too, with some idea of accuracy and control. I would like to have a practice bunker conveniently adjoining this practice green. I would also appreciate having on my practice fairway, yardage markers which would give me some idea of what kind of distance I am getting with the various clubs. I know that most of the members would appreciate that sort of thing very much. I feel that ample practice facilities are rapidly becoming a "must" in the proper layout of a first class private club.

After finishing hitting my various approach shots and long shots, I would like to put on the finishing touches by practicing a few putts. I would hope to have a practice putting plot that was similar in texture and speed to the greens on the course. Particularly if the greens on the course are rolling at all, I would like to have a putting plot that was not entirely level. In other words I would like to have some slope to my putting greens so as to practice a few "borrow" putts so that I would gain something from my practice once I went on to the golf course itself. I realize that in all of these things, that a lot of times circumstances cause the result and you cannot be ideal. Again in things like these meeting here, we can more or less organize our thoughts and aim for something that we feel will suit the greatest majority whether we all have the idea or not, but I know that on most of the golf courses that I've played, the practice putting plots have been very level. We finally got a little slope in that one at Oak Park CC--not much, but a little, and I think that a lot of golfers would appreciate that, and I know that a lot of complaints from golfers, pros and amatuers, that the putting plot is nothing like the greens on the course. Well, there is usually an excuse, but again the alibi or the legitimate reason should be coordinated to reduce the amount of complaints.

As I would go to the first tee, I would like a bench or two around the first tee. Although I suppose it is more essential to have benches around your tee, if you have a bit club where there is any delay. I also like to see some kind of a bench, it doesn't have to have a back on it but some sort of a place where the caddy boys can rest their bags conveniently, and also rest themselves a little bit if they please.

I think that ball washers are very essential, if you can afford it at every tee, I think it is a nice thing. On my tee I would like to have plates, without making too elaborate a sign board out of it, but I would personally like to see the number of the hole, the par of the hole, the yardage and the handicap stroke number. In other words, indicate what number of handicap stroke does falls on each hole. I believe without making a bill board out of your tee plates, that you could put that much information on them and I believe that it would be appreciated by many golfers. It tells the whole story. While it's true that the score card is there for a purpose, but I think it's a nice convenience. Usually one man keeps the card in a foursome, the others probably don!t have a score card and they are constantly saying, "Do I get my stroke on this hole, or is it on the next hole?" If that were right on the tee plate, then that's up to him to notice where he gets his stroke, whether it's the first stroke or the eighteenth, or what.

I've always thought there has been a tendency though it's only a small point, of many clubs to separate their tee markers on the large tees so wide that it makes it difficult for the non-expert to tell whether or not he's teeing in front of the plates or not. I don't think anybody wants to cheat for a foot or two, but

again observing the rules and trying to maintain the real values of the game, I've always felt, I like it better anyway, if the tee markers are close enough to kind of make a more decisive teeing ground. Not only that it lets you find out if you are in line, but I would think that it would tend to save the turf and would "rest" some other area. I have played many courses where the tee markers were the whole width of a great big wide tee, and at the particular time that you get up there and you are wondering, you don't want to sacrifice any inches or feet, but you are a little bit in doubt as to whether or not you are teeing ahead of the markers.

For the tee itself, I have always like a rather firm ground. Of course, I wouldn't like it as hard as the floor even though it would probably stay level, etc. But in playing golf the foot work is very, very essential, and you do like to have a little "give" effect to the ground. Those of you who have played a lot of golf, just try to hit a ball when you are standing on a board. You will find that you can't pivot nearly as well. It seems to tighten up your leg muscles and you don't get a grip and you don't feel like you are really "into" the shot. So, although I have always favored firmness in tees, I would like to qualify by saying that I would like to have some response from the ground to my stance. I've always liked short grass on the tee because when we tee up the ball we use our most circular swing, and you might say the most sweeping sort of a stroke, therefore high grass or anything like that is sort of objectionable. I mean, you feel like you are going to catch your swing, and then it also makes it difficult. You can't determine the height of your tee, your artificial tee, as well if the grass is very high and I always like that neat kind of appearance. Furthermore, if your imagination is very active, if the grass is high you figure that maybe a few blades of grass between your ball and club might put a little "spit ball" effect, a little slipperiness on it, so you don't like that. So without getting technical, that's what I would like about a tee, reasonable firmness and as short as you can safely keep the grass, so you can drag the club a little bit.

As I would look down the fairway, I would like to see a definite demarkation line of play. One thing I would like regarding rough and fairway is to have a line that is definite enough that you could see if from the tee. I've played lots of courses where they had shallow roughs and from a distance you couldn't tell whether you were shooting into the fairway or into the rough, particularly if there is a little twist to them. I feel the same way about traps. I like to see a trap that really stands up and says either, "come into me," or "shoot over me," or "stay away from me" or something like that. I have always been a little partial to that white colored sand which really shows up the bunkers. I suppose again there you have your local problems of expense and availability, but to me it adds glamour and nice appearance to a golf course to have sand traps that show up very nicely.

I feel much the same about the fairway, as I expressed about the tee. I think there has been a tendency with a lot of the people who have just acquired watering systems to "over use" them to the point of making those "baggy", lush sort of sloppy fairways. I know none of the leading players like to play a shot from such "baggy" fairways because it gives you that "spitball" effect and it's not a controllable shot at all. I do feel that watering the fairways too much has depreciated the value of that nicely hit line drive, for example, the type that a lot of ladies hit. I think there again you've got to have a compromise between your safety of maintenance and your controllable situation. Sure if you've got sloping fairways, extremely sloping, youhave to keep them a little bit softer and maybe that would be better so that the ball won't roll all over the place. I know from personal experience in teaching players, a lot of nice golfers prior to the irrigation of fairways have felt that something was taken away from them, now that fairways are extremely soft. The people that used to hit those very true

lower tee shots, now don't get any roll, and it has changed the character of the game a little bit. I think it has tended to reward the slugger and the power hitter. I question the value of this trend. And there again, I would appeal to you fellows who control playing conditions to coordinate and realize that they are not all sluggers whether they are the top golfers or your club members. There are fellows who hit true shots that don't have that sheer power to bat the ball in the air a great distance and so a watered fairway just penalizes them.

As for as playing an iron shot, well I'll tell you at the Detroit Golf Club we have watered fairways on both courses, and this practice fairway strip of ours gets just sort of stepchild attention, or less. I would rather hit, particularly an iron shot, from this practice fairway that I would on any other fairway that we have at the Detroit Golf Club. There is a dryness and a firmness and a base whereby if you strike the ball first and then hit down and through as you really should hit a proper iron, you can play with much more control. I hit better iron shots from that unwatered practice fairway than I can from our regular fairways. The reaction I get of course, is that on our regular fairways there doesn't seem to be any base to it. There is always that tendency to get a little grass before you get to the ball because the grass is not growing upright. It is viney or stringy or whatever you call it and it looks good. I will say this however, that some of the poorer players get a little bit more feeling of security when they can kind of mash or press the club behind the ball. They seem to feel that if they hit a little bit behind it they can still get the club into the ball. But there again, we have got to compromise between teaching and playing and maintenance and the general aspects of the game. I do feel that we should consider the ladies and the people who don't have physical advantages of power and keep the fairways firm enough that they will get some reward from that truly hit shot.

As to the height of the rough, that depends an awful lot on the type of the rough. I do feel there should be some definite penalty for driving into the rough and a reward to the man who hit it accurately into the fairway. There's got to be some premium on accuracy or we are going to lose some of the value of the true game. I think, as Bob Harris said, that this "hay field" sort of rough is definitely "out". I remember that when I first caddied I was about 12 years old and I almost got lost in the rough myself it was so high. Golfers won't tolerate hunting around in that hay field stuff. The hunting or losing of balls plus the delay becomes too much a nuisance. I do strongly think that the leaders involved should keep the premium on skill and maintain the worthwhile standards and traditions of the game. There have been many estimates regarding proper height of rough. I know that some of the boys at the P.G.A. last summer said that they felt that a man should be penalized so many percent of his yardage or something like that, but it is a matter of opinion. All I would say is that I like to be penalized when I go in the rough, just like I like to be relatively rewarded when I drive into the fairway. I think it is pretty much of a local problem as to how high the rough should be--it depends somewhat on the texture of the grass. Idealistically, it would be nice if we had such a thing as graduated rough so that the man who is just 5 yards off of one side or the other was not penalized as severely as the man who hit a terrific wild hook or slice and is 15 or 20 yards off. However, that is getting it down to pretty fine points and I fear would be putting an awful problem on the maintenance.

As for the fairway traps, I've never been in favor of having extremely high banked fairway traps. I don't like the idea of just downright penalizing a man and saying, "Well you have lost a stroke brother", the moment you hooked or sliced into a trap. For that reason I don't like to see the fairway traps ridged or furrowed. I would like to have fairway traps that would certainly retard you and all that sort of thing but I wouldn't like to have it assumed that the moment you hit into a fairway trap that you had to reach for your lofted iron or dynamiter, and that there was no chance of your making the green whether you wanted

to gamble, take a chance and play skillfully or what not. There have been a lot of courses we have played in tournaments that I would just reach for my sand club the moment I hit my tee shot off of the fairway. For me that removes all the skill of recovery and thus destroys one of the real values and one of the interesting phases of the game of golf.

Regarding shooting to the green. I have been annoyed in many courses where we have a little dinky flag pole that you can't see from even all the parts of the fairway. I always like to see maybe a multi-colored kind of a flag pole which stands up certainly in proportion with the length of your shot and the type of your green. I've never liked these iron poles, where a pitched ball will hit and may bounce 40 yards away. I've never liked those basket top type of standards where a ball will also do a lot of wild bouncing if it hits it. I've always liked the flag if possible, to have the number of the hole on it. Again you might well know what hole you are playing, but still you would be surprised that a lot of people who haven't played a lot of golf would consider that as a convenience and I think it makes a good color combination if you can have a flag and the number of the hole in a different color. I favor the flag as against any of the fixed kind of standards because it lets you know which way the wind is blowing in case you can't tell otherwise, which I think is interesting. I think the flag waving a little bit is sort of a graceful thing to have on the golf course.

Now for the putting green. I feel that without a doubt that medium fast greens emphasize skillful approaching and skillful play, as well as skillful putting. Greens that are extremely slow, do not bring about a skillful putting touch, they tend to de-emphasize shots to the green, because many times on extremely slow greens I would rather play a little 30 yard pitch shot than an approach putt of 40 or 45 feet. If the green is extremely slow with your putter, the touch element has to be subordinated and it becomes more or less of a "muscle shot." I would rather play toward the "muscle shot" with a lofted club where I can use some of my force in pitching the ball with a little "cut" on it and a little more control. So I am convinced, based on my personal experience and observation, that without getting to the slippery side, medium fast greens very definitely emphasize the true value of golf. In playing to the green it gives you your reward. It doesn't give the man who has missed the green a chance to chip up and get his par quite as easily. Then for the putting itself, it really brings out the skillful touch. My own theory of putting is that I like to contact the ball so truly that I can use minimum force so as to emphasize the delicacy of touch and the feel. Naturally if I've got a very slow green I have to "bat it" and there is not much touch there, and so we go. Of course, like Taylor Boyd and some of us were talking last night, there are various yard sticks that you use to try to determine how fast the green should be. Of course that usually comes back to judgement and local conditions, but I hate to see a ball gain much momentum of its own accord. In connection with slopes and speed of greens, I think that severe slopes naturally should be avoided just like severe speed of greens should be avoided, because you will tend to encourage negative play. Architecture is involved too, but if your greens are extremely fast and extremely sloping, for example, in one direction, a man is probably going to be playing short of the hole all the time and I think that is bad. We have a course in Missouri that wasn't too well laid out. Most every green slopes right straight up from fromt to back. There is quite an extreme degree of slope. Most of the time when I am playing very seriously and don't want to make a fool out of myself, and don't care whether I shoot real low or not, I just shoot short, short, short. I've broken par on that layout a couple of times to my knowledge in fairly important games and I never got up to the flag with the shot to the green, because I knew I would be more severely penalized by being 20 yards over the flat than by being 50 yards short. It is obvious that such severity of slope can almost make a lopsided game of golf. I can't say that I enjoy that. I like the pinehurst type where most of

the greens, not all of them, but several of them, give you just as much chance to "come back" to the flag as they do to "come up." I think such is sound golf and good architecture and construction.

Regarding traps around the green. While I wouldn't yell for it, I don't mind if they are ridged--furrows in them you know. If they are ridged, I would prefer that the ridges or the furrows run parallel with the edge of the green. I detest to play "with" the furrow, because you can't play a delicate chip shot. You must use force and take some sand, but if you've got to shoot down that open furrow, you've got quite a problem to control that type of shot. So, that's another little trick that might fit in.

In a general why, I don't like blind shots. I think that a blind shot to the green is very undesirable and something that should be avoided wherever possible. I don't mind too much a blind tee shot but there again I think that there should be a definite indicator (target or marker) of some kind to direct your play. I like things definite on a golf course as much as possible beginning from those tee marker ideas to your flags and flag poles, to your lines of rough, to your traps, your direction markers, and all those things. I like to see them as definite as you can possibly make them.

There are a number of factors of course that we could discuss, but I want to taper off by saying that among some of the courses that I have thought to be outstanding, all of them have good condition. Condition, I think to the experienced golfer is a very important thing, because just like on the greens when there is any "grain" the more skilled golfer with the more active imagination sees the green more readily and is more impressed with what it can do in running the ball off line. Of course, I would like to have upright growing grass where the ball would be controlled by the slope rather than by the grain or nap of the grass. It's true that you can manage it even if not preferred. I often ask some of our members if they noticed any grain in that putt. A lot of them don't know, so maybe they are just as well off by their indifference. And, of course, you can say that there were just as many grains to "roll you in" as to "roll you out." However, I think that it is highly desirable to have greens uniformly upright in grass growth and also as uniformly as you could get them as to texture and color. I think that condition means an awful lot to the successful and enjoyable game of golf. The courses that I like best all have good condition and particularly they have good condition on and around the green. This is really the "payoff" area of the whole game. I would personally tolerate a lot of bad things as long as I know that there is an objective up there which is uniform--a green and surrounding surface that is smooth and true. In other words it means a lot to know what to expect from your ball on the delicate approaches and putts, once you have reached the "payoff" zone.

One of my favorite courses is Cypress Point out at Del Monte, California. It is outstanding scenically in addition to being an interesting test of golf beauty. They have a lot of trees, pines, cypress, etc. They have definitely lined fairway borders, white sand which shows up the traps beautifully and also emphasizes the green color of the grass and the outline of the greens. They also are favored by playing some of their holes along the edge of the water. It is not the most difficult course in the world. It has some very tricky holes, but it is not extremely long. It is very attractive to play and it is very atrractive to look at.

Then we go to what I think is or was, the most difficult course in the world, around 1935. I understand they have removed a number of traps since. Oakmont in Pittsburgh, I think is not only one of the finest conditioned courses, as we played the national open there in 1935, but the toughest. Mr. Fownes, who I

imagine contributed lost of his personal time and money, used to study the play, his own play, and in years gone by he was a championship amatuer of course, but he used to just study where any stray shot would go and shortly after, there would be a trap. That's just the way I felt about it as we played the open there in 1935. I saw no way to cheat that course. I saw no way to "luck" around it. That was one of the courses where, when I missed my tee shot, I usually reached for my sand club because I knew that the trap would be ridged and I knew that my maximum would be 25 to 65 yards just the recovery sacrifice. But that represented to me perfection generally, a championship test I think---the course was too difficult for the average golfer. Of course they had a number of alternate tees which came in very handy for the membership and of course playing some of the shots from 100 yards instead of 200 yards made an awful lot of difference, whether you are pro or 15 handicap man.

The Augusta National Golf Club was originally one of the most unique. It featured national hazards, contours and "strategy." However, in this day of making the courses more difficult, I think they have given in to the extent of putting in hazards, traps, etc. of a more artificial type.

The Augusta National Golf Club is scenically very, very atrractive with the rolling hills and the distant views all around the various holes. They have beautiful tall pine trees, plus a stream that runs through it, but the thing that originally impressed me was the strategic phase of the golf course. They had many holes where you could simplify your second shot considerably by properly placing your tee shots. The present first hole, they altered the nines since the course was laid out, bends a little bit to the right, a trap on the right, trees on the right, one tree is standing out there more or less as a sentinel; but if you can hit your tee shot to right center, you shoot at a lot more gain than you can shoot at if you are on the left. If you are in the left center of the fairway and the flag is center or left center where they usually put it one round of the tournament, you've got to play over a rather abrupt steep bank of 6 or 7 feet in height. If you miss it, you're not in a sand trap, but you've got a tricky shot to play up there, either a tricky run or an almost impossible pitch. But that golf course features strategy. There are other holes where if you play to the extreme edge of one fairway, you can shoot at almost the length of the green which simplifies your shot and also improves your percentage. They can do quite a job down there by cup placement. They can change the character of the holes and the course considerably. They can make it easy by putting the cup in the big part of the green and very difficult without being ridiculous by changing the cup. They have always had excellent condition; the strategy is an important phase of that golf course and to me, they come as near having two games of golf there as most any course I know of. There is a game to get on the green and without being ridiculous they have enough contouring in their greens to make it almost another game after you get there. I think this is very good because there is a tendency on lot of your flat table top type of greens, to figure--well, the game is over now that I am on the green. It's just a question of one or two putts, but at the Augusta National there are a lot of three putts. If you play a poor iron shot you are not digging out of a bunker, but you are playing a pretty tricky putt with a little roll to it and it puts quite a premium on that shot.

Another course that I think is quite interesting, though I've never given it an awful lot of normal consideration---that is Pine Valley. It is a very severe penalty type of golf course. You can ruin your score there by making one or two bad shots. You can run up your score to any number of two figures by making the wrong shot at the wrong place. It is a very interesting adventure to play that golf course and I am always glad that we have such a course. While it's not too fat for me, it's too tough for me!

Another golf course that I think is outstanding is Pinehurst No. 2. Again I would call attention to the fact that around the greens, the approaches, the aprons, etc., they have them so well kept it gives you more or less an option regarding your approach. You can take your choice as to whether you want to pitch up over the little bank, or whether you want to run it through the fairway approach. The approaches there at Pinehurst are usually good enough that you can play your little pitch and run shot with pretty good accuracy. A lot of players even putt the whole distance when off the green. I think that is something that when possible should be considered in ideal maintenance. Pinehurst No. 2 is a golf course that, we call a "tee shot" course. If you drive with success, your second shots are simplified to a great degree. It doesn't have quite the same characteristics as the Augusta National, but if you do play your tee shots in the proper place with the good length, it makes No. 2 a fairly easy course to score on with the fine condition they have on and around their greens. That is borne out by the fact that in recent years there have been some very, very low scores in the middle and upper 60's during the past few years, despite the fact Pinehurst No. 2 can be stretched to 6700 yards or more. I think that one thing they have always done at Pinehurst that I have always liked, is to give consideration to the wind of the day in the placement of the tee markers. They have, for example, the No. 10 hole par 5, it must be over 550 yards, from the back tee. I have seen that hole played in a wind where nobody could reach it in three shots. Now of course it would be stupid under a condition like that to put the tee markers way back. Donald Ross and the Pinehurst people have always been very alert to try to give as much consideration as an estimate will permit them regarding prevailing wind and the placement of the cups and the tee markers. I think is a very intelligent and constructive thing.

