# PROCEEDINGS

## of

# 1949 TURF CONFERENCE

***Sponsored by the***

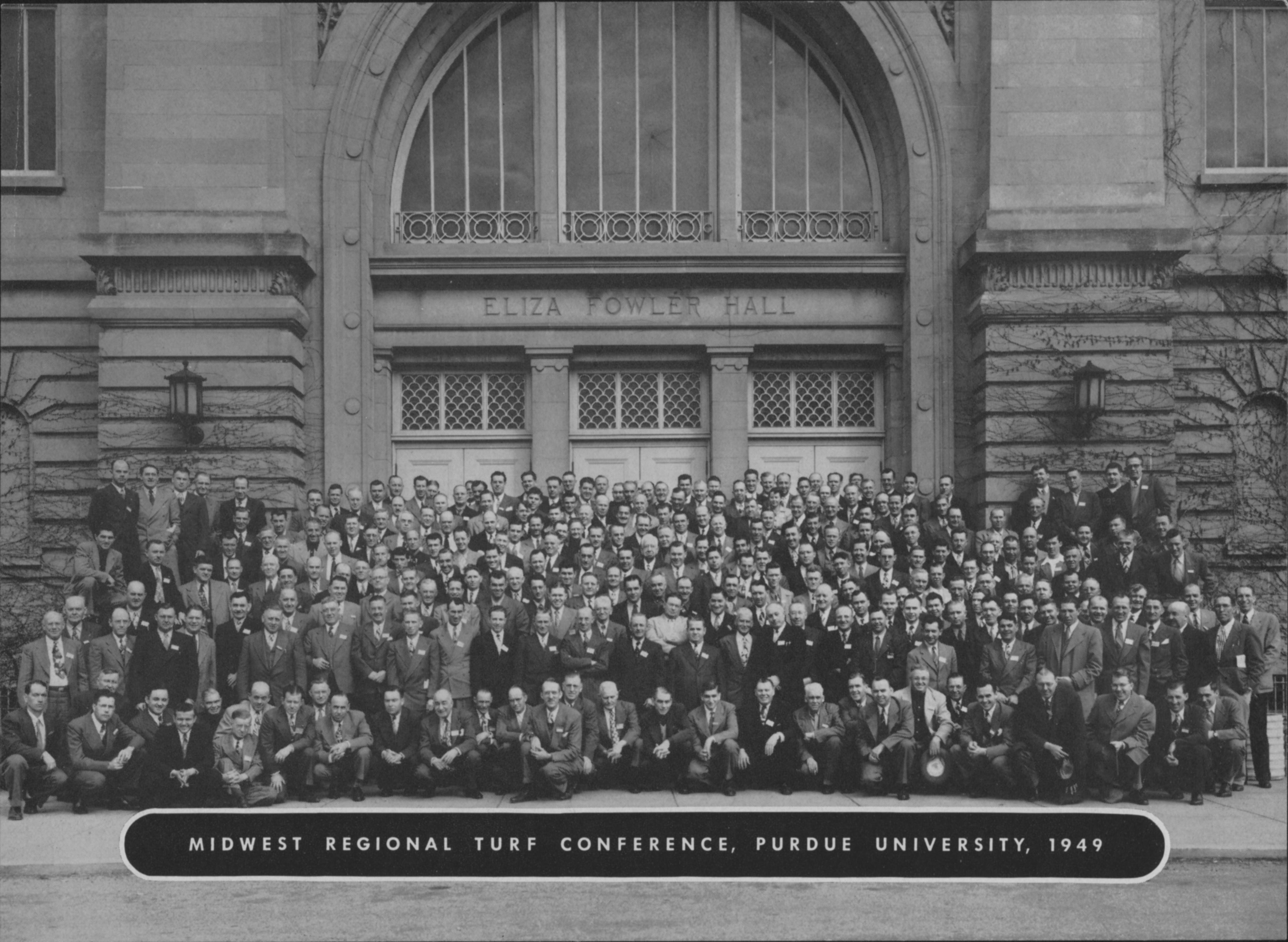
Midwest Regional Turf Foundation

***and***

## PURDUE UNIVERSITY

**LAFAYETTE, INDIANA**

**MARCH, 1949**




MIDWEST REGIONAL TURF CONFERENCE, PURDUE UNIVERSITY, 1949

## ACKNOWLEDGEMENTS

The 1949 Turf Conference was the largest ever conducted at Purdue University with 312 registered attendants. The attendance was so large that the group was divided into four sections and four lecture-demonstrations were conducted simultaneously to take care of the large crowd. We are particularly indebted to those individuals who repeated their demonstrations for the four sections. We wish especially to acknowledge the assistance of O. J. Noer, H. R. Lathrope, G. N. Hoffer, and G. E. Spencer. For a discussion of soil structure and soil compaction problems we are indebted to Fred V. Grau. We are also indebted to the Toro, Jacobson, and Worthington Machinery Companies for sending representatives to the conference to discuss the repair and maintenance of fairway and greens mowers.

Those of us on the Purdue University staff wish especially to thank the graduate students, Mr. Willis Skrdla, Mr. Richard Davis, and Mr. Don Likes for the time which they spent in making preparations for the conference and their active participation.

The recording and transcription of the papers presented in this proceedings were made possible through the courtesy of