I've probably taken a little more time and digressed a little bit too much, but those things dealing with condition and appearance and facilities just about expresses how I feel about the golf course. Some of the fellows in attendance have raised another special point and asked that I mention it. It happened that I wore down here a pair of those lug soled shoes, and I've been asked to discuss for a minute the idea of what effect we feel that these shoes might have. If you don't know what they are, these lug soles which I am wearing are not quite as severe as some that have been made. I was asked to test these shoes about a year and a half ago and I told them that for a pro that liked to teach and run in and out of the club house and maybe play on the spur of the moment, that they were very handy shoes. But that I questioned the damage they might do on soft greens if any considerable number of players used them on the course. The president of our club was given a pair of these shoes some time ago and I brought it up with him and he said that he did not think they would damage the greens. While most grass springs up immediately, I am dubious about the imprint these soles might have on soft ground. Now this involves merchandising on the part of the pro, maintenance on the part of the superintendent, and some kind of control from the greens chairman. Jack, have you had many of those at Canterbury, use these shoes? What was the reaction? Well, you see that was the thing, that was an expedient that sold a lot of people on them. In the Detroit district the shoe has become quite popular and I think that all of us should stay abreast of this thing and if we feel that it is going to harm the greens, we had better do something about it. I am going to check it very carefully at the club this spring and see what they want to do about it before I stock up on any number of shoes in my shop. But that is the sort of thing that groups like this might coordinate. One thing that I feel that all of the people in charge of maintenance are entitled to and that is, any rules and any coordination of rules and playing conditions. It will ease all of our problems. Though the U.S.G.A. officials are very opposed to departing too much from the rules, and so am I for most purposes. However, we are trying to put into effect a rule at the club to make it a local ground rule that the player should fix his own ball divot mark on the greens before putting. The thought

being that it would save this embarrassing situation, if I am playing with somebody and my ball pitches in front of him, I don't like to be a bad sport, so you usually fix it down, which is of course a violation of the technical rule. Then of course the abuse of the rule is that everybody is fixing everything and patting down the grass. We tried to use the rule that the player should fix his own ball divot mark before putting. You should be able to pretty well determine your own ball divot mark and fix it and there is no problem for your foursome and no problem for the following players. Also less a problem for the greenskeeper, if the members are taught properly how to fix those scars.

Well as I said before, I think a meeting like this is a very constructive thing for golfers to hold and I wish you every success with this conference and others that you have. I am certainly happy to have been here to not only see what goes on, but to get a lot of good ideas. As Red Mackey said, if you can pick up one thing, it will help a lot. Thank you very much for your attention.

FOR THE GOLFER

Burr S. Swezey

Golf has come a long way in the United States since it got its real start here sixty years ago. Five men, headed by John Reid, formed the first Golf Club in the United States at Yonkers, New York. As you might know, it was called the Club of St. Andrews.

They first had three holes. These were enlarged to six in 1892 and to nine in 1894. The members of the Club were called the "Apple Tree Gang." There was an old apple tree near Number 1 Tee, where the members hung their coats and lunch baskets and sometimes a demijohn. This was the first nineteenth hole.

At the outset the courses were shorter than they are now and mostly flat. The hazards consisted principally of bunkers, which ran across the fairway at right angles to the line of play. The greens were small and square and were also flat. They were called Postage Stamp Greens.

There is a vast difference between the modern clubs used in golf and the old ones. The old clubs were all wooden shafted - hickory with beach heads for the woods, which were called a driver, brassie or baffy. The irons were few in number and an iron was known as a cleek, mid-iron, lofter, mashie, niblick or putter.

The woods at first had spliced heads. Then the one piece woods came out and later the socket woods were developed.

We now have four woods and ten irons. The woods are numbered 1 to 4 and the irons 1 to 10. You now speak of a No. 2 Wood or a No. 6 Iron.

With the advent of these new clubs the playing of the game has greatly changed. When only a few clubs were available the player had to learn to play 1/4, 1/2, 3/4 and full swings, depending upon the distance he desired to obtain. Now the same swing is used for practically all shots save short chip shots. You simply pick the club that will give you the desired distance and swing.

In 1905 the "fishing pole" woods came in. They were about 48 inches long. The average length of a wood is about 43 inches. These clubs lasted only one year. About 1910 saw the advent of the Dreadnaught Woods - woods with enormous heads. They did not last long either. Matched sets came in about 1921 and steel shafts were sanctioned about 1926.

The first golf balls had leather covers and were stuffed with feathers. It took a hat full of feathers for one ball. The stitching of the leather was a fine art and much skill and much patience was necessary to stuff the required amount of feathers into the limited space. It was said that no ball maker with a conscience could make more than three balls a day. Some made as many as six.

Gutta Percha balls came in about 1858. They were first made with smooth covers. After being nicked it was found that they flew further and truer. Molds were then made to give them the necessary markings. In very hot weather these balls would get soft so ice buckets were carried in order to keep them cool. (Painting - white and red).

About 1900 the rubber core ball came into existence. It was invented by Coburn Haskell. These new balls called "bounding billies" by the golfers, gave much more distance than the old gutties and in less than a year the guttie became nothing more than a relic.

Another startling innovation in golf ball making came in 1908 when the Spaulding Dimple appeared. All rubber core balls had been bramble marked up to this time so the new recessed marking was a decided revelation.

The Silk Pneumatic ball was made by compressing air inside a rubber cover. It was supposed to have the distance of the rubber core ball and played like the Gutta Percha ball on short shots and the putting green. These balls would get knocked egg shaped and sometimes in hot weather they would blow out just like an automobile tire.

In starting the play at each hole in golf it is customary to tee up the ball. Sand had been used for this purpose from time immemorial. The sand boxes in Scotland and England had always been put on the ground. After golf had had its advent in the United States for a few years the sand boxes were put on legs so the players would not have to stoop over to get a pinch of sand.

Characteristic with everything that goes with this country, we tried to develop a better tee. Truncated celluloid cones, affording a place for the ball to rest, were developed. These cones were very fragile and were quickly broken. Rubber was then employed in many forms to make a suitable tee but it did not seem to serve the purpose well and sand still seemed to be the answer until a dentist, Dr. Wm. Lowell, of New Jersey, hit upon the idea of a wooden tee - the Reddy Tee. 1922 saw the wooden tee the accepted tee and since that time the old sand box has passed into oblivion.

Clothes were an important adjunct to the golfer in the early days. No golfer was seen upon the course without a coat. This coat was red with green cuffs and green collar and lapels. Sometimes this was reversed, the golfer wearing a green coat with red cuffs and red collar and lapels. Knickers of course, were the accepted apparel for the lower appendages. But only the good golfers wore knickers. The duffer was still relegated to long trousers. It was always a mark of golfing prowess to wear knickers. A tie was always worn no matter how hot the day might have been. That has all been changed now and your modern golfer wears slacks of plain or brilliant hues and an open shirt with the tail out or in, as the fancy suits him. He also may wear a T-Shirt. In the old days a golfer would wear nothing but a cap and preferably a Scotch cap. Today they wear nothing, or sun shades or almost any kind of a hat that may appeal to their fancy.

Just a word about caddies. In the old days the regular fee was 15¢ for nine holes and 25¢ for eighteen holes.

To be more specific as to what makes a golf course pleasing to me, I would like to have the tee level and well trimmed and the fairways firm, weeded and well cut. For the average player, I think it is better not to have the rough too severe. The greens should be firm but should not be lightening fast. They should be kept so that a player can use a bold, crisp stroke. The traps should be well kept.

The vast majority of players today shoot in the middle nineties or higher, and in my opinion, the course should not be made so difficult as to wear them out, both mentally and physically. It is a different question when it comes to tournament golf.

There are thrills in skiing, boxing, wrestling, football, hockey, baseball, basketball, track, horse racing and all the sports but to me there is no greater thrill than to step up on the tee of a good golf course and smack a long drive down the middle, or to have a ten or twelve foot putt for a win and after sighting your putt step up, stroke the ball crisply, and then see it take off on the line and curl into the cup! Those, gentlemen, are thrills.

FOR THE SUPERINTENDENT

Taylor Boyd

The Club member, architect, and golf pro who preceeded me have kicked this subject around until they have all of the dirt off of it so I'll take the negative side and get some dirt on it.

There are many things other than the actual golf course that causes a player to be dissatisfied. The entrance to the club should be well marked and by all means kept neat and tidy. There may be some reason to find bottles, paper, and debris in general along the drive and in the parking lot on Monday morning but certainly not after then. If it is that someone there is careless, then most of the course will reflect that type work.

The parking lot should be close to the club house, easy to locate with individual parking spaces well defined - by all means hard surface if possible. The entrance to the club house, locker room and pro shop should be easy to locate and readily accessable. Too many pro shops are so located that a stranger may think it might be a bath house because it is nearer the pool than either tee or green.

Many times a golf game is ruined because a locker room attendant can't be found, a locker located or lunch served quickly without fuss or fanfare. These last items are not the responsibility of the greenskeeper but he can bring them to the attention of the proper club official who can correct a bad situation.

Caddies, a subject itself, handled as a rule by the club pro, usually very efficiently, but where a caddy is hard to find or his duties not well defined--- really, a player is happier without one. I'm lazy - no caddy - no golf for me - a good caddy too!

While on this subject of club house, pro shop, locker room etc, a lot of good can be done by regular meetings of the various department heads. This system will stop member gripes at their source, if corrected by the various department heads exchanging information and criticizing the other fellow. Constructively, of course.

Now that everything possible has been blamed on everyone but the greenskeeper, let's start on him. The first (and/or tenth) tee should be easily located, should be firm, closely cut, have good tee markers, ball washer and towel. This seems to be the concensus of opinion, but maintaining such tees may be difficult. During these preceeding talks I have heard no one mention drainage for tees. They need it as much as greens if proper conditions are to be kept. The grass should be a type that can stand close cutting and will control weeds.

The ball washer and towel should be clean and kept that way or at least the member convinced that they are properly cleaned and changed. I have found that to do this work on Saturday afternoon and Sunday morning while members are playing will be proof enough that this item is not being neglected.

The fairway should be closely cut and the line dividing the fairway and rough not be just two straight parallel lines that will ruin an otherwise beautiful course. Fairways need drainage and 2, 3 or 4 parallel lines may not do the job. Many times a line across the line of play or across the surface slope will stop a bad surface problem. I made this mistake when building Kenwood and have had to correct the weakness. A player should expect the entire fairway to have some firmness and drainage is the answer.

There certainly isn't much I can add to what has been said about greens. They should be undulated enough to be interesting, (not terraced) flat enough to have ample cup location, slope enough to have surface drainage, and most certainly be properly tile drained. Dr. Welton said he thought a 5 or 6 thousand foot green needed no tile. I don't agree with him as I have 36 greens tiled and 18 that are not and the ones that are not tiled are surely a headache.

There has been much said about the architecture of a course affecting the maintenance cost. The next statement is based on actual figures. A properly designed 36 hole course can be maintained for less money than 18 holes improperly designed, improperly drained and improper type grass used. Tees, green banks, etc., should be so built that a fairway mower can be used on them.

The rough on a golf course is cut at the height prescribed by the chairman of the greens committee but rough in my opinion, should penalize a player 1/2 stroke, - ball be easily found with no cuppy lies from which a ball can't be hit. The grass on bunkers cut rough height and no banks so steep towards the rear of a shot that the back stroke of the club can not be completed. The sand in the traps should be smooth. Sand in its natural is a smooth surface, not ridged which looks unnatural and <u>is</u> so.

This talk of doubtful value to golf has lasted long enough, so to close I will make a bet that no greenskeeper in this room, if he is honest, will say that he is doing the best job he can. There are many reasons. First, he works too hard, too many hours on too many days, and as a result he is so tired and stale that he neglects the niceties. Second, the valuable information the USGA, Purdue etc., passes out, either misses he and his chairman or is ignored by him so that an obsolete product is used for fungicide to please a business associate of the chairman. Third, he has a chairman that is not qualified for his job, (I've had two in 18 years; last one for 12 years and he is still good) which can take the heart out of any good greensman. Fourth, having to use poor or improper machinery. Most of it is good, some is just plain lousy. Fifth, just plain, downright carelessness on his part. Sixth, having men that take no pride in their work.

There may be other things that cause a player not to enjoy his golf but I promised to quit so,--that's it. Thank you.

ALTA FESCUE FOR TURF

C. R. Runyon

When I received a copy of the program and saw that I was scheduled for a talk on Alta fescue, I asked myself "What do I know about Alta fescue", and, I had to admit, it wasn't much. We have had only about a year's experience with it or a little less than a year. In fact, I didn't see it under turf conditions until about a year ago.

Apparently there is not a whole lot of information available in our area in southern Ohio, but it looks like a promising grass. Because of the wet weather, we couldn't get our trial plots seeded last spring until during the first week in May. It rained, and then it rained some more. We had torn up some small areas, where there was or rather had been a thin stand of bluegrass and some crabgrass. Then it started to rain again and two weeks went by before we could get the seed in. We raked out what clumps of bluegrass we could, and, because we didn't want to wait until it dried out all the way down and tear it all up again, we then seeded one plot with Alta and another with Kentucky 31. Both of them came up rapidly with a good stand. One of the errors that was made in the rush of work was that the projected application of fertilizer wasn't given for some time. Shortly afterwards, the hot weather arrived. The Kentucky 31 went right through the hot weather all summer; grew, and grew rapidly, and made a dense turf. The Alta grew slowly during the hot weather and many of the seedlings disappeared. We did no artificial watering of any kind. We wanted to see how tough these grasses really were. As soon as the weather became cool, the Alta grew more rapidly. There was enough of it to make a pretty fair covering and during the fall grew well and is now in pretty fair shape. It isn't a dense turf, but at least there is a lot more turf than if it had been seeded in the summer time, or practically in the summer time, with any other type of grass I know of.

In the fall, along at about the first week in September, some other areas were seeded, with Alta and Kentucky 31. This time, liberal applications of nitrogen were given. At least we thought they were liberal. We used one pound of nitrogen per thousand square feet. (Five pounds of ammonium sulphate, approximately). On one area we doubled that because of soil deficiencies. The area that had the doubled application, which happened to be sown with Kentucky 31, had to be cut four times before cold weather came in to stop the growth. On the other plots, the Alta and Kentucky 31, have both grown satisfactorily and made a pretty fair turf in just a few weeks in the fall. Just what they are going to do during the coming season, remains to be seen. The original plots which were sown in the spring, but didn't have any too much fertilizer, have not maintained a good green color over the winter, but the plots seeded in the fall, have maintained an excellent color over winter. Whether that is caused by the extra fertilizer or difference in age, we shall have to wait and find out. On <u>all</u> plots, I would say, the results are satisfactory. Whether there will be any difference in appearance between Alta and Kentucky 31 as far as usefulness for turf purposes is concerned, I doubt. There are some differences. Kentucky 31 is slightly wider in leaf, a little lighter in color, and more uniform. There is more variation in the Alta. In general, the turf from Alta is a little finer, but when it comes to hot weather, Kentucky el withstood the heat last summer better than Alta, at least in the seedling stage, so there seems to be some difference. In the Ohio valley, as was pointed out yesterday by Dr. Tyson, the hot weather arrives quicker and we pass from winter to summer with amazing rapidity. Up to the present time, no grass sown in the spring has been worth the time, money and effort to get it in in the spring. Ryegrass will germinate rapidly but ryegrass is more of a nuisance than anything else.

There are a few things about Alta and Kentucky 31 that stand out. One of them, is that the blade is cut cleanly under a lawnmower doesn't have to be any too well adjusted. Whether you've all had the same experience that we have had with ryegrass I do not know but with us, the lawnmower had to be perfectly adjusted to cut it cleanly. The wiper blades of reel type mowers chew the grass blades off instead of cutting them cleanly. There seems to be a fiber in ryegrass that is tough and at the height that we like to cut, we found it necessary to use the horizontal cutting Whirlwind or Goodall type of mower. The tall fescue blades seem crips and cut cleanly. It stands up well and seems to stand a good deal of use and wear. On one of these plots I took particular occasion to walk over it in the same path about every day or every other day whenever I could think of it during the summer but it didn't show any appreciable signs of wear and that may be excellent for a football field.

We also started Alta on the University of Cincinnati athletic field which has about as poor soil conditions as I have ever seen. Here, as in many non-agricultural schools, the idea of annual application of fertilizers has not made much progress. In other words, they had an idea that turf well established would stay that way. I believe that they have learned better. We finally got some fertilizer on, and considering the condition of that field, the results were pretty fair. One error that was made was in applying a heavy shot of soluble nitrogen in late summer. As a result, we had some pretty soft grass. With the wear from play, no canvas cover, and frost, by Thanksgiving Day, the field looked pretty bad. With the top inch thawing and the under layers frozen, the game that day tore it up severely. After it was smoothed down with chain harrows early in December, we could see that a lot of the Alta was still alive and apparently in good condition. A small patch where I used a little Kentucky 31 had made a little better growth. Now here may be a difference that is worthwhile under emergency conditions. The great trouble is the difference in price. Kentucky 31 costs about four times as much as Alta though both of them should be cheaper next year. So far, we have seen no evidence of disease on the grass, on either type. Our one plot of 31 stood up all summer, with good color during a period of dry weather that turned the bluegrass almost to the brown stage. The latter reached that grey-green color that bluegrass gets before it goes down completely. Neither the Alta or the Kentucky 31 had any artificial water at any time. The rate of seeding on this initial plot also may have been a little low for lawn purposes. We used about 75 pounds per acre and for turf purposes I have an idea that 100 pounds per acre may give a better turf, but seeding rates remain to be determined. Whether an undergrass is desirable seems to be the $64.00 question and if so "What grass": You might say bluegrass. We have some Alta sown in some areas where the bluegrass was thin, and we are watching it with interest to see what happens. If we have a fairly thick bluegrass turf, and bluegrass soil conditions, I would not expect Alta to give much improvement. On the other hand if we have Kentucky bluegrass struggling along and rather open and thin, Alta probably would take over and drive out the bluegrass. From the standpoint of their apparent nutrient requirements you would expect some of the bents to grow about under the same conditions as Alta; in other words at lower mineral levels. We have a plot where colonial bent, and another where redtop, even though I dislike redtop for our area, and one where bluegrass were used in combination with Alta. Last fall we were busy with a lot of things and it did not occur to me in time but I wonder whether chewing's fescue and the tall fescues will get along under the shade of trees.

Under the shade of trees where the fertility level usually is pretty low, Alta fescue looks to me to be much superior to ryegrass and will grow about under the same light intensity, or even better than ryegrass. It is a mistake, in my opinion at least, to try to establish turf under trees in the spring just about the time they are about to break out into leaf and make the maximum demand on the nutrients in the soil. On the other hand, if such areas are sown when the trees

are ready to go into their dormant season, there is a better chance for the grass, in our area at least.

For cemeteries, parks, and playgrounds, Alta seems well adapted. However, the actual experimental work that we have at our disposal right now is limited. From its performance so far Alta may be expected to do better on hot, dry banks than bluegrass and the other commonly used grasses. On these banks with southern or western exposure about all one sees is crabgrass particularly when the grass has been cut close and then a lot of water used on it. This condition is such a serious problem that many people in our area have built up small walls and made themselves little wall rock gardens on their banks because these wall gardens are easier to maintain than turf.

Alta comes quickly, but apparently needs nitrogen to keep a good green color. Whether that will continue after the turf is established or not remains to be seen.

I realize that this is rather limited information on Alta and Kentucky 31, but on the strength of their performances last season we are going ahead with them on a fairly large scale, and, as soon as the weather gets settled, we shall seed small patches of Alta and Kentucky 31 about every two weeks from the time we can get soil prepared until the hot weather arrives. This should give us some additional information as to the behavior of both under varying conditions.

ESTABLISHING TURF ON OHIO'S ROADSIDES

W. J. Garmhausen

Turf to have a part in Highway consideration must be established economically, maintained easily and function satisfactorily. The Ohio Department of Highways has after years of experience of Roadside Improvement, arrived at a program which meets these requirements and we take pride in every further point of efficiency and economy that we can add to it.

I would like to tell you how we arrived at our present seeding specifications and in order to do that let me trace for you our history of turf development. By pointing out the faults in our early attempts I hope to make our present progress clear. Our Landscape Department had its beginning in 1933 when the Highway Department came to the realization that erosion was a major problem. A survey showed that 70% of its Right-of-Way was in roadsides. In the beginning seeding was not a separate specification but was written as a supplement to the construction item of "Finishing Shoulders, Slopes and Ditches." It was sold as part of the general contract. The seeding specifications were similar to those followed by landscape architects in private practice.

Top soil was an essential "just". Four inches of top soil was required on all finished berm work and two inches for all slopes. The Basis of Payment was per lineal foot and the method of measurement was along the certerline of the road, on both sides of which the shoulders, slopes and ditches had been completed and accepted.

Little or no fertilizer was used. The seed mixture was made up by the Division Landscape Architect with a wide variation of mixtures from a few varieties to shot gun mixtures. The only thing in the latters favor was that something always did well. But even this feature could not keep it from being discarded rapidly. After the seeding was done all areas except the slopes that were 2:1 or steeper, were rolled with an accepted water filled roller. In some cases watering was specified and the contractor was required to show a "stand of green" before he was released from his contract. All maintenance and repair was his responsibility and the only disaster he could hope to place a claim for would have to be one he could call "an act of God".

This then was the early procedure - here are its faults. The general contractor always bid the job high because this work was new to him. He would always sublet it to protect himself against the "unknown" as he thought of it. Costs were also high because of the extra excavation through cuts to allow for the top soil fill and for furnishing all top soil. Then too many projects were held up for acceptance because the seeding could not be completed. This was because we only allowed seeding to be done during the favorable spring and fall seeding months.

Well! these were our first efforts and it was costing too much. To obtain lower seeding bids the department decided to "let" separate Roadside Improvement contracts immediately following the grading contract. It was at this time that a seed specification was introduced. The department had found out that much bad seed was on the market and that it seemed to be common practice to "unload" it on highway seeding projects. An Agricultural Seed Specification Table was worked out within the Department and all seed had to pass this specification before it could be used. The specification had a minimum requirement as to purity, weed seed, germination and hard seeds allowed. The Seed Laboratory under the Ohio Department of Agriculture made these tests for us.

Separate Roadside Improvement contracts did not bring about the desired results. Too often areas eroded badly before the Roadside Improvement contractor could get on the job as the time allowed for doing the seeding was still only during the spring and fall months. These eroded areas created another problem and that was equipment. The landscape contractor did not have adequate equipment to meet it. Up to this time when it was a part of the general contract, he had needed only a cyclone type of grass seeder, a harrow and a few rakes and shovels. But now he was required to have equipment to handle topsoil to replace that which had eroded away to bring the area to grade.

In most cases he had to rent equipment or pay for this topsoil in place. The finished grade was too often a polished affair. Prices instead of coming down, increased steadily. Something had to be done to prove our value to the Highway Department and to show that erosion control was not only a soil saving proposition but also a financial saving. We reviewed carefully our experiences and results of the past years and after much thought decided upon three important major changes. The first was to again include the Roadside Improvement items with the general contract. The second was to do away with the top soil item and the third was to seed at any time during the year.

Now, let us consider the merits of these three changes. The first one is including Roadside Improvement items with the general contract. This was done to eliminate the time lost between contracts and consequently erosion of the newly graded roadsides became a very minor item. Because there was no delay the contractor went right on for he had the necessary equipment already on the project for use to carry out the landscape work.

The second change - doing away with the top soil - not only eliminated one pay item but reduced the amount of excavation. The third change - seeding at any time - allowed the contractor to finish his job. Regardless of when he completed his operations he could be released from his contract with no delay or hold overs to finish his seeding item.

These changes necessitated making seeding a separate specification and not a supplement of "finishing shoulders, slopes and ditches" as it had been up to this time. So our present specifications of "Seeding and Protecting or Seeding Roadway Areas" was made a part of the Highway Construction Manual.

This specification included many new items. Since no top soil was required lime and fertilizer were substituted. A straw mulch was required over all seeded areas to insure grass growth. This item was necessary because seeding was done without regard as to season.

These three basic changes were made about 1938 - they still are in effect under our present day specifications. To see how this specification works let us follow it from planning operations, through to final construction and acceptance.

The construction plan is prepared in the Division Planning Office and the Division Landscape Architect checks the plan as to alignment, cross section, drainage and Roadside Improvement items. Since your main interest is the turf item we will consider only it in detail. First the landscape architect studies the soil profile data to determine if liming is necessary. Since this is a test case let us assume he found that the cut is deep. The finished grade will be soil that has not been aerated therefore lime will have to be used. He specifies that 100 pounds of Agricultural Ground Limestone be used per 1000 square feet of area. Next he specifies that a 10-6-4 fertilizer be applied at the rate of 20 pounds per 1000 square feet of area. The reason for using a high nitrogen fertilizer is that not only is the soil low in nitrogen but the straw mulch will use much of this in its breaking down. He next considers his seed mixture taking the berm area first. The soil

profile data will help him know what to expect in the cut areas. For fills he will have to rely upon the composition of adjacent areas where the borrow pit may be located. He is interested in a low growing grass and in many cases this will be Kentucky Bluegrass, then he will choose a clover for its nitrogen fixing qualities and a quick germinating grass no doubt perennial ryegrass. This mixture also applies to the roadway ditches, median strips and areas immediately in front of residences. For the back slopes he will use the same mixture but will add a sweet clover and hairy vetch for soil builders. Many times he will use Reed Canary grass for special areas and he has found Alta Fescue and Ladino clover to produce very favorable results.

He will then specify a straw mulch over all seeded areas, which is to be placed within 48 hours after any given area is seeded. Tge mulch is to be tied down at once. After these items are estimated he is finished with the construction plan until the contract is sold and construction is ready to begin. At which time he will have jurisdiction over all Roadside Improvement items.

In most cases a landscape contractor has bid the job with a general contractor and he will do the Roadside Improvement items for him. If this is not the case the general contractor may sublet this part of the contract or do it himself. In either case a competent landscape superintendent is furnished by the general or sub contractor to have charge of all landscape construction. If there is any top soil to be removed it is salvaged and stock piled for incorporation in to the upper two inches of shoulders, slopes and ditches. The total area covered will depend upon the amount of topsoil available and the length of the project.

Some of the landscape material will have to be tested and approved before they can be used. This applies to Agricultural Ground Limestone and grass seed. Grass seed is still tested for purity and germination. All of this material must be properly stored. The finished grade is to be at least one inch below the road surface at the metals edge. As soon as the area to be seeded is satisfactorily loosened the required four inches and shaped the agricultural ground limestone and fertilizer is applied on the surface. It is then thoroughly worked into the soil to a depth of not less than one inch.

These shall be applied not less than 24 hours nor more than 48 hours before the seed is sown. All leguminous seeds are inoculated with the proper amount of approved cultures and the specified seed mix is made up. The seed shall be sown within 24 hours after treatment. The seed is applied at the rate of four pounds per 1000 square feet and raked in to a depth of one-half inch. Within 48 hours after any given area is seeded mulching material shall be evenly placed two inches thick, loose measurement, over all seeded areas, and shall be tied down at once and kept in place by the twine and peg method. This method of holding the straw in place works very satisfactorily. The twine used is binder twine of treated sisal fiber. The pegs can be No. 50d or 60d steel wire nails or weed pegs $\frac{1}{2}$" x $\frac{1}{2}$" x 8" long.

Three lines running parallel to the pavement are placed so that the first is 4" the second 8" and the third 20" from the pavement. The two lines of twine nearest and parallel to the pavement shall be held by pegs spaced four feet apart. The twine cross ties and pegs shall extend from four inches from the pavement edge to beyond the shoulders for a distance of ten feet over the break of any fill slopes. On cut shoulder slopes they shall extend from four inches from the pavement edge to the center of the shoulder's rounded edge. Cross ties shall be placed in all ditches and up on all cut slopes, 2:1 or steeper, for one-half the slope distance or a maximum of 15 feet measured from the outside edge of the ditch, these measurements to be on the slope surface.

Cross ties in ditches shall have sufficient pegs to hold twine approximately at finished grade of mulching material. In addition to the cross ties, two lines of twine shall be placed in the bottom of the ditch on top of the cross ties and parallel to the direction of flow and with spacing between the two lines of one-third the width of the ditch. Pegs shall be spaced four feet on the parallel lines.

Cross ties shall be placed at the top of all cut slopes 2:1 or steeper and six feet or over in height, measured on the slope. They shall extend down the slope for one-half the slope distance or a maximum of fifteen feet measured from four inches back of the break of slope.

Pegs will be used where any lines cross in addition to those already specifically mentioned. Mulch is to be kept in place during the life of the contract. Mulch which is displaced shall be replaced at once but only after the seeding or other work which preceded the mulching and which work was damaged as a result of displacement of mulching material has been acceptably repaired.

After the contractor has carried out all his responsibilities the project is inspected and if everything is satisfactory it is accepted. We encourage the contractor to use as much equipment for his operation as possible. One such machine is a straw blower used to place the straw on the areas to be mulched. This machine is a time saver as quite an area can be covered in a very short time. It even works well on long slopes by working both from the bottom and top of the slopes.

We have even set up projects where the contractor can use a pulvi-mixer to prepare his seed bed, incorporate his lime and fertilizer and to tie down his mulch. This speeds up operations and does away with the twine and peg method of typing down the mulch. As one man can operate this equipment it saves many man hours of labor.

This spring we are trying out several projects using an asphalt mulch instead of straw. This specification for using this type of mulch requires that immediately after the seed has been sown and raked in the seeded areas shall be moistened to a depth of one inch. Two hundred gallons of water are used per each one thousand square feet of seeded area. Watering shall proceed over the areas in such a manner that the asphalt can be applied without tracking over any wetted area by machine or workmen. If rainfall is such as to satisfactorily take care of the above watering, the watering may be non-performed at the direction of the engineer. Immediately after a given area is watered and before this area dries out, Cut-Back Asphalt mulch shall be applied uniformly at a rate of 0.25 gallon per square yard. An optimum application temperature of the material at 170 degrees Fahrenheit may be varied by the engineer, but shall not exceed 190 degrees Fahrenheit. The application shall be made only with an approved hand spray or by a distributor equipped with a suitable spray bar.

This special Cut-Back Asphalt shall be treated so that it is not toxic to vegetation. It shall be of such character that it will crack without breaking the bond between the asphalt and the soil. The Cut-Back Asphalt will have to pass the specific specifications set up for this material.

In summarizing our work over the past years we have come to the following conclusions:

Our specifications are workable since they adapt themselves to various situations and allow for the use of many kinds of equipment.

The landscape contractors are familiar with the specifications and consequently are more efficient in doing their work and at a profit.

All of this has helped us to reach our goal - lower seeding costs.

Highway construction is judged from a structural and a functional standpoint and Roadside Improvement has had a part in both.

Structurally the seeding of the roadsides has eliminated the sand papered finished grade. The grass cover protects his grading work and he has no re-shaping or re-grading to do.

Functionally we have been instrumental in flattening the slopes and widening the Right-of-Way so that maintenance is more easily accomplished.

The Landscape Department suggests a third measure of judgment for roads - psychological. For seeded roadsides are restful and help to eliminate driving fatigue.

The roads of a busy modern civilization then are indebted to grass - as mankind has been indebted to it through the ages.

In closing I quote from John J. Ingalls who says of grass - "Grass is the forgiveness of nature - her constant benediction. Fields trampled with battle----- grow green again-----and carnage is forgotten.....grass is immortal.....Its tenacious fibers hold the earth in its place and prevent soluble components from washing into the sea. It.....modifies climates and determines the.....character and destiny of nations.....Banished from the thoroughfare and field, it bides its time to return, and when vigilance is relaxed or the dynasty has perished, it silently resumes the throne.....which it never abdicates."

I have a few pictures I'd like to show to stress more of the important things I have been telling you about. I told you that our first contracts specified 2" of top soil over all the cut slopes. This picture shows men hand spreading the top soil on a slope. A lot of hand raking was required in our earlier specifications and these fellows are spending a lot of time getting this slope in shape. We no longer require this to be done.

I told you that a lot of erosion took place between the two separate contracts. This is one shot of some erosion that has taken place during the lapse between the grading contract and the roadside improvement contract. All of it was not this bad but some of it was worse than this. We did succeed in covering this particular slope with vegetation and this is an after picture of the one that had the bad erosion in it. I also told you about the inch of grade drop along the pavement's edge. The reason for this is that the berm grade will gradually build up. This is caused by the original mulch, the grass clippings, ice control material, etc.

Here you see a mulched slope of straw. Protruding through the straw is honeysuckle. Many times we plant honeysuckle on seeded banks to come in and take over the area as the grass more or less dwindles out through the years, and the honeysuckle will fill in the thin spots.

I mentioned about using equipment on these contract jobs. Here the contractor is using an air space to dig pocket holes for his planting. This is that same slope after it has been seeded, planted to honeysuckle and mulched.

This is a pulvi-mixer which was used on a particular job. Here we used it to prepare our seed bed and to incorporate fertilizer and straw. The seed bed is being prepared here and the fertilizer and lime incorporated at the same time. This shows a little closer view of the operation.

When the machine is used to prepare the seed bed and incorporate the fertilizer and lime at the same time the back lid is left down but you have to raise it when you're using it to incorporate the mulch with the soil.

The straw has been placed on this berm. This picture shows the pulvi-mixer running over this area incorporating the soil with the straw to keep the mulch in place.

This is a view of the job a few months later, so you can see that we do have a good coverage from this type of procedure. Now, I have told you about the straw blower. This is one type of straw blower that was used on contracts last summer.

This next picture shows a close-up of the straw mulch being blown on an area that has been seeded. I put this picture in just to show you what type of terrain it was that this straw blower was used on. There were a lot of large cuts and the right-of-way was deep. The plan is for a two-lane highway, but only one lane is being built at this time. The Highway Department expects to put in the other lane in a few years.

Here is a view of the berm after the mulch has been placed and tied down. The extent of this particular project was 3.75 miles with 370,000 square yards of seeding, so you see we had a lot of area to cover. I did not tell you anything about our Roadside park seeding, because most of our park seeding is done by maintenance. If the top soil is not very good, or if the seeding is done at any time other than the favorable seeding months, we use the same procedure of seed bed preparation and seeding that we do on our berm work. This includes lime, fertilizer, and a mulch. During the favorable seeding months we will omit the mulch if the top soil is of a good quality. Incidentally, we have around 285 roadside parks in Ohio now, and expect to increase that about 10 parks this year.

In our medium strip we use a low-growing grass as you can see here. Mr. Runyon mentioned that slopes that have the hot sun beating down on them during the long afternoons, are difficult to get a good stand of grass. Many times we plant honeysuckle to take care of that condition. This is one view of a honeysuckle slope. The honeysuckle pretty well covers this entire slope area.

For a narrow road we often use 18" of aggregate right along the pavement's edge. At the left of this picture you can see the stone out-croppings. We are not too concerned about covering these out-croppings. We seed around them and many times we do plant vines - honeysuckle, trumpet vine, or matrimony vine.

This is the last slide, and I merely show this so you can see that what we are after is a pleasing right-of-way. If we can get that with grass and with the help of chemical weed control, we think we are doing the public a service in presenting to them more attractive roadsides.

CRABGRASS CONTROL IN PARKS AND LAWNS

Marvin H. Ferguson

Crabgrass control, like other weed control, may be considered in two phases. The first is "crabgrass prevention". If crabgrass comes in despite preventive measures, we must consider "crabgrass eradication". The irony of the situation is that after crabgrass is eradicated one must still follow good management practices and use preventive measures to keep crabgrass out.

We might try to answer the question "Why does crabgrass come into turf?" The soil is apparently pretty well infested with crabgrass seed whihc are waiting for an opportunity to germinate. As soon as the turf is left open enough to allow germination, the crabgrass goes to work. Turf may be so thin and unthrifty that crabgrass can take over. Management practices such as very close mowing may encourage crabgrass. Scars resulting from maintenance operations, chemical or fertilizer injuries, or erosion may leave the ground bare or open enough for crabgrass to come in.

It is obvious therefore, that crabgrass prevention involves the use of proper management practices. Attempts should be made to have a strong, vigorous turf going into the summer. Fertilizing should be done in early fall and early spring. 2,4-D or other weed treatments should be avoided in early summer when the turf may be opened up by the removal of broadleaf weeds. In bluegrass turf the mowers should be set at about 2 inches.

The use of grasses that are able to thrive in spite of crabgrass may be an answer to the problem on many areas.