West Point Lawn Products
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Table of Contents

ATTENDANCE

MIDWEST REGIONAL TURF FOUNDATION CONFERENCE

At Purdue

March 7, 8, and 9, 1949

| | Name | Address | Country Club Or Company |
|---|---|---|---|
| 1. | Aarnink, Clifford | R.2, Box 209, TerreHaute, Ind. | Terre Haute C. C. |
| 2. | Allen, Mark | Purdue University, Lafayette | Purdue University |
| 3. | Allen, Joe | Cincinnati, Ohio | Cincinnati Mun. GC |
| 4. | Bailey, H. S. | 2015 Colfax St. Evanston, Ill. | Rep. Geo. A. Davis |
| 5. | Baker, A. Stuart | 2529 Catalpa Dr. Dayton, Ohio | |
| 6. | Baker, C. I. | 425 E. 14th Blvd, Chicago, Ill. | Chicago Park District |
| 7. | Baker, Paul E. | Rushtown, Ohio | Elk's C. C. |
| 8. | Barnhart, George E. | 306 Chandler, Evansville, Ind. | Municipal G. C. |
| 9. | Becker, Richard | Fontana, Wisconsin | Big Foot C. C. |
| 10. | Beckstrom, Carl | R.1, Box62E, St.Charles, Ill. | St. Charles C. C. |
| 11. | Bennett, Wayne F. | R. 6, Kokomo, Ind. | Kokomo C. C. |
| 12. | Berggren, Fred | Publicity Office, A.E.S. | Purdue University |
| 13. | Bertramson, B. R. | Purdue University, Lafayette | Purdue University |
| 14. | Bertucci, Adolph | 1325 S. Telegraph, LakeForest, Ill | Lake Shore C. C. |
| 15. | Bertucci, Elmer | 345 Highwood, Highwood, Ill. | Old Elm Club |
| 16. | Bishop, Lester L. | Canton, Ohio | Edgewood G. C. |