Alta fescue can be seeded in the spring and will compete with crabgrass. In Beltsville when we seeded in June we obtained a good stand. We don't keep the crabgrass from coming in the first year and competing with the Alta but at the end of the season when the crabgrass goes out, the Alta fescue is still there and it makes a cover. By next year you have a pretty nice turf. I don't know whether there is a grass you can plant that won't get some crabgrass in it that first year, before it becomes sufficiently established.

We might also consider the Zoysias. Zoysias are well adapted throughout the crabgrass belt. They have some disadvantages, they have a poor winter color, and are slow growing, and at the present time there isn't seed available and vegetative propagation is rather expensive. However we have been working on Zoysia quite a bit at Beltsville.

We have some strains which are going to be pretty good seed producers. Formerly it was pretty hard to get the seed to germinate and we found that by hulling its seeds we can get 65 to 70% germination, which is pretty good. There are a lot of seeds in a pound of Zoysia, about a million and a half in Zoysia japonica.

Bermuda grass might also be considered in some parts of the crabgrass belt. I expect I'm talking to the wrong group about Bermuda grass here because I don't expect you fellows like it very much in approaches and flower beds or any other areas you want to keep it out of. It does have a poor winter color, but it is one of the things that can compete successfully with crabgrass and it will make you a nice turf during those months when crabgrass is a menace and bluegrass and fescue take their worse beating.

Another way to prevent crabgrass that has been used somewhat is the use of lead arsenate. In some soils lead arsenate seems to have an effect on crabgrass seed or on the young seedling, I don't know which; it prevents crabgrass from germinating and coming in. However, I think the indirect benefits from the use of lead arsenate are probably of greater importance in the control of crabgrass than the direct action of the lead arsenate upon the plant. I'm thinking of a fairway in Baltimore. About 1938 the greenkeeper there went out and put on a treatment of lead arsenate across one fairway in a strip about 8' or 10' wide. He didn't know how much lead arsenate he put on but it was a heavy application. He applied it in sufficient quantities to whiten the earth, and today he has a beautiful strip of bluegrass right where he put that lead arsenate. On the rest of the fairway the turf is poor and weedy. He hasn't used very much fertilizer for the past 20 years. His fertility level is low. Just two years after he put that treatment of lead arsenate on we had an awfully bad infestation of Japanese beetle grubs in that area. His fairways were just about eaten up. Now I have the idea that the treatment of lead arsenate, by controlling the beetle grubs had more to do with his freedom from crabgrass in that area than the actual benefits derived from lead arsenate in killing his crabgrass seed.

Now those are some of the ways we might prevent the investation of an area with crabgrass. After we get crabgrass, we have the task of getting rid of it. Unfortunately we don't have tools like 2,4-D that will take care of crabgrass. A number of chemicals have been used on it, chiefly the arsenicals. The arsenicals require quite a lot of care and you have to have a man who knows turf pretty well and is acquainted with the actions of the arsenicals, otherwise he will injure his permanent grasses. It doesn't appeal to the home owner because these are poisonous materials, and although he has been told he may use it with safety if he handles it carefully, he is scared of it and he just won't accept such things for use on a home lawn. There is sodium chlorate. Sodium chlorate will control crabgrass if it's used properly. But sodium chlorate has a fire hazard. People don't like to use that because there is some danger in it and even though you tell them they can use it with safety, the fact that it is a fire hazard deters their use of it. There are the dinitro compounds. They have been used successfully in some cases, mostly in experimental work. The dinitros have some drawbacks. If you aren't careful with them you might injure your other grass. They stain clothing very badly, so these compounds also have their disadvantages. Probably the newest thing in the field is phenyl-mercuric-acetate. There have been some very promising results with its use in Rhode Island. So far as I know it hasn't been used widely where crabgrass is a very bad pest. Most of you know that crabgrass is not the pest in New England that it is down in Philadelphia, Washington, Cincinnati, and St. Louis, and so far as I know it hasn't been tested widely in those areas. Until it is tested more widely I don't know that we can make any recommendations for its use. There are rumors of petroleum fractions that are selective for crabgrass and that will control it without damage to permanent grass. We don't know very much about those things yet. I think probably the best thing to do in trying to live with crabgrass is use our old management practices and common sense rather than expecting something miraculous like 2,4-D has been in case of broad leaf weeds.

I think probably we have gotten used to having these miracles happen. We had DDT come along, a better insecticide than we have ever known, and 2,4-D came along and practically takes care of the broad leaf weeds if used properly. Now I think we expect something like that to come along and take care of crabgrass. I have a feeling that it is not going to be forthcoming soon. I think we will have to rely on our management practices and common sense to control crabgrass. We just must grow enough good grass to keep crabgrass from coming in.

TURF PROBLEMS ON PARKS, CEMETERIES AND LAWNS

O. J. Noer

The order to the program was changed, because of Fred Grau's inability to be here. I have been asked to act as mediator, moderator, or what have you on the golf discussion this afternoon. Since that would conflict with my appearahce here this afternoon, I am taking Dr. Grau's place this morning and I presume that Ferguson or somebody else will pinch-hit for me.

I wish to pay tribute to Dr. Grau of the Greens Section for the fine work that he is doing. I am sure that you are missing a lot by not having him here with you. I've had occasion to see his work for two years, and he is doing an excellent job and deserves the support of everyone interested in turf.

I've decided to tell my story in pictures and simply give you a few pictures that will show some of the problems that we encounter in traveling around the country.

This morning when I was introduced in the other room to talk on water management on golf courses, Enfield said, "The sheep stay here and the goats go to the room you are occupying". Now that I am here I fail to see any goats. Maybe Mr. Shatwell uses them in place of mowers on deactivated Army establishments.

The first few pictures deal with the problem of new seedings, particularly with respect to fertilization. I hope they will show the thing that probably all of you know, namely that when turf is thin or when grass is seeded, it is necessary to have enough fertility in soil to thicken the existing grass or to get a good stand of grass from seed. When the fertility level is satisfactory for grass, heavy rates of seeding are not necessary. Many people think it necessary to use 300, 400, 500, 600 pounds of grass seed to the acre in order to have more plants. Actually the stand will be even better and at less cost by supplementing seed with adequate fertilization. With these initial remarks we will start with the pictures.

The first picture is of a new seeding which we had on Forest Home Cemetery at Milwaukee some years ago. The grass seed mixtures were seeded in the direction parallel the lines and fertilizer was applied so that it crossed each one of the seed mixtures. This is the line between no fertilizer on the one side and the plot receiving adequate quantities of super phosphate and nitrogen. I think you can see what a tremendous difference fertilization has made in the stand of grass.

The next three pictures represent plots operated about 25 years ago in Milwaukee in the days before Kodachrome. It was necessary to hand color the slides. You will notice the same fence in the background of each picture. It was along the boundary line of the property. The grass seed was seeded lengthwise and the fertilizer was applied crosswise. The first picture is the unfertilized plot which was seeded with about 125 pounds of seed to the acre consisting of 80% Kentucky bluegrass and 20% red top. Notice the non-uniformity of stand. The soil on that area is a Miami silt loam, which is a light color, silt loam soil. It consolidates and gets very hard after a rain. It is difficult to improve the stand of grass by reseeding after the turf starts. It is much simpler to get a good one at seeding time.

The next picture shows the superphosphate plot. It received the equivalent of 500 to 600 pounds of 20% grade super phosphate per acre. Notice what a tremendous difference it has made so far as uniformity of stand is concerned.

Here we have a good uniform coverage and we are off to a fine start so far as producing a good turf is concerned.

The next picture is of the plot where nitrogen was used in addition to the super phosphate. The rate of nitrogen was probably about 80 to 90 pounds of actual nitrogen per acre. The super phosphate was responsible for uniform coverage and the nitrogen improved the density of the turf and fostered vegetative growth.

A small nine hole golf course was built north of Milwaukee along Lakc Michigan at Port Washington. It was sponsored by a few local Milwaukians who had summer homes there, and the natives of Port Washington. The seeding of the fairways was done rather late in the fall for Wisconsin, and I was there with the man who built the course and in talking to the Board of Directors, happened to pass the casual remark that unless the fairways were fertilized before they were seeded they might not have any grass in the spring. I didn't realize the handicap because of working for the sewage commission at Milwaukee. A couple of old hard-shelled farmers were present and said, "Hell, that damn young whipper-snapper doesn't know what he is talking about. Who the hell ever heard of putting fertilizer on before seeding grass? We've seeded grass for 20 years and know it is ridiculous!" So, no fertilizer was used and the next spring Mr. Campbell, who is an attorney in Milwaukee, called me up and said, "Noer, your prediction has come true. There isn't a sprig of grass on any one of the fairways". He said interest has lagged so it would be necessary for him to put up the money for reseeding and fertilizer. I told him to fertilize the landing areas and the approaches only and let the other areas come in as they would. Fairways were seeded that spring, and I happened to be coming down from the northern part of the state in early June. As I passed Port Washington, I decided to stop and see how the grass was coming along. There had been a little controversy about money for maintenance, and as a result, nothing had been done so far as cutting was concerned. You can see the area where fertilization stopped on the seeded areas. Grass is almost knee high on the seeded areas in the back as compared to the short, thin grass on the unfertilized area in the foreground.

The next picture tells the story of why I told Directors at Port Washington that they might not have grass in the spring unless an adequate amount of fertilizer was used immediately before seeding. This is a plot at Blue Mound County Club in Milwaukee established when the new club was built probably 25 years ago. That fall we fertilized the area in the background approximately an acre. We used 500 pounds super phosphate and 1500 pounds Milorganite for nitrogen before seeding. In the fall the contrast wasn't near as great as the one you see here. The unfertilized grass in the foreground did not make enough growth to become well established before winter. It didn't have a sufficient root system to withstand the heaving action of the front in the spring. As a consequence a tremendous amount of the grass was lost in the unfertilized area in the foreground, whereas in the background with the adequate amount of fertilizer, the grass got off to a good start in the fall. It made sufficient growth and a good enough root system to it was able to go through the winter without being damaged.

This is one of the tables given to me by Mr. Rabbitt who is now with the Navy. Before that he was with the National Parks at Washington. When he came with them, customary practice was to seed at 600 pounds to the acre. When they did that I presume they didn't have any money left to buy fertilizer. In the experimental plot he varied the seeding rates as follows: 40-80-120-200-400 and 600 pounds of seed to the acre. The plots were then cross fertilized using 200, 400, 800 and 1600 pounds per acre. A 10-6-4 mixture was used. The soil was very light in color which meant that it was low in organic matter and consequently also low in nitrogen. Phosphoric acid and nitrogen were the principal limiting

factors so far as growth is concerned. The chart represents the density of turf a year after seeding. Notice that the stand of grass on the plots seeded at 40, 80 and 120 pounds per acre with 1600 pounds of fertilizer was denser at the end of one year and better than with seeding rates of 200, 400 and 600 pounds per acre even with the same rate of fertilization. In other words, the plant population was too thick with the heavy rates and as a consequence smothering occurred and at the end of the year the turf density was actually poorer as a result. The 40 to 120 pound rates did the job. In other words, on areas where reasonably quick coverage is wanted probably 120 pounds of seed to the acre is enough, particularly where a blue grass mixture is used.

This is another chart showing the density of turf a year after seeding. Notice that $47.00 spent for 80 pounds of seed and 1600 pounds of fertilizer gave a far better grass than $145.00 invested in 600 pounds of seed only. Rabbitt has many other charts, but these are enough to show the relation between fertility and amount of seed.

The next picture shows the difference between spring versus fall feedings in crab grass areas. This is the fall series and the other is the spring seed series. Notice crab grass on the spring seeded plots. In other words, crab grass has taken over and smothered out all of the grass on the spring seeded plots, but on the fall seeded ones, where the grass got off to a good start and made turf that fall so there wasn't a crab grass problem.

This is a close-up showing two of the plots at $47.00 per acre for seed and fertilizer, 80 pounds of seed, 400 pounds of 10-6-4 and the area at a cost of $152.00 per acre, 600 pounds of seed. Notice the difference in the number of dandelions in the two plots. There are almost none of the 80# seed and 400# fertilizer.

This is an area of turf in Canada, outside Quebec City where the grass is so poor. It is not only full of weeds, but is also growing violets. They were picturesque, but turf was bad for the golfers from the standpoint of playing. Most people would say in an area like that, reseeding is the thing to do. The turf was improved on that golf course without using any seed because the existing grass was suitable for the soil and climate. It was scattered more or less uniformly over the area, so improvement was simply a problem of furnishing enough fertilizer to cause the existing plant to spread and form a turf.

2,4-D of course, had done a lot toward popularizing better turf. I think it has done a grand job, but it is only another tool which speeds up the thing we did before it was discovered. This is a fertilizer plot which was operated many years ago, long before we thought of our arsenic acid, sodium arsenite, 2,4-D or the other herbicides. I think you can see that there are fewed dandelion blooms in the area between the strings than on either side. There are fewer dandelion plants in the fertilized area and the reduction was due solely to competition of the density of turf as a result of fertilization. I didn't go in and pick the blooms off the fertilized area. If you doubt the statement look at my waist line, you will see that I don't indulge in that kind of exercise.

The next slides are from Jim Tyson to substantiate what he said yesterday. As I drove home in Milwaukee one day, along the lake drive, I noticed a mower out on the parkway and a fellow getting ready to mow. I realized the streaked condition due to fertilizer, would make a good picture sales talk for the value of fertilizer on poor lawns. The streaks may have made the man realize the importance of giving grass a square meal as well as himself.

The next picture is the one that Jim talked about. This isn't down at Michigan State campus either, Jim. It's right along side of George Davis' office on Northwest Highway to Chicago and maybe Bill Bailey put the fertilizer on, I don't know. You will notice that it shows what fertilizer does. It is a good thing the workmen didn't realize the necessity for overlapping and that he should not go straight back in the wheel tracks. He is a convert to the cause of lawn fertilization.

This is a popular type of fertilizer spreader for lawn areas. It does a perfectly good job, provided the operation overlaps.

This next picture shows a green on which fertilizer is being applied with a cyclone seeder. One can go over an area much quicker and probably get a more even distribution with a cyclone seeder than with any other kind. It only costs 3 or 4 dollars and for some purposes it is excellent. I am inclined to think that it is good for cemeteries where there are tomb stones to contend with.

Each spring we frequently find large areas of turf that look like the grass in this picture. There has been winter kill in the low spots and depressions which were covered with ice. You will notice in the center some creeping grass that survived the beating the blue grass couldn't take. We often call creeping bent a water grass, by that we mean that it usually withstands much more water than fescue of Kentucky blue grass.

Snow mold is quite common on golf greens. It isn't often seen on lawns. This is a creeping bent lawn which was planted vegetatively. I happened to drive by early one spring and saw the snow mold, so I took my camera out and made the picture to show that snow mold does effect bent grass in lawns occasionally. I am sure that damage is superficial and has not killed the grass underneath. Just as soon as conditions become favorable for growth if a little fertilizer is applied damage will disappear.

Up until 1928 anybody that even mentioned the use of lime on turf was presumed not to know his business. We had considerable damage in the summer of 1928, it was a hot, wet season and greens throughout the country went out by wholesale. It was realized that soils can become too acid even for bent grasses. This happens to be fescue, a grass which tolerates considerable more acidity than blue grass.

It is on a golf course in Troy, New York. There is a slope below the line where the turf was so poor that a local rule was made permitting winter rules on the area. Lime was applied on a strip across the top and bottom to mark the boundary. When drought came, the limed strip stayed green for several weeks after the other grass was entirely brown. It looked like it had been fertilized and watered. Then the area on the slope was limed, and yet even the following year, when the dry weather started, the effect of the original heavy application of lime still showed.

On the next picture you can see a green strip 8 feet wide extending across the picture in a circular pattern. Forget about the dandelion on the strip. This is a rough at Tam-O-Shanter in Canton, Ohio. The soil had a reaction somewhere between pH 4 and 5. We suggested that all fairways be limed before they were fertilized. When I came back the next summer, I saw this strip of green grass going from one fairway across the rough to another, and since this course was using Milorganite, I thought, here is a chance to impress the owner of this property, Mr. Pearson, about the merits of Milorganite. So I walked over and said to the greenskeeper, "You must have forgotten to close the fertilizer spreader when they went from this fairway over to the next one", and he

replied,"No, that wasn't it, it was the lime. We forgot to close thespouts on the lime spreader and that strip got lime and no fertilizer". The fact it didn't get fertilizer was partly why you see more dandelions. The principal difference in the grass is that plants of blue grass are growing more vigorously on the limed strip and on the other side it is small and puney. Most of the grass you see there is quack grass.

A couple years ago I was driving along the highway from the George Washington bridge in New Jersey, and I passed a spot being limed. The Experiment Station must have told the highway people to use lime on the turf along this right-of-way. They were probably disappointed in the results with the lime. Materials of that kind and fertilizer also do not move laterally in the soil. When applications are made a spreader of this kind shouldn't be used because it drops the material in rows. A scatter board should be used so the application is a uniform one from one side to the other.

The next picture is on a fairway in Westchester County that has been limed. The lime used is called agriculture lime and is a mixture of 50% hydrated lime and 50% ground limestone. But you will see that the spread out there has been absolutely uniform. The greenkeeper is putting a brush harrow over it so as to get some of that lime down into the soil, so golfers will raise less objections when they walk over the area. After doing that, he sprinkles to wash it in. There isn't much point in spending money for materials and then doing haphazard work and expect to get satisfactory results.

This is a picture in St. Louis of a watered fairway. The brown blotches of turf over the entire fairway. This is what happened, there are grubs of the June beetle under each one of the brown spots and they of course are responsible for loss of grass in those areas.

The next picture is a closeup on the same area with some of the turf turned back to show the grubs underneath. The customary treatment for grubs in the past always was lead arsenate. The usual recommendation is 200 to 400 pounds per acre.

The next picture shows another area of the grub damage in turf in Westchester. Injury was caused by grubs of the Japanese beetle. Generally the damage is in spots scattered over the area. The turf is torn up here because starlings and skunks have been in the area getting food.

This is the worse case of grub damage I have seen in 25 years. Every bit of turf on the fairways was ruined. I believe the next picture will show what we found underneath.

As I said before, lead arsenate always was the customary treatment for grubs. In the East where Japanese beetle is the main menace, the recommendations generally were to use 400 pounds of lead to the acre because the grub is an annual affair. In the midwest the May and June beetle is apt to be bad about every third year.