| 17. | Bishop, W. B. | R.4, Box 218, Decatur, Ill. | Southside C. C. |
| 18. | Bockoski, Chester | 6433 Broadway, Indianapolis, Ind. | Willow Brook G. C. |
| 19. | Bond, R. R. | Madison, Wisconsin | Old Orchard Nursery |
| 20. | Booterbaugh, E. E. | MilwaukeeCC, Milwaukee, Wisc. | Wisc. Green. Assoc. |
| 21. | Borg, Gus | Springfield, Illinois | Illini C. C. |
| 22. | Boyer, Harry C. | Cincinnati, Ohio | Losantiville C. C. |
| 23. | Boyd, Taylor | Box 21, Station M, Cincinnati, O. | Kenwood C. C. |
| 24. | Bressler, William | 1300 E. Virginia, Evansville, O. | Oak Hill Cemetery |
| 25. | Bretzlaff, Carl | R.16, Box641, Indianapolis, Ind. | Meridian Hills C. C. |
| 26. | Brinkworth, W. H. | Minneapolis, Minnesota | Toro Mfg. Co. |
| 27. | Brei, Henry | 5501 W.Larcom Ave. Chicago, Ill. | Edgebrook G. C. |
| 28. | Brown, Agar M. | St. Charles, Illinois | Nat'l G.S. Assoc. |
| 29. | Brown, Carl R. | Indianapolis, Indiana | Mississinewa C. C. |
| 30. | Brown, Orville | Fort Wayne, Indiana | Elks C. C. |
| 31. | Brown, Varnon | 3445 Western Mattoon, Ill. | Mattoon C. C. |
| 32. | Browne, Wm. K. | | Willett Lumber Co. |
| 33. | Browning, James | 8151 N.High, Worthington, O. | York Temple C. C. |
| 34. | Brundage, R. W. | Box 24, Copley, Ohio | Landscape |
| 35. | Bucher, Keith | Fond du Lac, Wisc. | Takodah G. C. |
| 36. | Burdett, Paul | Lombard, Illinois | Golf Course Supplies |
| 37. | Butler, Albert | R.1, Springland, Mich.City, Ind. | Pottawattomia |

| Name | Address | Country Club or Co. |
|---|---|---|
| 38. Cagle, J. C. | Indianapolis, Indiana | Speedway Golf Course |
| 39. Canale, Joseph | 442 E. Walnut St. Oglesby, Ill. | Deer Park G. C. |
| 40. Carico, Ernest | Terre Haute, Indiana | Elks C. C. |
| 41. Carson, G. P. | Stroudsburg, Penn. | Worthington Mower Co. |
| 42. Cassier, E. W. | Sycamore, Illinois | Sycamore G. C. |
| 43. Chaplan, Frank | Elyria, Ohio | Elyria C. C. |
| 44. Clark, Milton | 3520 Indiana Ave. Fort Wayne, Ind. | Ft.Wayne Park Board |
| 45. Clarke, Wm. | 2541 Prospect Ave. Evanston, Ill. | Northwestern G.C. |
| 46. Clark, Frank | Sheldon, Illinois | Shewami C. C. |
| 47. Clauss, W. L. | Peoria, Illinois | Madison Park C. C. |
| 48. Cler, W. F. | Fort Wayne, Indiana | Orchard Ridge C. C. |
| 49. Clevett, M. L. | Fieldhouse, Lafayette, Ind. | Purdue University |
| 50. Coble, Clem | 34th & Kessler, Indianapolis, Ind. | Broadmoor C. C. |
| 51. Corlett, E. J. | 3389 Dorchester Rd. Shaker Heights, O. | Beechmont C. C. |
| 52. Cornwall, W. | 1015 Vernier Rd. Grosse Point Woods 30, Mich. | Lochmoor C. C. |
| 53. Coval, Elmer | Lebanon, Indiana | Ulen C. C. |
| 54. Coval, Pete | Indianapolis, Indiana | Indianapolis C. C. |
| 55. Coyne, Mike | Chicago Heights, Illinois | Lansing G. C. |
| 56. Coyne, Tom | Chicago Heights, Illinois | Lansing G. C. |
| 57. Crandall, Doc | Elyria, Ohio | Cherry Ridge G. C. |
| 58. Csepegi, J. T. | River Road, Madison, Ohio | Madison G. C. |
| 59. Dahman, C. A. | 3701 Vine St. Cincinnati 20, Ohio | Vine St. Hill Cemetery |
| 60. Daniel, W. H. | Mich. State College, E. Lansing, Mich. | Michigan State College |
| 61. Davis, Ralph | A.E.S., Lafayette, Indiana | Purdue University |
| 62. Davis, R.C. | Medinah, Illinois | Medinah C. C. |
| 63. Davis, Richard | A.E.S., Lafayette, Indiana | Purdue University |
| 64. DeBruyn, L. | 10916 S. Trumbull Ave. Chicago, Ill. | Ridge C. C. |
| 65. Didier, Ray | 6730 Howard Ave. Miles, Ill. | Tam O'Shanter C. C. |
| 66. Dienhart, Alvin | R. 10, Lafayette, Indiana | Elks C. C. |
| 67. Dinelli, F. J. | 1302 Clavey Rd. Highland Park, Ill. | Northmoor C. C. |
| 68. Dinelli, Joe | 1302 Clavey Rd. Highland Park, Ill. | Northmoor C. C. |
| 69. Dowell, Earl | 1114 State St., Lafayette, Ind. | Lafayette C. C. |
| 70. Dowling, C. C. | 1301 W. 38th St. Indianapolis, Ind. | Woodstock G. C. |
| 71. Dryfoos, Sidney | 3108 Mayfield Rd. Cleveland, Ohio | Horticultural Supplies |
| 72. Duehr, E. J. | Midlothian, Ill. | Midlothian C. C. |
| 73. Dunlop, F. | Cleveland, Ohio | The Country Club |
| 74. Easter, Jim | Logansport, Indiana | Dykeman Park |
| 75. Engelhardt, P. | Worth, Ill. Box 273 | Westgate Valley C. C. |
| 76. Ermer, F. | Cleveland, Ohio | Ridgewood C. C. |
| 77. Esterline, W. | R. 3, Muncie, Indiana | Delaware C. C. |
| 78. Fairfield, D. | 121½ E. Beardstown St. Virginia, Ill. | |
| 79. Fannin, H. | Cleveland, Ohio | Mayfield C. C. |
| 80. Fannin, R. | Warren, Ohio | Trumbull C. C. |
| 81. Ferguson, R. C. | Eau Claire, Michigan | Ferguson & Sons |
| 82. Ferriero, A. | Kent, Ohio | Twin Lakes C. C. |
| 83. Fields, J. E. | 659 Coburn St. Akron 11, Ohio | Brundage Landscape |