The next picture is the one I have been looking for. Can you see an 8 foot circular strip of draker grass out in the rough? The golf course became infested with grubs of the Japanese beetle, and the directors of the club were asked to provide funds in order to treat the fairways and roughs with lead arsenate at 400 pounds per acre. They reluctantly voted funds so the fairways could be treated, but they just simply refused to do anything to the rough. The workmen,when they were putting the lead arsenate on this fairway, came down on this side and made a circular turn into the rough and then went up on the other

side. The operator forgot to close the outlet spout, so here is a strip 8 feet wide in which the fescue-and the roughs were all fescue at that time - was protected from damage. The club only had to buy the lead to complete the rough afterwards, but they also had to buy seed in order to get new grass in those roughs, and that's what you see here. Had I been there a year before, you would have seen the 8 foot strip with bare ground on either side. So after all, it was a bit of false economy on the clubs part when they ridiculed the use of lead on the rough. As a matter of fact, I can't help but feel that an acre of good turf is worth a lot of money and even though the cost of treating may seem high, say $30.00 to $35.00 an acre, it is money well spent. Today lead arsenate costs about 25 to 30 cents a pound and in acre cost that means about $100.00 for treating. DDT and even chlorodayne are being used instead. DDT at 25 pounds of actual DDT per acre is doing an excellent job in knocking down grubs, it is even quicker than lead, and I am told by people that are doing work with DDT, that they are sure of protection for three years at least. So where control of worm casts is not necessary, DDT will unquestionably replace lead arsenate for grub control.

This picture shows a fairway where sodium arsenite was used. It is one of the chemicals for weed control. It was used over a period of several years. The concentration of arsenic was built up to a point where the turf was protected when the grub of the June beetle was in the area. Damage was confined to spots out in the untreated rough. On the 18 holes of treated fairway there wasn't a small spot of injury.

This is an example of injury caused by lead arsenate used to grub proof the turf. You will notice that the grass is brown and that strips show that a spreader used wasn't doing an effective job of spreading. However, you will notice all over the fairways there are patches of undamaged grass. This is permanent grass, mostly bents. In the areas that have gone out, the injury was hastened by the lead, the grass in there was poa annua and in my opinion it probably would have gone out about two or three weeks later even if the lead hadn't been used. So that all that the lead did there, was to kick out poa-annua a little bit quicker than it normally would have gone under the weather conditions prevailing in that area.

You have heard about hairy chinch bug. This is an example of damage caused by it on a piece of Metropolitan bent in a nursery at the Pine Valley golf course about 25 miles out of Philadelphia. Notice that the clover hasn't been affected but the injury was only to the bent. The hairy chinch bug sucks the juices out of the plants and makes it look like it is wilting, then it turns brown and dies. I haven't seen any considerable injury in the Middle West. Hairy chinch bug can be controlled with Sabadilla dust or with DDT, so we aren't quite as concerned about it as we were some years ago, particularly before the War. The injury shown here occurred in about three days.

I have a few weed control pictures. We will go through them rather rapidly. Next picture is one of the plots on a golf course in which clover was being treated with 2,4-D. Clover is one of those things that responds sometimes and at other times it does not. This is the golf course of the Ames country club at Ames, Iowa and Professor Lantz who has charge of the turf school which will be held next week. He is showing the effect of 2,4-D on that course. The job was done in August. The picture was taken about three weeks after the area was sprayed. I believe he used less than a pound of 2,4-D to the acre. Note that an excellent clean-up was obtained.

HANDLING NURSERY STOCK, SHRUBS AND TREES

Lowell A. Moore

Shrubs, trees and evergreens as well as other plants, which parks and cemeteries use to beautify their grounds, should be properly handled and planted for best results.

When bare rooted trees and shrubs are received from the nursery, they are "heeled in", or temporarily planted in trenches until such time as they may be permanently planted. After taking bare rooted plants from the heeling in ground to their permanent locations, care should be taken to keep the roots covered with wet burlap while the holes are being dug.

Planting Deciduous Trees

The proper way to plant a tree is to dig the hole two feet wider than the diameter of the root system or ball of earth and one foot deeper than the height of the root system. Dried or broken roots should be cut cleanly. Place the tree in the hole on a layer of top soil so that the depth of the tree is the same depth which it grew in the nursery. Plant the tree in top soil mixed with one-fourth peat moss or woods loam. After the hole is filled to within six inches of the top and the soil firmed down around the roots, water the root system thoroughly. After the water has soaked into the soil, finish filling the hole to the ground level and make a ridge of soil around the outside of the hole so as to create a basin which will catch water.

A three-inch mulch of ground corncobs or strawy manure is recommended. We cannot overemphasize the importance of mulching newly planted plants.

Proper guying and wrapping of newly planted trees is also important. Prune the tree by thinning and shortening the branches in a manner to preserve the natural form of the tree. In shortening branches, cut one-fourth inch above the branch or bud. If the lower limbs are too close to the ground, it will be necessary to remove enough of these limbs to make a higher headed tree.

Planting Deciduous Shrubs

Shrubs should be handled as carefully as trees when they are received from the nursery and during the time of actual planting. Before shrubs are planted, the shrub bed should be thoroughly prepared by spading and working the soil. Individual holes should be dug two feet wider and eight inches deeper than the root system. Place the shrub on a layer of top soil so that the roots are one to two inches deeper than they were in the nursery. Work the top soil around the roots to within two inches of the ground level and firm down. After the water has soaked into the ground, finish filling the hole with top soil to the ground level, leaving this upper soil loose.

Prune shrubs so that the leaf surface is reduced one-third by thinning and shortening the branches. Preserve the natural form of the shrub. Mulch shrub beds with compost, rotted straw or ground corncobs to a depth of three inches.

Planting Evergreens

Evergreens should be either planted or heeled in immediately after receiving them from the nursery. Covering the balls of earth with wet straw or burlap is a satisfactory temporary measure. Evergreens should always be handled by the ball

of earth.

Dig the hole two feet wider and eight inches deeper than the ball of earth. Place the ball of earth on a layer of top soil so that the top of the ball is one inch below the ground level. Fill top soil around the ball of earth to within four inches of the top of the ground and pack the soil firmly around the ball. After thorough watering and the water has soaked into the soil, finish filling the hole with top soil but do not pack. Never pile soil around evergreens.

A three-inch mulch of granulated peat moss or ground corncobs is recommended.

In conclusion, let us say that newly planted plants require special watering and care during the first year or two after transplanting. Another thing we wish to emphasize is that plants properly handled and planted not only live but thrive.

HOW TO HANDLE PERENNIALS

Henry J. Schnitzius

Not being a trained Park, Cemetery, or Golf Course man, it will be necessary to discuss this problem more as a layman, or an ordinary citizen. Some of the ideas advanced may seem outrageous to you as you struggle with limited budgets and personnel, but times may not always be as strenuous as they are today.

Since there are several somewhat divergent interests involved, it will be necessary to wander from Parks to Cemeteries to Clubs, and then back again, but there are certain fundamentals which should be interesting to all.

In the Park and Club field there has been the necessity of providing intensive recreational facilities to meet the urban crowding due to war. In all the fields there has been the necessity to eliminate every item where labor would be needed. But this should not always be true and there should be at least some turn towards some of the more cultural phases of Park work. There are millions of people in this country who are interested in other phases of recreation than sport and physical exercise.

Why consider perennials in park plantings? Primarily, because they are one of the most extensive and flexible groups of our natural plants. They are the transition material, serving to tie mass areas together. A lake or bog area is surrounded by them before it merges with the field or prairie. The edge of a woods or a fence row has this sturdier group of plants existing in the area where grasses just can't quite compete.

In a more practical application, they can be the most economical space fillers in the park or cemetery grounds. In the club group, they can serve to materially cut down the costs on cut flowers from April to November. This, we know, because one of our most valuable by-products at the nursery is the daily cut of cut flowers for the wholesale florists.

Maintenance is much lower than that of annuals and is usually off season work. Propagation of most sorts is simple and the original investment need not be great. They stand abuse from both mowers, and public use, and are better adapted to use in landscape transition. They have valuable leaf and form effects when not in bloom. They, along with the bulbs, give color effects from early Spring to late Fall. The demands on seasonal labor are not so exacting as annuals.

Drawback in perennial use

A short bloom season. Since they do not have to depend on propogating themselves in one season, they can be less showy and presistent in bloom than annuals. For this reason, they make very poor formal beds. For this same reason, they should be planted for seasonal effects. Some of you park men might be agreeably surprised as to how you might scatter your land use and lessen the load on high use areas by providing some seasonal flower attraction in some of the lesser used spots.

With a few exceptions, they should not be planted formally. In a country club garden, beds could be planted with a succession of bloom but this would entail intensive gardening by an experienced man.

In some locations, flowers must be protected against the thoughtless vandal. There will be some of this in spite of all the care, but experience shows that this is usually more prevalent at the beginning of a program when the plantings are unusual and new. If a caretaker is needed, let him be a gardner or naturalist,

instead of a police officer. Vandalism in flowers is often nothing more than uneducated interest, and often reflects more on the community than on the individual.

What perennials---and why

For the general purposes of this group, perennials could be divided into three categories: Cultivated, semi natural, and those which can be naturalized. In the first group are the Delphinium, Columbine, most Shasta Daisies, Phlox, Chrysanthemum, Gallardia, Dianthus and some of the new Pentstemon. This group must be cultivated and watered. They are suitable for gardens near the clubhouse, entrances or offices. They are subject to certain diseases such as crown rots, leaf spots, mildews, etc., and require more intensive care than the later mentioned groups. In this group, however, are some of the finest cut flowers and those with longer bloom season. They are not so long lived, and some require dividing each year or two to provide fresh plants. I will not go into detail on cultural practices but will answer questions later.

In the semi-natural group are some of the finest of the true perennials. Most of this group are free from diseases, of long life, and require a minimum of care. Some, like Dictamnus, Funkia, and Oriental poppy are more productive each year they are undisturbed. Iris, Hemero callis, Peonies and Bleeding heart require dividing each four or five years for best results, altho they often persist for years undivided.

Many of the Lillies, Physostegia, Kansas Gay Feather, Lythrum, Caryopteris Phlox subulata and Heuchera are in this group. Some, such as Lythrum and Liatrus are excellent in low places where even grasses do not thrive. Hardy Verbena is an excellent ground cover in sunny places.

This group requires very little artificial watering but should be kept reasonably free from weeds. They are not troubled much by disease or insect pests, altho it is best to treat the crowns whenever they are taken up for division, or if they show effects from disease.

In the last group are some of the best of the low maintenance, labor saving plants. Many of them were at one time among our native plants. Plant Lobelia Cardinalis in masses in wet edges of lagoons where Hibiscus will also thrive. Use colorful Asclepias in acid sands or gravels. Ajuga repens, Vinca Minor (myrtle) and the native wild flowers make good shade ground covers. The low sedums thrive in hot dry places. Gentians, Hardy Asters, Thalicratum, Tradescantia and Yucca all have use in transitions from tree or shrub plantings. And where there are odd corners around the work or tool lots, throw down a few handsfull of Hollyhock seed each season for one of our best midsummer shows.

This last group requires no artificial watering, no spraying and no cultivation other than that grasses not be allowed to get started in them. In locations where they have been thoughtfully planted, they will persist for years. Always plant them in good relation to the basic woody plantings and always use them in heavy mass.

I have discussed these plants more from the standpoint of their landscape use, rather than cultural methods.

MIDWEST REGIONAL TURF CONFERENCE, PURDUE UNIVERSITY, 1948

NEW METHODS OF APPLICATION OF 2,4-D

H. A. Waters

Gentlemen. You have all followed with interest the development of 2,4-D during the past three years. Within the past year there has been considerable development in spray equipment which has completely revolutionized the method and the practicability of 2,4-D application.

This development revolves around what is now called the low gallonage method of application. A method whereby only 2 to 5 gallons of spray are used per acre. The past practice was to use 100 to 200 gallons of liquid per acre when you sprayed for weeds, and you will recall that in the first two years of work with 2,4-D most recommendations were given in parts per million or strength of solution, figuring you would fully wet the weeds. That took in the neighborhood of 100 to 200 gallons of water, depending on the density of the weeds.

During the past year most recommendations have come out in quantity of 2,4-D per acre, rather than in strength of solution, because we have found that it isn't the quantity of water that you use. It is how much 2,4-D you put on per acre. It doesn't matter whether you use 1, 2, 5 or 100 gallons. As long as you properly distribute the correct quantity of 2,4-D you get the same results. In dense brush or very tall weed growth there are certain advantages for the more dilute spray, but for the average application encountered on golf courses, where you are working with short weed growth on level surfaces, you can get entirely satisfactory results by using a very low gallonage of liquid.

The low gallonage method has been made possible by the development of specialized types of nozzles, nozzles that have a very fine aperture and are very precisely made. They require only 20 to 40 pounds pressure, depending on the type. The pressure has to be fairly accurately governed. If 30 pounds is the best pressure, you do not want to operate at 20 or 40 lbs.

There are now a number of sprayers of this type on the market. There are probably 30 or 40 companies that are making so-called low gallonage sprayers. Some of them are of a very high quality, some of them are not so well made and are being put out more on a price basis. From the practical standpoint it will pay to get a reasonably good quality sprayer.

You have three choices in securing a low gallonage sprayer. You can buy a new one, you can make one, or you can convert your present high gallonage sprayer.

The key to low gallonage spraying is nozzles, ones that will properly distribute a low quantity of liquid over an acre. In buying a sprayer or making one, there are certain features that you want to look for, and the type of nozzle is one in particular. Nozzles are one place where you do not want to try to make a saving on your sprayer, because a good quality nozzle will save money in material and time and in giving you better weed control.

The nozzle make most commonly used is one made by Sprayings Systems Company in Chicago. It is known as the Tee Jet 650067. It has a flow rate of 3.6 gallons per hour at 30 lb. pressure. That is a very small amount of liquid to come out of one nozzle in the course of an hour. Each of these nozzles is protected by a 200-mesh screen, built in to the nozzle to eliminate clogging problems. Without that, they would immediately clog up.

Most of the low gallonage nozzles make a fan type spray. However, there is another one that has been developed by Spraying Systems that will put on as low as

2 gallons per acre and is called Tee Jet 1.97.

It makes a cone type spray, and it gives an even coverage when spaced at 18" intervals across the boom. These various Tee Jet tips are made interchangeable in a common type of nozzle body. If you want to change from one type to another, the only change necessary is the tip. The nozzle body is permanently attached to the boom and need not be removed from the boom for cleaning.

Another acceptable nozzle is made by the Monarch Manufacturing Co. in Philadelphia. Their nozzle is made in one piece, that is the spray plate is built solidly into the body that screws into the boom. The entire nozzle must be removed for cleaning. Another good nozzle is made by the Ken Standard Co., Evansville, Indiana. It is called Adapto M-24-5.

As to the pumping machanism, there are a number of different types of pumps that are being used. The one most commonly used is the gear pump which can generate up to 125 lb. pressure. The desired low pressure is obtained by use of a regulator. For working with liquids only, a gear pump is entirely satisfactory. However, you can not run suspended solids through it. It will handle only liquid mixtures. All 2,4-D is used in liquid form. You either use 2,4-D salts that dissolve in water or use the ester form that makes an emulsion in water. Also low gallonage nozzles are not adapted to handling suspended solids.

If you wish to apply DDT or some other insectrocide like chlodane or toxophene for grasshoppers, the same sprayer can be used, providing you would pick a liquid formulation.

A centrifugal pump can be used and will generate up to 40 lb. of pressure. A small piston pump with a suitable regulator can also be used.

One advantage of a small, light weight pump, such as the gear pump, is that it can be mounted directly on the tractor power take off. A piston pump, as a rule, is larger and is better adapted to a trailer model of sprayer.

The spray boom can be mounted directly on a tractor. It can be put on the front or on the back, preferably on the front. If you are doing a very large acreage, mounting the boom directly on the tractor gives you a more mobile unit. The trailer type, however, is quite satisfactory.

If you are making your own sprayer or buying a new one, pay particular attention to the boom structure. For average golf course work an 18' boom is quite satisfactory. They are available with 30' booms or larger, but for getting around irregular areas, such as you have on the golf course, an 18' boom is more adaptable. This shorter length is lighter in weight and simpler in structure.

A desirable boom feature is that the two side arms that project from the center section be hinged so that if they strike an object, such as a tree, post or a bank, they can move back. If you have a completely rigid boom and strike an obstruction your sprayer is out of operation until repaired. If you have the hinged feature, the boom simply swings back. On some models it automatically swings back into place while on other models you have to stop the tractor and push it back into position. Either of these types is satisfactory. There are some models that have boom arms that will swing any direction, forward, backward, or up. Other models will only bend backwards. In golf course work it is desirable to have boom arms that are hinged to raise up and are controlled by cables. On irregular ground the operator can raise or lower one arm or both arms so the boom fits the contour of the ground. To get proper distribution the boom should be held at a reasonably definite distance above the top of the weeds, so that the spray fans just meet at the level of the top of the weeds.

If you have a large high gallonage sprayer it is a relatively simple matter to convert it over to low gallonage. First secure new nozzles. Space them at around 18 inch intervals if possible. However, if your old boom has 20" spacing of 16" spacings you can still substitute these nozzles. It simply changes your application rate slightly and the height at which the boom is held above the weeds.

Next you must change the pressure regulation system. Most of the large sprayers are made to operate at a high pressure, well above 100 pounds and the result is that the regulator is not sensitive when you get down in the 20 to 40 lb. range. The best thing to do is set this regulator as low as it will go. As a rule, you have trouble getting it under 100 pounds. Set it in the range of 50 to 150 pounds. Then in the line between the pump and boom insert what is called a diaphragm pressure reduction valve. Use a 1/4 to 3/8" size. One that may be used is made by the Norgren Company in Denver. With this valve you can have high pressure on one side and by adjusting the valve you can set it for any constant low pressure on the boom side. The pressure on the high side can vary considerably but you get a constant pressure for whatever you set it on the low side. If for any reason you want to go back to high gallonage operation, you simply remove the pressure reduction valve and substitute your old nozzles.

One thing that is essential in low gallonage spraying is an adequate filter system. All the better type low gallonage nozzles on the market now have a built-in filter of 100 to 200-mesh screen. In addition to that there should be a fine mesh screen inserted in the liquid line leading from the tank to the pump. The filter on the high gallonage sprayer, if you are converting an old one, will have a very coarse mesh screen and it is not satisfactory. You should purchase another filter that has a 100 to 200-mesh screen and install it in the liquid line. That will keep the bulk of the dirt out of the boom. Then you will not have to clean the nozzle filters very often. Otherwise, after a few hours operation, you may have to remove all the nozzles and clean the screens.

You have the option of buying a sprayer with or without the supply tank. An ordinary 50 gallon oil drum is satisfactory. If you have a tractor mounted unit you simply put a platform underneath the engine and you can set a tank on either side. Or if you are just operating on a small acreage, you can take a 10 gallon milk can or similar container and set it on the bank of the tractor. A ten gallon can will treat two acres. If you buy a trailer model, it comes equipped with a tank.