| Name | Address | Country Club or Co. |
|---|---|---|
| 84. Fifield, E.E. | Gary, Indiana | Gary Parks |
| 85. Finger, Carl | Canton, Ohio | I.G.Harman & Sons, Inc. |
| 86. Fletcher, J. | Rochelle, Ill. | Rochelle C. C. |
| 87. Folbigg, H. S. | Lacon, Illinois | Lacon C. C. |
| 88. Fontaine, L. L. | Louisville, Ky. | Big Spring G. C. |
| 89. Ford, O. C. | Fowler, Indiana | |
| 90. Forsee, G. | 1301 W. 38th, Indianapolis, Ind. | Woodstock C. C. |
| 91. Gabbey, H. | Racine, Wisc. | Johnson Park G. C. |
| 92. Gabriel, S.J. | 536 N.Harlem Ave.River Forest,Ill. | Cook Co. Forest Preserve |
| 93. Garringer, C.E. | Indianapolis, Indiana | Speedway G. C. |
| 94. Gerber, Don | Glen Ellyn, Illinois | Glen Oak C. C. |
| 95. Gerber, R. | Glen Ellyn, Illinois | Glen Oak C. C. |
| 96. Gibford, L.D. | Auburn, Indiana | Auburn C. C. |
| 97. Gillett, A. J. | Rockford, Illinois | Forest Hills C. C. |
| 98. Gilley, Angus | R. 6, Connersville, Indiana | Connersville C. C. |
| 99. Gillie, David | Fort Wayne, Indiana | Park Department |
| 100. Gilmore, G. | 3265 Robin Rd. Louisville, Ky. | Audubon C. C. |
| 101. Goodrich, F. | 246 Eddington St. Flint, Mich. | Flint G. C. |
| 102. Graham, P. J. | R. 1, Edwardsburg, Mich. | FourLakes C. C. |
| 103. Graffis, Jos. | 407 S. Dearborn St. Chicago, Ill. | Golfdom |
| 104. Grau | Beltsville, Maryland | U.S.G.A. Green Section |
| 105. Graves, S. H. | R. 17, Box 2, Indianapolis, Ind. | Municipal C. C. |
| 106. Grenier, Fred | 6901 S. Calhoun St. Ft. Wayne, Ind. | |
| 107. Gridley, O. | Lakeside, Mich. | Chikaming C. C. |
| 108. Grotti, D. | Winnetka, Ill. | Sunset Ridge C. C. |
| 109. Habenickt, C. B. | 15200 Pualina, Harvey, | H & E Sod Nursery |
| 110. Hair, R. M. | Piqua, Ohio | Piqua Park Director |
| 111. Hamilton, R.R. | A.E.S., Lafayette, Indiana | Purdue University |
| 112. Hannah, Jack | A.E.S., Lafayette, Indiana | Purdue University |
| 113. Harasty, L. | Cleveland, Ohio | Canterbury G. C. |
| 114. Hardy, P. | 6301 Golf Rd. Marton Grove, Ill. | Indian Boundary G. C. |
| 115. Harvey, C. W. | New Augusta, Indiana | Hillcrest C. C. |
| 116. Hause, A. | 6159 Winthrop Ave. Indianapolis, Ind. | Meridian Hills C. C. |
| 117. Helmbold, G. | Dayton, Ohio | Madden Golf Club |
| 118. Henry, T. | St. Louis, Missouri | Forest Park |
| 119. Herd, Bruce | Flossmoor, Illinois | Flossmoor C. C. |
| 120. Heston, L. | Fieldhouse, Lafayette, Indiana | Purdue University |
| 121. Hewitt, E. | Cincinnati, Ohio | Hamilton C. Park Dist. |
| 122. Hjort, C. H. | Michigan City, Indiana | Long Beach C. C. |
| 123. Hocker, O.L. | 1824 Coventry Rd. Dayton, Ohio | Dayton Parks |
| 124. Hodson, B. | 6155 Brandon St. Kokomo, Ind. | American Legion C. C. |
| 125. Hoffer, G. N. | Lafayette Life Bldg. Lafayette, Ind | American Potash Inst. |
| 126. Holland, C.F. | 3265 Robin Rd. Louisville, Ky. | Kentuckiana Green. Assoc. |
| 127. Hoover, J. | Pontiac, Illinois | Elks C. C. |
| 128. Hopkins, A.E. | R. 4, Decatur, Illinois | South Side C. C. |
| 129. Hopkins, V.C. | R. 3, Elwood, Indiana | Elwood C. C. |
| 130. Hosfeld, A. | 813 N. Main St. Rockford, Ill. | Rockford Park Dist.<br>Sinnissippi G.C. |