In the use of this equipment, you want to be reasonably sure of the dosage you are putting on. This is not a case where if a little bit is good, more is better, because 2,4-D is a selective weed killer. We take advantage of the fact that the dosage it takes to kill grass is somewhat higher than it takes to kill the weeds. If you apply too much of an overdose, you may injure the grass and at the same time waste materials. So you want to be sure of your dosage. That means that you have to be reasonably sure of your travel speed and pressure. You should know what that speed is and then calculate accordingly, so you will put on a given quantity of your 2,4-D per acre. On agricultural crops, a speed of about 4 miles an hour is generally advised. If you go much faster than that, the roughness of the fields is too hard on the equipment. For golf course and other turf work you can go faster but 4 miles per hour is recommended. It is an easy speed of operation and still covers acreage fast. Four miles an hour is 6 feet per second or two 3 ft. paces a second. You can have someone pace along side the tractor, using a watch to time the paces accurately. In this way you can find the tractor throttle notch that gives 4 miles per hour.

The low gallonage principal can also be applied to hand spraying. There are certain corners, or rough irregular areas on the golf course that you cannot reach with a power boom sprayer. There are hand sprayers being put on the market, a num-

ber of different types, which if you follow the directions that come with them, as to dilution that you use, how you use them, and how fast you walk, you can cover an acre, in some cases with as low as 2 to 5 gallons. One comes equipped with 3 Spraying Systems 1.27 nozzles spaced at 1 foot intervals. It has a hood to stop spray drift. With it you can take an ordinary 4 gallon pump up sprayer, put a gallon of spray in it, and pump it up to 25 pounds. You can empty the entire gallon with the pressure dropping to about 18 pounds. These nozzles will function in that range. With the one pumping, if you move at a fast walk, you can treat one half an acre. You can make such a hand boom by attaching several Tee Jet 1.97 nozzles at 18" intervals, or the 1.27 at 12" intervals and operate it from a garden pump up sprayer or one of the side arm knapsack sprayers.

One unfortunate feature of low gallonage hand spraying is that you cannot see what you are putting on. Two to five gallons per acre does not cause much wetting of the plant, yet you are getting the right amoung of 2,4-D on and it is properly distributed. You have to work it out on a pattern basis. If you are covering a swath 3 feet wide, walk down a 3 foot strip, move over 3 feet and come back. You have to move at a fairly constant speed and you have to figure it out so your strips don't overlap too much. With a little practice that is easy to do. You can save yourself a lot of time on cleaning up these odd spots by a low gallonage hand sprayer.

There are other new developments in equipment that apply more to agriculture than golf courses. One is the development of airplane spray application of 2,4-D. Airplane application is hard on the nearby trees since it is difficult to keep the spray off of them. If you have a broad area without trees, this method can be used.

Recently I had the pleasure of visiting the Bell Aircraft Corporation at Buffalo. They demonstrated their new helicopter spray equipment. It is really quite a remarkable instrument. They have certain advantages over the ordinary airplane, in that they can hover or move at any speed or direction they want, get into odd corners, and spray at a speed up to 40 miles per hour. They take up a 400 pound load. You really have to see them to appreciate what they can do. I think that you are going to see them develop quite a place in agriculture. However, I doubt if they will be usable on golf courses because of the danger of drift onto trees.

I will read a statement from the policy committee report of the North Central Weed Control Conference to get some idea of their opinion of this low gallonage method. The first practical low gallonage sprayer was made just a year ago. Up till then, there had been a fewly scattered attempts at it, but there had been little done about making a practical unit. This whole development, then, has come on very fast. At the North Central Weed Control Conference meeting of a year ago last December, someone mentioned that some day they might get down to 10 gallons per acre, and he was not taken very seriously. At that time it just did not seem possible. This year they accepted 5 gallons per acre as though it had been standard practice for years. In just one season it proved itself. Following is the statement they make in their policy committee report: "In large scale spraying the concentrated sprays are replacing conventional dilute sprays. Weed control, crop injury and drift are considered to be about equal for either method, but the concentrated sprays can be applied more cheaply and with greater ease. The dilute sprays penetrate dense foliage better than concentrated sprays."

Thus, for brush or tall dense weeds dilute sprays are still preferable, but for the greater percentage of the types of application of 2,4-D low gallonage is here to stay. At the present time most sprayers going out are equipped with 5 gallon per acre nozzles. You may see a trend toward the 2 gallon nozzle and others of that type, particularly where large acreage is involved.

TURF WEEDS AND THEIR CONTROL

O. C. Lee

We have a movie that was made by Sherwin-Williams Company, I think we will show that first and then we will open the session to questions. When this program was made up it was taken for granted that the use of 2,4-D, had been pretty well discussed and we know what it will do to weeds. The newest thing of course is the application of concentrated sprays. That is what Dr. Waters was talking about. This film is not necessarily a golf course or lawn film. It is, I think, the latest film that has been made on the subject of 2,4-D including its use on farms. So if you're not a farmer I hope you'll bear with us on that part of it. You will notice the film shows the use of 2,4-D on lawns, in pastures, on woody plants and on crops. One of the latest developments of using 2,4-D has been in the corn and grain fields. Now if you're ready, George, we'll turn it on.

You noticed the picture pointed out that 2,4-D is used in certain crops, to kill weeds, you can use it on grasses. Such plants are not easily killed by 2,4-D. I think you'll find that 2,4-D is going to be a very good weapon against weeds. Maybe we shouldn't put all the other methods of weed control aside, but should look upon chemicals as just one more way of eradicating weeds and that added to other methods that we have used in the past the job of weed control should be a lot easier. If you have any questions we'll try to answer them at this time. I may call on someone out in the audience if I can't answer them. If you have an experience that will help to answer the question, please feel free to speak up.

Question: The question is, how would it effect lifestock?
Answer: 2,4-D is not a poisonous material. It has been fed by the U. S. Dept. of Agriculture and they report that it is not damaging to livestock. It is not poisonous. It is not labelled poisonous. The only objection I have to 2,4-D is the odor. I don't like the smell of it. Any other questions?
Question: Will it kill chick weed?
Answer: You can get some measure of control of chick weed. We find that when we spray chick weeds there's a difference in the plants themselves. It will kill some of them, some of them are quite resistant. Then you'll find, of course, that it's only a matter of a few weeks before you have another crop from seeds in the soil. So it's not entirely satisfactory for the smooth chick weed. The mouse-eared chick weed, I think you'll find more easily killed.
Question: Will it kill crabgrass?
Answer: No, it will not kill grasses. It is not recommended for the control of crabgrass. However, we know that some measure of control with 2,4-D can be obtained if you applied it to crabgrass in the small seedling stage. I'm tempted to recommend the use of 2,4-D as a summer application on lawns and golf courses for the reason that you don't open up the turf by killing the weeds earlier allowing crabgrass a chance to come in the place where weeds were growing. Generally speaking, grasses are very tolerant to 2,4-D and so it doesn't effect them greatly unless excessive dosages are applied.
Question: What is the effect on seed?
Answer: Does somebody have information on that? The question is, what is the effect on seed? Supposing we spread crabgrass after it has gone to seed, 2,4-D will not kill the seeds. If applied in the blossom stage or before the seeds develop, seeds will not set. That is true of several weeds. For instance, ragweed - it takes a very small amount of 2,4-D to prevent seed formation. I did some work in the Ohio Valley this year near Evansville on cocklebur. From one-eighth to a quarter of a pound of 2,4-D acid per acre applied to these plants when they were in blossom prevented the formation of mature seeds.

Question: Effect on wild onion? That question often comes up.
Answer: We have had rather confusing results with garlic and wild onion control. We have them both in southern Indiana, in Kentucky and down in Tennessee. I think Tennessee and Kentucky have had somewhat the same experience. Farmers are finding these weeds difficult to control. They grow in the winter time, the bulbs develop during the cool weather, and at a time when it's very difficult to apply sprays. Applications of an ester type of 2,4-D in the fall along in November has shown some promise. Tops are killed but the bulbs survive. Last spring we made several applications, along about April, the latter part of March and the first of April. We were able to kill the tops but we didn't do very much to disturb the bulbs. The garlic plant starts to grow along about September or October and grows all winter long. Then the new bulbs develop real early in the spring and many times down along the Ohio river they develop in March, and if you don't contact the plant and destroy the top before those new bulbs develop, you have no way of contacting them through the tops. So it's somewhat questionable whether or not we're going to get a good kill of garlic with 2,4-D. It has some possibilities.
Question: If you plowed the soil and brought the bulbs up to the surface and then sprayed the bulbs, would they be killed?
Answer: I think undoubtedly you could. I know that freezing doesn't kill them and it would probably take a heavy treatment. I haven't any information on that, I wouldn't know.
Question: The question is, would bruising the plants before spraying make 2,4-D more effective? Is that Right?
Answer: I doubt very much if that will make any difference. We are not sure just why some plants do not respond to 2,4-D sprays.
Question: How much 2,4-D is necessary to kill dandelion?
Answer: From 3/4 to 1 pound of 2,4-D acid per acre is sufficient. Any other questions? Well, that takes care of the questions pretty well. There is one line of work that I want to mention and that is pre-emergence treatments with chemicals. It is experimental at present but may have a place. For instance, if you have an area that you want to plant, 2,4-D may be applied to the soil to kill germinating weed seeds and the grass planted after the 2,4-D has been applied after the corn was planted but before it emerged. The application of 2,4-D made at the rate of 1½ to 2 pounds to the acre would spread a protective surface over the top of the soil, killing weed seedlings as they came through. Under our weather conditions last spring on the University Farm, the chemical stayed on the soil for a period of from 5 to 6 weeks, killing ragweed, cocklebur, horseweed and other annual weeds. Actually what was happening was that the 2,4-D on the surface was picked up by weed seedlings as they came through, and of course the corn growing on the area being more resistant did survive. I realize that grass seedlings are very sensitive and may be killed. You may not be able to use large amounts.
Question: The question is how would this work in a tree nursery?
Answer: If the trees are not too susceptible to the chemical it might be alright. You would have an advantage there in not disturbing the soil. I don't know that it has been used in nurseries. It will take some time to work out the details because we don't know just how long these chemicals are going to stay in the soil. For instance, if you put a heavy application of 2,4-D on the soil it may stay there a week or it may stay there 6 months.
Any other questions? All right, I'll turf this back to Dr. Volk.

PROMISING NEW CHEMICALS

H. Waters

On this discussion of new chemicals, I'll confine it to new chemicals that are now on the market for weed control but are still in the developmental stage and have proceeded far enough to be interesting. They are not at the present time being marketed as weed killers. The research organizations of a number of companies have materials which they are working on. Some of them have made preliminary announcements on them and there are probably 10 to 15 promising materials that are being investigated by these research organizations. However, I will confine my remarks in this session to three chemicals which are fairly well along in the experimental work and for which there may be recommendations within a year.

The first one is a close relative of 2,4-D. It is called 2,4-5, Trichloro phenoxy, acetic acid, 2,4-5-T for short. It has three chlorine atoms in the molecule instead of two. It has some rather unusual properties. On turf weeds it is less effective than 2,4-D. Its strong point is its greater effect on many species of brush. It will control many species that 2,4-D does not do well on, for example, ask and oak. One that it is very outstanding on is briers. 2,4-5-T will give control of that type of plant. Unfortunately the cost of production per pound is about 3 times that of 2,4-D so it will be a higher priced material and it will be limited to definite specific uses. It will not replace 2,4-D but will simply compliment it. In areas on golf grounds where you wish to eliminate brush, it is in the long run more effective than 2,4-D. We are not in a position yet to come out with specific recommendations. However, the information that has been accumulated by various organizations indicates that it will definitely have a place. The power line people are particularly interested. Any organizations that have rightaways where brush grows are vitally interested in this new material.

One point on the usage of this material, and 2,4-D, is in a developmental stage on which we do not have complete information. We know that if in the spring you cut a tree or brush and paint the freshly cut stem with a 1% ester formulation of either 2,4-D or 2,4-5 in kerosene that in many cases you can eliminate or greatly reduce the number of shoots that will come back. This applies to all sizes whether it's a small stem or a large tree. It works best during the first half of the growing season. It will not give 100% results, but it will greatly reduce the number of shoots and in many cases completely kill. Even with 2,4-D you can get effect on certain species that you can not get by treating the foliage. Between the combination of 2,4-D and 2,4-5 and the practice of painting the cut stems when you clear and spray the regrowth when it is a year old, we feel confident that a program can be worked out for clearing brush from land in the matter of two to four years.

Another compound that holds some interest is ammonium trichlor acetate. It shows promise against certain perennial grasses such as Johnson grass, or other perennial grasses such as quack grass. It is applied to the soil by most any method you want. It does not have to be plowed under. It is applied to the surface and is carried in by the rain. Use from 1/4 to 3/4 pounds per 100 square feet. That runs from 100 to 300 pounds per acre. In many experiments it has practically eliminated the perennial grasses. There again we have not enough information to come out with a positive recommendation but the test results so far look as though that may give a means of controlling some of these grasses that we have not been able to get before. It causes about a three months sterilization of the soil. It is not selective and takes out most everything that is growing. Where you have these patches where there is no other way of eliminating the perennial grasses, this chemical may offer a means of getting rid of them. It means it would

have to be reseeded after the sterilization period is over.

Another compound on which there has been less work yet, and which we are not in a position to talk too much about it, is Sodium pentachlor phenate or Pentachlor phenol, two different forms of the same type of material. They seem to show strong results against annual grasses, and they seem to show some selectivity. There may be a chance of taking annual grasses out of perennials, although present data does not justify a positive recommendation. It does not take a large poundage per acre. Instead of several hundred pounds per acre as the previous chemical, probably a few pounds, 3, 4, 5, 10 pounds per acre will do the job, and by the end of another years research, there may be enough information to make specific recommendation.

There are many other compounds being worked on. The screening organizations of industry and of the federal government in some states are continually turning up new compounds, that seem to have specific uses. A number of these were reported on at the meeting at Topeka, but so far none of these has progressed beyond the hands of the people who originated them, and there is not too much information available on them.

So those three compounds are probably the most interesting of the new ones coming out.

Question: They didn't get the name of the last compound.

Answer: Pentachlor phenol

Question: Are there simpler names for these compounds?

Answer: They have not been used enough so that common names have been applied.

Question: Will these phenol compounds dissolve in water?

Answer: Pentachlor phenate dissolves in oil and can be made into an emulsion for use in water.

Question: Is there any possibility that extremely dilute applications of these chemicals would cause stimulation of growth rather than killing?

Answer: Well, there is no information on that on the last three that I know of. On the 2,4-5 and 2,4-D, there is some evidence that even the weed killing dosages or in some cases lower dosages have a definite stimulating effect on the plants. For example, you can take blue grass which is weed free but is rather short of fertilizer and not too dark a green. You make an application of 2,4-D and it becomes, within the course of a month, a very dark green. It may bleach temporarily but by the end of the month it will be a much darker green as though you had applied fertilizer. In corn we get conflicting results with the use of 2,4-D. In an area around Henderson, a number of farmers had evidence that there was greatly increased root growth. You could pull up plants and take averages of the weights of roots and get much larger roots on the treated plants. However, over in the Iowa area where corn was treated, the result was not so pronounced, so we are not sure. In the case of grain there may be a possibility, but there again there isn't enough evidence to say positively. Sometimes we seem to get it, and sometimes we do not. Most of these "hormone-like" compounds at low dosages do have what you might call hormone effect. That is that they effect processes of the plant, but don't kill a whole lot, it would depend on the dosage and timing.

It is like a combination lock, you hit it in just the right manner, you get a given result where perhaps at a later stage, you do not get it. For example, we had some tests in Texas trying to control mesquite, one of their range brushes. Over a period of several months they made an application every week. There was one two-week period where they get a complete kill, and the rest of the season they got very little results. There was something different at that particular time, although the applications were identical all the way through. There was something about the physiology of the plant at that time.

Question: Can 2,4-D be used with insecticides in sprays?

Answer: 2,4-D is a rather unreactive material. It is quite all right to mix the 2,4-D with other things you are going to be applying to the turf, such as ammonium sulphate. It is compatible with most all liquid insecticides, DDT, chlordaae and toxophene. In the case of applying it with liquid fertilizers and you are using high gallonage, several hundred gallons per acre, where you are washing it down into the roots it would not be advisable to put the 2,4-D on in this combination. You want to keep 2,4-D off of the roots as much as possible as roots of grass are quite sensitive. That is one advantage of the low gallonage spraying. You don't wash it down on the sensitive part of the grass. It stays right where it hits.

Question: Will 2,4-5-T or 2,4-D control water weeds?

Answer: There has been little done with 2,4-5, but 2,4-D is now definitely recommended for the control of certain water weeds. In the south the water hyacinth is a problem. 2,4-D gives a very satisfactory answer. Lily pads, if you wish to get rid of them are very sensitive to 2,4-D.

Question: Will 2,4-D harm fish?

Answer: No, we raised gold fish in a 1/10% solution of 2,4-D.

Question: Will 2,4-D control algal?

Answer: In the work with water hyacinths there have been algal formations in some of the ditches and there was no apparent effect on it at the doses we were using.

Question: Will repeated applications of 2,4-D on turf during a season harm grass?

Answer: In the case of turf with a properly planned program, you do not have to put on a number of applications in one season. In other words, one application a year will be the most you will need, and this has not harmed grass.

Question: When is the best time to apply 2,4-D to turf?

Answer: I believe Dr. Lee agrees with me, an early fall application of 2,4-D on turf is best. In early fall the open spot where the weed dies is not filled in with crab grass. In the fall blue grass will stool, that is it will grow laterally and fill in the bare spots, particularly if you fertilize. It will do this to some extent in the spring. However, if you treat after the cool spring period is over, say in June, where you have a heavy weed infestation and knock those weeds out, the blue grass is not going to make a rapid fill in and you are apt to get more crab

grass than you ever had before. For the first year you might want to go in with both a spring and a fall application, but after that you wouldn't have to treat more than once a year, preferably an early fall application.

Question: If you have two or three haphazard attempts and don't kill the weeds, will it become resistant to this chemical?

Answer: We do not have enough information to answer this.

NEW FUNGICIDES FOR TURF DISEASES

John Rowell

Dr. Volk, gentlemen. As I am an Easterner, you may wonder what I know about your midwestern turf disease problems. Frankly, I know little of turf culture and bent grass diseases in this area. The varieties of turf, the environment, and the important diseases vary throughout the country, and only regional studies will determine the best fungicidal treatments to maintain a disease free turf.

The importance of these three general factors has been demonstrated in the turf fungicide tests at Rhode Island. A few examples illustrate the complexity of the problem and may explain the conflicting results obtained by different investigators.

The outstanding environmental factors affecting the usefulness of turf fungicides are the weather and the soil. Extremes in weather conditions may sensitize the grass so that it is injured by a normally non-toxic material. For example, in our tests we have found that applications of the inorganic mercurials in hot weather injure the turf. The soil has a number of effects on turf fungicides. The aforementioned inorganic mercurials were applied to experimental plots at the recommended rate for five years. Toxic residues of the mercury to the bent grasses apparently accumulated in the soil and the turf began to decline in vigor. On the other hand, some of the new cadmium materials accumulate in the soil without injuring the grass. However, the residues remain toxic to the disease fungi and thusly reduce the number of applications of fungicide necessary for disease control.

Investigations have demonstrated that no fungicide can control all of the 50-odd fungus parasites of bent grasses. The mechanism of fungicidal action varies with the chemical, and disease fungi have different degrees of sensitivity or resistance to such mechanisms. In practice this is reflected in the specificity of a compound to control efficiently only a few diseases. Such fungicidal specificity was strikingly demonstrated in a test on Piper velvet bent which had a mixed infection of dollar and copper spots. In the thiuram disulfide treated plots the dollar spot disease was completely controlled, but the copper spot was as prevalent as in the check plots. As shall be shown later the organic mercurials also show varying degrees of specificity.

There are two principle modes of action, protection and eradication, by which fungicides may control the parasites. In the first method the chemical covers the plant surfaces as a protective barrier which prevents establishment of the pathogen by killing or inhibiting the infective hypha. Such a fungicide must be applied frequently at short intervals to maintain disease control. The grass blade grows and elongates mostly at its lowermost point near the node, and as this growth is exceedingly rapid new unprotected tissue is produced daily. The necessary frequent mowings cut off the blade tips which were covered with the protective deposit, leaving the susceptible new growth. Therefore, most of the turf is unprotected during the interval preceding another treatment with the protective material. It is for this reason, I believe that 200-odd fungicidal materials that we have tested have failed to control the Helminthosporium leaf spot which attacks our R. I. Colonial bent. It is simply impossible with the bent grasses to keep all susceptible tissues continuously coated with a protective fungicidal layer. In eradicant action, the chemical enters the plant and modifies its life processes so that the parasite is inactivated and the "sick" plant is cured. The combination of these two principles of action in a single material is highly desirable in a turf fungicide as the protective action prevents spread of the disease and the eradicative action aids in the recovery of the diseased turf.

The sensitivity of the grass host to the fungicidal material is important. The many different varieties of bent turf are dissimilar in their tolerance to fungicides. For example, the thiuram disulfide type of material was found to be a very good fungicide and was non-injurious on the creeping bents. On the other hand, Piper velvet bent under certain conditions was rather sensitive to the same material. This factor can be determined only by field trials in each locality. The unrelated disease problems existing on the many grasses further complicates the determination of the most effective chemicals.

The fungicide development plots at the Rhode Island Experiment Station are designed to give information on these variables for the Northeastern States. The materials are tested simultaneously on four adjacent plots of different bent grass varieties. These are: Rhode Island Colonial, Toronto (C-15) and Congressional (C-19) creeping, and Piper velvet bent grasses. These plots are maintained by the cultural practices generally used in this area for putting greens. Twenty-four treatments, including two checks, are tested on each variety in five randomized replicate plots (5 x 5 ft.). The materials are applied by a Dobbin mechanical sprayer with 150 lbs. pressure at the rate of 10 gallons per 1,000 square feet. Applications are made biweekly from early June to mid-September.

Five major turf diseases appear in the experimental areas in varying degrees of intensity. Dollar spot (Sclerotinia homeocarpa) occurs on the creeping bents, and pink patch (Corticium fuciforme) and copper spot (Ramulispora sorghi) on the velvet bent. Large brown patch (Pellicularia filamentosa) and Helminthosporium leaf spot (Helminthosporium sp.) also are present in the plots, but no significant data have been obtained on the control of these diseases. Many materials will give partial control of large brown patch, but the measure of the greenkeepers professional excellence is an unblemished turf. Therefore, in our development of new fungicides we have searched for those which will give absolute control of the various diseases.

Following the seeding of the R. I. Colonial bent test plot, a severe infestation of post-emergence damping-off occurred. This disease of the emerging germinating seedlings is a frequent problem on newly seeded turf. In this plot, the disease was checked by spraying with a suspension of Spergon. However, we believe that most of the standard fungicides would have been fully as effective in controlling the damping-off.

The new fungicides which were tested in the plots during 1947 and controlled turf disease fall into two categories, the water-soluble phenyl mercurials and the cadmium compounds.

The water-soluble phenyl mercurials were relatively specific in controlling one or two diseases. PMAS (soluble phenyl mercury acetate) controlled dollar spot and copper spot. Puratized 641 (a coded compound related to Puraturf) controlled dollar spot and pink patch. Puraturf (phenyl mercury triethanol ammonium lactate) controlled copper spot but not dollar spot or pink patch at the recommended dosage. The first two materials also inhibited crabgrass. On Congressional creeping bent where 10 per cent of the plot area in the checks was covered with crabgrass, only a trace of this weed was present in the PMAS and Puratized 641 treated plots. A greater infestation of crabgrass occurred in the R. I. Colonial bent area, affecting 30 per cent of the area in the checks, and this was reduced in the treated plots to 8 per cent. However, these surviving plants failed to produce any seed, consequently the crabgrass infestation in the succeeding year will be greatly reduced. The inhibition of crabgrass by the phenyl mercurial compounds is a selective action. These chemicals are toxic to both the crabgrass and to the bent grasses, but the latter is less sensitive. However, overdosage or uneven applications of either PMAS or Puratized 641 results in injury to the turf. It was interesting to note,

that a water insoluble phenyl mercury acetate which was tested in these trials failed to control diseases or inhibit crabgrass.

As a group, the cadmium compounds have the widest margin of safety for use on turf. Applications of four times the recommended dosages did not injure the grasses. The cadmium pounds can be subdivided into the inorganic and organic forms. Two inorganics, cadmium sulphite and Crag #531 (calcium zinc copper cadmium chromate), controlled dollar spot and pink patch but not copper spot. The organic cadmium pounds were the most effective chemicals applied. Four such materials, Puratized 177 (p-aminophenyl cadmium dilactate) and three new experimental compounds all controlled dollar spot, pink patch, and copper spot and therefore were the least specific of any of the materials tested. These chemicals also appeared to have a high residual activity in the sod. Four monthly applications of Puratized 177 at 2 lbs. per 100 gallons of water controlled all three diseases just as effictively as the 8 bi-weekly applications at the recommended dosage of 1 lb. per 100 gallons. In another test the organic cadmium compounds controlled an infestation of copper spot which appeared one month after the last fungicide application. Tests conducted in 1946 demonstrated the eradicant action of Puratized 177 against dollar spot. Applications of several treatments of this material to diseased Narragansett creeping bent resulted in the disappearance of the disease and filling in of the killed area within a month, yet the pathogen was still active in the check plots.

We are suggesting to growers who have a complex disease problem in our area a bi-weekly spray program with alternating treatments of a cadmium and a mercurial compound to utilize the best qualities of these two groups of fungicides. The program would start in mid-May with the application of the cadmium fungicide and this treatment would be repeated in the middle of June, July, August and September. The mercurial fungicide would be applied on the first of June, July and August. Such a program utilizes the residual activity of the cadmium compounds, making fewer applications necessary during the season, as well as its eradicative and broader fungitoxic properties. The mercurial treatments increase the range of diseases controlled and the fewer applications reduces the danger of mercury toxicity to the turf. Furthermore, if crabgrass was a problem the use of the phenyl mercurial compounds as the mercury containing fungicide would materially decrease this pest.

It must be reemphasized that these tests were conducted in Rhode Island where the complexes of environment, diseases and grass varieties differ from those of a midwest locality. No single fungicide now available will control all the diseases of bent grasses in all localities. The program of chemicals which will be most useful in maintaining a disease- and weed-free turf can best be determined by investigation under local conditions.

Question: The name of the crabgrass chemical.
Answer: The chemical which inhibits crabgrass is phenyl mercury acetate in a soluble form. Phenyl mercury acetate alone is insoluble, and in our tests as such was ineffective against either diseases or crabgrass. Certain agents when added to phenyl mercury acetate render it soluble in water, and this formulation has been trademarked as PMAS. Various distributors sell the product under their commercial names, such as "Tat-C-Lect", "Tat Soilicide", and "Ridz Crabgrass Killer". There will probably be many others on the market during the next season.
Question: Would you recommend a higher dosage for crabgrass control?
Answer: I am not a weed specialist, and my remarks concerning the control of this weed by the phenyl mercurials were simply from the information obtained on our plots in connection with testing these materials for disease control. Dr. Jesse DeFrance of the Agronomy Department at our Experiment Station has investigated the control of crabgrass by these chemicals under many conditions of turf and lawn culture. He has found that the sensitivity of the grass to the phenyl mercurials depends to a great degree on the length of the cut.

INSECT CONTROL

Glen Lehker

Insects are more of a problem in turf and upon ornamental plantings now than they were half a century or so ago. Their destructiveness has increased because of the importation and spread of species which formerly did not exist in this area and also because of greater concentrations of turf and plants upon which they feed. The disappearance of insect feeding birds and animals which formerly occurred in large numbers has also had a marked effect upon insect populations.

In addition to turf insects, most of us are also interested in the control of pests attacking trees and shrubs, but time does not permit a discussion of this latter group and therefore we will confine our discussion to turf insects alone.

Among the more important turf insects are grub worms, sod webworms, ants, and occasionally chinch bugs. Earthworms and moles are also major problems. In the past lead arsenate has been one of the best materials for the control of all of these pests except ants and chinch bugs. Lead arsenate is commonly used in turf at the rate of 10 or 15 pounds per 1000 square feet. Some greenskeepers apply the entire amount at one time, but a more common practice is to build up concentrations over a period of time. Successful control of sod webworms with lead arsenate is largely dependent upon not washing the poison into the soil too thoroughly. Webworms construct silken chambers at the base of the plants and feed upon blades of grass which they cut off and drag into their burrows.

White grubs, on the other hand, feed upon the roots, and any insecticide used must be washed in thoroughly. Incidentally, 1948 is the year for white grub damage in the Middle West. Most of our species in this area have a three-year life cycle, and this will be the year during which the grubs will feed during the entire season. Next year (1949) they will feed for a short period in the spring but will soon change to the inactive pupa stage and remain as such until the spring of 1950 at which time the beetles will emerge. Not all of the white grubs of course are on "schedule" and a few are present every year.

At present most of us are interested in the effectiveness of the newer organic insecticides for the control of turf pests. Among these are DDT, benzene hexachloride, chlordane, Toxaphene, parathion and several others. DDT is most commonly used at the rate of 25 pounds of the actual material per acre. This would be 250 pounds of a 10 percent DDT dust or 50 pounds of a 50 percent DDT wettable powder in sufficient water to spray one acre. DDT has been rather widely used by greenskeepers during the past couple of years, and many report good control of grubs, webworms, and ants.

Another new material that offers considerable possibility is chlordane. Dr. John C. Schread of the Connecticut Experiment Station reports that it is superior to DDT, benzene hexachloride, and Toxaphene for the control of ants and Japanese beetle grubs. For a complete turf treatment for ant control he suggests 4 ounces of a 50 percent chlordane wettable powder in 100 gallons of water applied to 1000 square feet with 100 pounds pressure. The turf should then be watered with another 50 gallons of water to obtain maximum penetration. For the control of grubs he suggests its use at the rate of 10 pounds of the actual material per acre, either sprayed or dusted on and watered in.

Benzene hexachloride, at least for the present, has little use on golf courses because of the musty odor it imparts to treated turf. Toxaphene apparently has no important advantages over chlordane and some disadvantages. Parathion offers possibilities but not enough is known about it to make definite recommendations. Tests to date indicate that Toxaphene gives best results when used at the rate of about

8 pounds per acre and parathion at about 4 pounds per acre.

Chinch bugs are not a serious turf problem in this area, but a 10 percent sabadilla dust has given good control elsewhere.

I am not familiar with control procedures for moles and earthworms, but Mr. G. C. Oderkirk, district agent for the U. S. Fish and Wildlife Service, reports that lead arsenate is still the best soil insecticide for preventing damage by these pests. The poison kills earthworms and also many insects and thereby reduces mole populations because they feed upon these creatures. Trapping, he says, continues to be the best means of eliminating moles after they make their appearance. The choker type trap is best.

THE LANDSCAPE DESIGN OF THE GOLF COURSE

R. B. Hull

Landscape architecture has never had the place in the development of golf courses which the situation warrants. The primary consideration naturally has been the creation of such layout as to provide ideal conditions for playing the game of golf. Fortunately, the selection of the site has often been a fortunate one, to include interesting topography, good surroundings and sufficient irregularity in the terrain to provide the necessary handicaps for a good game of golf. However, the failure to include proper consideration of the landscape architecture has resulted in much haphazard planting of poor materials and a failure to achieve the maximum results for use and enjoyment of the golf course.

I believe we will agree, that people play golf for a variety of reasons. There is, of course, the golf devotee, who loves the game and spends all the time he can away from his business in pursuing the illusive objective of high scores. And along with this group there is the group which likes to sit on the terrace of the club house and play bridge, getting part of their enjoyment no doubt, from the fine vistas sometimes prevailing from this vantage point, across green fields to blue hills in the distance and distant woods and other features of the landscape to which man has always turned for relaxation.

I would not be understood as saying that the development of the golf course should be left wholly in the hands of the landscape architect - far from this unless he heppens also to be skilled in the design of golf courses. It appears to me that complete cooperation between the golf architect and the landscape architect is the happy situation. Naturally, there would be poor economy in planning a distribution of plant masses which would create dead air pockets over the golf course, to aggravate all the fungus diseases to which grass is heir, and pursuing the desire of creating beauty at every possible point one would most certainly complete the job with a layout which would not meet the exacting requirements of the seasoned golfer.

There are many ways, however, in which the landscape architect can be of great use in the development of golf courses. Let us take, for instance, the selection of the site. The landscape architect would be invaluable in the selection of the site for the reason that it is always possible to select a site which has the possibilities in the development of the terrain, both for playing golf and for creating fine surroundings. Certainly the landscape architect will make a valuable contribution in the molding of the ground to create fine slopes, which while they accommodate the fairways in their proper position, will also insure refinement of the native landscape in such way as to add to the enjoyment of those who utilize the course.

In any rolling topography there are likely to be presented opportunities for the development of good landscape, with here and there a view of quiet water which, while adding to the interest of the outlook, may also feature among the hazards presented by the course. Refined type of grading, with fine sagging slopes, and a proper distribution of plant masses to create fine long vistas and exploit distant views is definitely in the field of the landscape architect.

In the matter of the selection of plant material particularly, the service of the landscape architect is invaluable. I believe that we will all agree that the landscape development of the golf course should be done with a view of exploiting all the possible inherent natural beauties of the locality, and certainly this would involve the utilization of the best of the native materials.

The predominant planting of both trees and shrubs should be of indigenous materials so that the completed golf course would appear merely as a refined portion of the native landscape.

The marginal planting of the golf course is of particular importance as here the landscape architect may create the illusion of woods margins - he may screen out objectional views, he may enhance distant views of good terrain off the course, where such exist, and he can confine the view entirely within the course where the adjacent terrain is not such as to add to the beauty of the outlook, involving the planting largely of native materials. These may be selected with the view of variety of foliage as to texture and color, variety of form to produce interesting skyline and certainly the selection may be limited somewhat to those trees and shrubs which present fine coloration during the autumn season.

Many fine opportunities for the introduction of masses of trees has been overlooked in the average golf course, partly due to the cost of proper planting and partly due to the absence from the picture of the professional landscape architect. Thus, interesting groupings of trees may be introduced between fairways, they may be introduced to form backgrounds for the greens, to accentuate dog-legs and, with the advice of the golf architect, may be so placed as to not only avoid interfering with the golf game but actually enhance the possibilities of creating a sporty course. Careful grouping of trees at the hands of a trained designer may mean much in enhancing the topography of the golf course. Thus, on gently rolling land, any slight eminence may be accentuated by groups of pines or other spire-like trees. A low swampy area, difficult to drain, may become a beauty spot if proper ecological considerations are kept in mind as to the placing in such areas of those trees which naturally are associated with swampy areas. Thus, one might find here large trees - birches, weeping willows and elders, which might make an asset of a feature which otherwise would be quite a liability in the development of the course.

One feature which is often misplaced and entirely too prominent in the view is the service area where equipment is stored and where are found the piles of compost and other undecorative features, and certainly here some judicious planting is indicated.

The plantsman, with a proper view to design and economy of maintenance, will certainly select for screen areas those things which involve the least possible maintenance and which, from habit of growth, provide the desirable screen. For such areas one might expect to use some of our fine glossy leaved varieties of hawthorns, such as the Washington Thorn or Crataegus nitida. Certainly, here is a spot where all the fine family of Viburnum should find a place, and the maintenance of such material can be reduced to a minimum if trained personnel is supplied on this job.

I recognize that in presenting this argument for better design of golf courses I am talking to men who have been burdened with the unending task of making both ends meet and of combining the necessary maintenance of fine fairways, greens and other features of the game with the task of stretching the budget. You men, I am sure, will be very sensitive to any proposals involving additional financial burdens. I am going to say, however, that proper landscape development need not materially affect the expenditures on a golf course if ample preparation is made and proper planting methods are followed as material is placed.

Thorough plowing of all shrubbery beds, incorporating as much rotted manure as it is possible to find, or compost, is perhaps half the battle.

Actually a great deal of the maintenance on public grounds is wasted labor. I am referring particularly to the popular method of pruning shrubs and trees. There seems to be in the mind of every gardener or maintenance man a desire uppermost in his mind to leave the imprint of his hand on every tree and shrub in his care. This finds expression in the popular "haircut" which is given to every individual shrub, so thatwhen the annual job of pruning is done a mass of shrubbery looks like an accumulation of globular individuals. Nothing could be more wasteful of time, or nothing could be least conducive to vigorous plant growth. Ideally, the pruning of a shrub should consist of an annual removal of one or two old canes right down to the ground, to keep the shrub open and maintain a greater percentage of relatively young vigorous shoots. If this plan were followed in the maintenance of shrubbery masses the cost could be reduced to a rather negligible figure and two or three days' work once a year would be all that would be required to maintain all the shrubbery that the average golf course should have on it. Coupled with this, instead of the manicuring of shrubbery beds which is so popular by maintenance men, if when the leaves are raked in the fall they were spread evenly under all masses of shrubs and allowed to rot there as they do in the fence row, there would eventually develop under these shrubs a condition very closely comparable to a woods floor condition and this is the condition in which shrubs make their maximum growth and maintain their most vigorous health.