| | Name | Address | Country Club or Co. |
|---|---|---|---|
| 131. | Howe, Robert | | Wisc. Green. Assoc. |
| 132. | Hoyt, Walter | LaGrange, Illinois | Timber Trails G. C. |
| 133. | Hull, H. N. | 1158 Welch Ave. Akron, Ohio | |
| 134. | Husted, A. M. | 522 Court House, Cincinnati, O. | Hamilton C.Pk.Dist. |
| 135. | Huter, J. C. | Louisville, Kentucky | Big Spring G. C. |
| 136. | Irion, C. G. | A.E.S., Lafayette, Indiana | Purdue University |
| 137. | Jackson, W. | | Rockford Park Dist. |
| 138. | Jackiewicz, J. | 5900 Leader Ave. Chicago, Ill. | Billy Caldwell G. C. |
| 139. | Janssen, E. | Rock Falls, Ill. | Rock River C. C. |
| 140. | Johnson, Nels | Evanston, Ill. | Commercial |
| 141. | Johnson, N. C. | 48th & Brainard, LaGrange, Ill. | LaGrange C. C. |
| 142. | Jones, C. M. | Sullivan, Indiana | Sullivan Elks C. C. |
| 143. | Jones, Fred G. | 6025 Guilford, Indianapolis, Ind. | Sarah Shank G. C. |
| 144. | Jones, LeRoy | 1904 W.Mt.Hope, Lansing, Mich. | Lansing C. C. |
| 145. | Kavanaugh, M. | Cincinnati, Ohio | Hamilton Pk. Dist. |
| 146. | Keely, C. R. | Notre Dame, Indiana | Univ. of Notre Dame |
| 147. | Killmer, W. | 2143 Maple Rd. Homewood, Ill. | Ravisloe C. C. |
| 148. | Kengsley, D. C. | Arlington Heights, Ill. | |
| 149. | Kirchdorfer, J. | | Kentuckiana Green. |
| 150. | Kirkhart, E. | Hartville, Ohio | |
| 151. | Knox, G. P. | Homeweed, Ill. | Calumet C. C. |
| 152. | Kobelt, E. | Box 56, LeRoy, O. | Westfield C. C. |
| 153. | Kohnke, Helmut | A.E.S. Lafayette, Indiana | Purdue University |
| 154. | Krak, J. | Ravenna, O. | Meadowview G. Links |
| 155. | Kramer, H. H. | A.E.S. Lafayette, Indiana | Purdue University |
| 156. | Kress, Allan | 3200 W. Grange, Milwaukee, Wisc. | |
| 157. | Kress, Frank | Milwaukee, Wisconsin | Tuckaway C. C. |
| 158. | Kurek, Bill | Peoria, Illinois | Northmoor G. C. |
| 159. | Kurz, A. T. | 43 S.Delaware St. Indianapolis | C. E. Griener Co. |
| 160. | Lambert, R. J. | 2802 Kenmore Ave. Dayton, O. | Madclen G. C. |
| 161. | Lamboley, H. L. | Fort Wayne, Indiana | Fort Wayne Pk. Board |
| 162. | Lange, Henry | Golf, Illinois | Glen View Club |
| 163. | Lankford, M. T. | 6177 Guilford, Indianapolis, Ind. | Kenney Mach. Co. |
| 164. | Lapp, Amos | 468 Locust St. Elgin, Ill. | St. Andrews Club |
| 165. | Lathrope, H. | A.E.S. Lafayette, Indiana | Purdue University |
| 166. | Lawson, C. C. | Rushville, Indiana | Rushville Elks C. C. |
| 167. | Lawson, J. | Franklin, Indiana | Hillview C. C. |
| 168. | Lundblad, Nels | Wheaton, Illinois | Chicago Golf Club |
| 169. | Lee, O. W. | Muncie, Indiana | Delaware C. C. |
| 170. | Lahker, Glen | A.E.S. Annex, Lafayette, Ind. | Purdue University |
| 171. | Likes, Don | A.E.S. Lafayette, Indiana | Purdue University |
| 172. | Lendenschmidt, R. | Cincinnati, Ohio | Hartwell Club |
| 173. | Linkogel, A. | R.1, Lane 5, Clayton, Mo. | Westwood C. C. |
| 174. | Livingston, R. B. | Columbia, Missouri | University of Missouri |
| 175. | Lyons, W. | Akron, Ohio | Firestone C. C. |