There is a certain amount of spraying involved in some plant materials but here again a judicious selection will eliminate those shrubs most subject to scale. I refer to such plants as lilacs and other smooth bark trees commonly infested with oyster scale. Nowadays the maintenance equipment kept on a golf course always includes a sprayer ,so that some spraying might be done at no great cost.

The maintenance of trees, once established, again does not involve costly expenditure. Actually the greater part of the pruning will be done while the tree is young, so that its form may be controlled. Following establishment, the only maintenance involved on trees is likely to be that of removal of broken branches and an occasional fertilization where the tree has been planted in not too fertile soil. I believe one cannot too greatly emphasize the importance of the use of organic material in the maintenance of trees and shrubs. This, of course, is one of the commidities most difficult to secure. In the average region of the golf course, barnyard manure has practically passed out of the picture and it seems to me that the last recourse might be the production of great volumes of compost. I have a feeling that in this respect managers of golf courses have over-looked a fine source of organic material in the leaves which are collected in adjacent cities and burned every year at considerable expense. I feel that the alert maintenance superintendent might take a leaf from the book of the canny nurseryman about whom I was told recently, who induced a friend of his on maintenance work in the city to purchase a haybaler to bale up the leaves which his work crew was collecting here and there over the city, arguing that this would involve easier handling and lowering of cost which actually, I think, the conditions of subsequent experiences proved. I need not add, however, that this nurseryman was able to secure these baled leaves practically for the cost of hauling them away. Certainly here is a great supply, a great source, of organic material which should find its way some way or other into the compost heap in the service areas on the golf course and with an abundant supply of this material the job of maintaining plant materials on a golf course might be reduced to a rather low figure.

The hand of the landscape architect will be discovered in many other details of the well planned and well developed golf course. The approach to the club house, the entrance feature, the enhancing of the landscape, all add up to the total satisfaction which is reflected inevitably in increased membership and the possibility, when the necessity arises, of even increased dues.

The golfer, I must repeat, not only likes to play golf, but if the truth were known there is certain stimulation which he gets from his occasional contact with mother earth on the golf course, from what he sees there and enjoyment he gets from the views of distant blue hills and glimpses of water and all the features which go to create beauty in the landscape. You might not admit this but I believe a survey of all the fine golf courses which have proven popular will discover not only good playing conditions, conditions conducive to a fine golf game, but they will also disclose that considerable thought has been given to making the most of the situation in the effort to secure maximum use and enjoyment of golf grounds. I feel that landscape architecture has a definite place in creating this type of golf course and that the increased expenditure of professional fees and some additional maintenance costs would, in many cases, be amply repaid by the greater popularity of the course.

A Sound Fertilizer Program for Turf

J. Tyson

A sound fertilizer program for turf is one which supplies the necessary mineral nutrient elements to the grass to produce the kind of turf which is desired. Turf plants, like all other plants must be supplied with several of these elements by the soil, mainly nitrogen, phosphoric acid, potash, calcium, magnesium, iron, sulphur, manganese, boron, zinc, and copper. Whenever the supply of anyone of these elements in the soil available to the plants is reduced to the limiting point additions must be made or the grass will become stunted and show signs of malnutrition.

Nitrogen, phosphoric acid, and potash are the three elements that are most likely to be limiting factors as far as the growth of turf is concerned, with nitrogen being the one which is usually needed in the largest amounts. Phosphoric acid and potash alone will have little influence on the growth of the turf grasses if nitrogen is lacking. On the other hand, nitrogen will stimulate the growth of the grass even when the supplies of phosphoric acid and potash are at a low level, however, if the levels of these two are raised by additions of phosphate and potash to the soil, the nitrogen will be more effective.

Fertilization of turf with phosphate and potash should be such as to supply as much of these as are necessary to maintain a healthy, vigorous turf when nitrogen is added. Since these two elements become fixed in soil and do not leach as readily as nitrogen they may be added in sufficient amounts at one time to meet the needs of the turf for at least one year and in many cases for two years. On the other hand, they may be added periodically in smaller quantities in mixed fertilizers with nitrogen. Phosphate and potash in the soil, even in excess of the turfs actual needs will not cause excessive growth of the turf. Thus, the operator has a rather wide range in which to use these materials with safety and satisfaction. They may be applied in the fall, in the spring, or in the summer, and they may be added as individual materials, superphosphate for the phosphate and muriate or sulfate of potash for potash; as mixed fertilizers 0-20-20, 0-20-10, 0-14-7; and as complete fertilizers 10-6-4, 4-12-4, 3-12-12, 5-10-5, and similar analyses.

The fertilization with nitrogen on the other hand must be controlled within certain definite limits as the rate of growth of the grass, when other conditions are suitable, is proportional to the available nitrogen supply. If the soil supply of available nitrogen is low the growth of the grass will be slow; however, each addition of available nitrogen will result in a proportionage growth of grass. Thus, the operator must become skilled in controlling the nitrogen available to the grass to produce the type of growth desired.

Under certain soil conditions fertilization to supply manganese, boron, copper, calcium, magnesium, iron and sulphur is necessary. Manganese is frequently needed in alkaline soils, especially on golf greens in which the surface soil contains a high percentage of sand and peat. Boron very likely will be deficient under these same conditions. Iron and sulphur are frequently deficient in alkaline soils of the arid regions in the west and may occassionally become limiting in this region. However, sulphur is supplied in ammonium sulfate, superphosphate and sulfate of potash fertilizers. Calcium and magnesium are frequently deficient in very strongly acid soils. Calcium and magnesium can be supplied to strongly acid soils in the farm of dolomitic limestone. This material is sometimes used in mixed fertilizers to neutralize excess acids.

Greenkeepers must become well acquainted with their greens and with the effect of the fertilizers they use in order to develop a sound fertilizer program for them. This program includes the application of sufficient phosphate and potash to meet the needs of the grass, usually an application of approximately 2 to 4 pounds of phosphoric acid and 1 to 3 pounds of potassium per 1000 square feet each season will meet the needs of grasses on putting greens. Thus, one application of 10 pounds of 0-20-20 per 1000 square feet, 20 pounds 0-12-12, 20 pounds of 0-14-7, 20 pounds of 3-12-12, 20 pounds of 5-10-5, or 25 pounds of 4-12-4 will supply sufficient phosphate and potash to meet the needs of a green for one season. Likewise, 5 applications of 10 pounds 10-6-4 per 1000 square feet will furnish sufficient of these two elements.

Nitrogen must be available in amounts and at the times needed to produce the growth desired. Usually this requires approximately one pound of nitrogen per 1000 square feet per application during cool weather and one-third to one-half of this during hot weather. In other words, nitrogen fertilization is usually heavier in the north and especially in early spring than in the more southernly and warmer areas. The greenkeeper becomes an artist in his business painting the greens with his magic nitrogen fertilizer brush to give the shade of green that pleases, and that indicates a healthy firm turf. Soluble available forms of nitrogen should be used when soil temperatures are below 60°F. During the seasons when the soil temperatures are above 60°F the choice of nitrogenous fertilizer depends upon price per pound of nitrogen, convenience of application, and personal experience.

It would be well to include an application of one pound of manganese sulfate and four ounces of borax per 1000 square feet with the fertilizer two or three times each season if the soils are slightly acid to alkaline in reaction.

Fairway and general turf fertilization is not as difficult as is greens fertilization. The need of fertilizer is indicated by the rate of growth of the grass, the density of the turf, the encroachment of weeds and moss. The appearance of moss in turf is not an indication of acidity as often believed. Moss covers the soil where the grass has disappeared. It is natures way of covering man's mistakes.

If the turf is thin, weedy, and contains much moss it certainly is in need of fertilization. One, two, or three applications a year may be needed. In the cool humid regions the first application should be made as early as possible in the spring and usually a second application in early fall. Encourage and stimulate the grass in the season in which it grows best and in which weeds, especially crabgrass, are least active. The time of fertilization depends entirely upon the local climatic conditions and the best time for the region can be learned from your local research staff.

Fairway fertilization probably would not be needed if the state of fertility was high enough to keep a thick, firm turf. Fertilization in early spring is to be avoided if it causes too rapid growth of grass, causing undue trouble in keeping the fairways mowed when the grass is making its most rapid growth.

Fairway and general turf fertilizers usually contain a high percentage of nitrogen and a medium amount of phosphoric acid and potash, such as a 10-6-4 or 12-6-4. There are a few specially grades, such as, 8-8-8-, 10-10-10, and 10-10-5 that give equally good results. Likewise, the same effect may be achieved by fertilizing the fairways with a complete fertilizer, such as 5-10-5 or 4-12-4 for one application and then using a nitrogenous fertilizer like ammonium sulfate, ammonium nitrate, soybean meal, or milorganite for the second application.

Making a New Seeding

J. Tyson

There are many factors that contribute to the success of any new seeding, such as, seed-bed preparation, fertilization, kind of seed, amount of seed, time of seeding, method of seeding, and the management of the area after seeding.

Seed-bed preparation. A firm seed-bed is essential for successful seedings of turf grasses. The soil should be firmed by alternate rolling and harrowing until the seed-bed will permit the operator to walk over it without leaving foottracks. This is accomplished in the case of small lawn areas by alternate rolling with a hand roller and raking. The final preparation for seeding is a very light raking to loosen the top quarter-inch of soil to receive the seed. After seeding the area should be raked lightly and then rolled to firm the soil around the seed.

Large areas are prepared for seeding by alternate rolling and harrowing using tractor drawn field type equipment. The final preparation may be made with a cultipacker. The seed may be broadcast after cultipacking with no other operation. The seeds will fall in the tiny trenches and the first rain will cover them sufficiently.

Fertilization. A high level of fertility is needed for the production of good turf, especially in making new seedings. Although nitrogen is the element that needs to be applied in the largest quantities for growing grass, a relatively high level of phosphate and potash is needed for the best growth of the grass. A heavy application of fertilizer with a low rate of seeding is much more effective in producing a good turf than a heavy seeding either with or without the heavy rate of fertilization.

The fertilizer may be broadcast and worked into the surface soil before seeding, or the seed may be mixed with the fertilizer and broadcast in one operation. The fastest germinating seed in the mixture requires at least seven days for germination. In this length of time the fertilizer will have reacted with the soil and will have no detrimental effect on the young seedlings.

Fertilizer is applied through a fertilizer spreader on large acreages such as fairways. Likewise there are many types of small spreaders which may be used to advantage on small areas such as lawns, or the fertilizer may be broadcast by hand if one is careful to spread it evenly. There will usually be some places around trees and shrubs, and in odd corners where it is almost impossible to reach with a mechanical spreader in which it will be necessary to broadcast the fertilizer by hand.

Seeding. One point that needs emphasis is this, almost all turf grass seeds are very small. They should be planted at extremely shallow depth. When they are planted too deep too much energy is required to push the tiny plant up through the soil. Many of them will never reach the surface and those that do are weak plants and the establishment of the turf is delayed.

It would be much better to broadcast the seed on the surface of the soil without any attempt to cover it than to bury it too deep. Nature's method of seeding grass is to scatter it on the surface. A good example of this is found in farmers fields where grasses are grown in rows for seed production such as the fescue seed fields in Michigan. The crop is

combined in early July. If you visit these fields in August and September you will find a perfect mat of new fescue seeded between the rows. This is seed that fell on the surface of the soil and was not worked into the soil.

Methods of Seeding. There are many ways in which the actual application of the seed may be made successfully. An important item, however, is the even distribution of the seed. Seeding of large acreages can be made with one of the various types of grass seeders made for this purpose. As with any new tool the operator must become skilled in their use in order to do a good job with them. One of the recent machines to be put on the market is a grass seeder attached between the rollers of a cultipacker. There are also grass seeders which may be used to spread seed evenly over small areas, such as the whirlwind type of seeders, or the seed may be mixed with fertilizer or sand and spread with one of the small hand fertilizer distributors. In many cases the most satisfactory method is to broadcast the seed by hand. The amount of seed is so small that it is necessary to mix. It with screened soil, sand, or peat to make sufficient bulk so that it can be distributed evenly. Divide the seed mixture into three parts, broadcast one part while traveling north and south, one part traveling east and west, and the third part traveling northeast and southwest.

Rates of Seeding. The rate of seeding (lbs. per acre) used depends upon the variety of grass, the purpose of the turf, and the level of fertility of the soil. In general it is best to spend more money for fertilizer and less for seed. Experiments that have been conducted on various places show that the best turf is produced with light to medium rates of seeding and generous applications of fertilizer.

The number of seeds per pound is one factor that must be considered in making plantings. For instance in the case of Kentucky blue grass there are approximately 3000 seeds per square foot; with Red top and many bent grasses which are much finer seeds the above rate would be equal to about 9,000 to 10,000 seeds per square foot. Red fescue seeds are considerably coarser and at this seeding rate would only give about 700 seeds per square foot. However if you will take one square foot of sod and count the number of individual plants you will find it is considerably less than even this number. In other words one pound of Bluegrass or red fescue seed per 1000 square feet and one-third pound of bent grass seed per 1000 square feet is sufficient to make a good seeding and produce a thick turf is soil conditions and especially soil fertility conditions are suitable.

It should be remembered that the turf grasses also reproduce and spread vegetatively so that even if a thin seeding is made the grasses will fill in the bare areas quickly if well fertilized in water. An individual bluegrass or fescue plant will spread vegetatively and cover approximately one square foot of area in one growing season if well fertilized and watered. Fertilizing and watering are much more effective in thickening turf than reseeding alone.

When high rates of seeding are used there is not enough room for all of the plants to grow. The resulting overcrowding causes all of the plants to be weakened and many of them must die in order to make room for the relatively few that will survive.

Nurse Grasses. Another point that must be considered in making new seedings is the relative merits of seeding a desired species by itself and of seeding a desired species by itself and of seeding mixtures containing so-called nurse grasses. The term nurse-grass as it has been used should be deleted from our turf literature since it is erroneous to believe that the grasses that produce a quick cover aid the permanent grasses except as they prevent erosion. With this exception the quick growing grasses are competitors for space, fertility, and water which retards the establishment of the desired grasses in the turf.

With good soil conditions, that is, on a heavy sandy loam, loam, silt loam, or clay loam soil containing a large percentage of organic matter and a fairly high state of fertility quick germinating grasses such as redtop and ryegrass may be included in a seed-mixture with the desired grasses, such as Kentucky bluegrass or the red fescues. The quick germinating grasses form a green turf within a few days which serves until the slower germinating grasses become established. Generally the "nurse-grasses" do not hinder their establishment seriously under these favorable conditions.

The case is quite different however when the soil conditions are less favorable. If the soil is very sandy or gravelly and droughty the quick germinating grasses will not usually survive long enough to be competitors, but if the sandy droughty soil has just enough fine materials added to allow the quick germinating grasses to become established the competition is so great that the fescue does not survive.

We have a highway shoulder turf research project at Michigan State College conducted cooperatively with the Research Laboratory of the State Highway Department. Various sands and gravels that are used for shoulders have different mixtures of topsoils, clay, and peat in the top six inches for stabilization and to improve growing conditions for turf shoulders.

The plots which contained 20 and 30 percent of topsoil in the upper six inches produced a beautiful stand of ryegrass when seeded in the fall. The next summer when the ryegrass disappeared there was no turf as the fescue had been unable to become established in competition with the ryegrass.

Time of Seeding. The time to make a seeding depends partly upon the conditions under which the turf is used. We are well agreed that fall seedings of turf grasses are better than spring or summer plantings. The seedings that are made early enough in the fall so the permanent grasses have plenty of time in which to germinate and get established before winter stops growth are best. This is the time of the year when weeds are on the decline, and the grass has an opportunity to make a solid cover without weed competition.

Seedings made at East Lansing in early September were entirely free from crabgrass the following season although crabgrass seed was planted there in an attempt to secure an investation on which to try chemical control, however, on an adjoining area, where fescue was planted in the spring the crabgrass infestation was severe. Under the latter condition the crabgrass was a strong competitor for space with the fescue during the summer months.

There are many conditions that necessitate spring planting. One of these is football fields. Modern football is played largely in the middle one third of the field. The heavy play concentrated in this area wears

out the turf no matter how good it was at the beginning of the season. When the football season ends in the late fall it is too late to reseed the bare areas. The turf must be ready for the opening of play the next fall, therefore spring seeding is necessary. Unless sodding is substituted. I think that if the present system of playing football only in the middle third of the field is continued that it will be necessary to grow sod in a turf field for two or three years to produce a sod tough enough to stand the wear and tear and resod at least the middle of the field each year.

The difficulties that may be encountered in making spring seedings of turf grasses is illustrated by the case of the highschool football field at Jackson, Michigan. The turf on this field is thoroughly worn down each fall; twenty-four games including high school, junior high schools, parochial high schools, and professional games were played here in the fall of 1946. This field was reseeded in the spring of 1947 using a mixture of one third rye grass and two thirds Kentucky bluegrass. The field received an application of 750 pounds 10-6-4 fertilizer per acre. What came up was a mixture of approximately 90 percent knotweed and 10 percent grass. "2-40" might have been used to kill the knotweed but it would have been injurious to the grass as well. As soon as the weather became warm a new crop began to grow. It was black medic, yellow trefoil. I have seen pasture fields where agronomists have tried to establish black medic as a pasture forage crop, however, this football field was the most beautiful stand I have ever seen. It was too late in the season to try to eradicate the black medic so we left the mixture of grass, knotweed, and black medic as the turf for that particular football field.

Questions and Answers.

Question: Should the surface of a lawn being prepared for new seeding be compacted?

Answer: There are degrees of compaction. An area that is being prepared for seeding where the soil has ben loosened by plowing or spading, or bring in new soil must be firmed by repeated cultivation and rolling until the seed-bed is firm enough so that seeds will not be buried too deeply. The term compact, however, is usually applied to the condition in which the soil has been worked (usually fine textured soils) so much when wet that the porosity has been so greatly reduced that aeration and drainage conditions are poor. This latter condition is to be avoided.

This brings up another point that needs consideration and that is the relative merits of rotary tillage implements in preparing lawn seed beds. Large tractor drawn implements are impractical to use in fitting lawn and landscape planting areas around small homes. Here is a place where a small implement such as the rotary tillers could be used to advantage if they can be used without injurious effects on the physical condition of the soil.

A landscape operator who has been using one of these implements for two years has been having difficulty in getting seedings established on areas where he has been using rotary tillage. Rotary tillage loosens the soil excessively and causes destruction of the granular structure. When the soil settles it is more compact than soil fitted by ordinary methods, aeration is poorer. Possibly this difficulty could be lessened if the soil was worked less.