| Name | Address | Country Club or Co. |
|---|---|---|
| 176. McCawley, R. F. | Knoxville, Tenn. | Holston Hills C. C. |
| 177. McCoy, J. S. | Cincinnati, Ohio | Cincinnati C. C. |
| 178. McCracken, C. H. | Mt. Vernon, Ohio | Mt. Vernon C. C. |
| 179. McIntosh, D. | Fort Knox, Kentucky | Officers C. C. |
| 180. McLaren, M. | Cleveland, Ohio | Oakwood Club |
| 181. McLaren, M. R. | Minneapolis, Minn. | Toro Mfg. Co. |
| 182. McLaughlin, Bud | Lafayette, Indiana | Purdue University |
| 183. Mackay, G. J. | Fieldhouse, Lafayette, Ind. | Purdue University |
| 184. Marchi, Gene | Dayton, Ohio | Miami Valley G. C. |
| 185. Marczinski, L. | Rand Rd. ArlingtonHeights, Ill. | Rolling Green C. C. |
| 186. Martin, James | Lafayette, Indiana | Purdue University |
| 187. Mascaro, Tom | West Point, Penn. | Westpoint Lawn Prod. |
| 188. Mathews, H. | Sullivan, Indiana | |
| 189. Mayfield, A. L. | Carlinville, Illinois | Mayfield Memorial Park |
| 190. Meetz, Ted | Michigan City, Indiana | Michigan City G.C. |
| 191. Mendenhall, Chet | 5301 State Line, KansasCity, Mo. | Million Hills C. C. |
| 192. Miklosko, Joe | Toledo, Ohio | Chippewa C. C. |
| 193. Miller, R. S. | 101 W.Third St. Dayton, Ohio | City Forester |
| 194. Monical, N. | Akron, Ohio | Portage C. C. |
| 195. Monier, C. F. | Charleston, Illinois. | Charleston C. C. |
| 196. Monroe, E. | Ft. Wayne, Indiana | Fairview G. C. |
| 197. Mortensen, T. | Racine, Wisconsin | Jacobson Mfg. Co. |
| 198. Mott, G. O. | A.E.S. Lafayette, Indiana | Purdue University |
| 199. Mueller, A. | Forest Park, Ill. | Woodlawn Cemetery |
| 200. Mueller, H. W. | | Cemetery |
| 201. Muller, Keith | Chicago, Illinois | U. S. Rubber Co. |
| 202. Munk, Robert | Jacksonville, Ill. | Country Club |
| 203. Needham, A. A. | Rockford, Illinois | Rockford C. C. |
| 204. Nelson, Darby | Miamisburg, Ohio | Mound G. C. |
| 205. Nelson, E.R. | Culver, Indiana | Culver G. C. |
| 206. Nelson, R. W. | Minneapolis, Minnesota | Golden Valley G. C. |
| 207. Newkirk, E. | 3235 Southerland, Indianapolis | Coffin G. C. |
| 208. Noer, O. J. | Milwaukee, Wsiconsin | Milwaukee Sewerage |
| 209. Nugent, W. C. | Brook, Indiana | Hazelden C. C. |
| 210. Oates, W. | Wheaton, Illinois | Arrowhead G. C. |
| 211. Parsons G. C. | 1235 Herman Ave. Akron, O. | J.Edw.Good Pk. G.C. |
| 212. Parsons, M. M. | Indianapolis, Indiana | Highland C. C. |
| 213. Patterson, J. K. | A.E.S. Lafayette, Indiana | Purdue University |
| 214. Payne, Kenyon | A.E.S. Lafayette, Indiana | Purdue University |
| 215. Peterson, Carl | 7059 S.Shore Dr.Chicago, Ill. | South Shore C. C. |
| 216. Peterson, J. B. | A.E.S. Lafayette, Indiana | Purdue University |
| 217. Pike, Howard | Indianapolis, Indiana | Kenney Mach. Co. |
| 218. Plent, R. A. | Cleveland, Ohio, 4902E. 95th | |
| 219. Popp, Paul | Riverside, Illinois | Riverside G. C. |
| 220. Purvey, A. | 104 John St.McHenry, Ill. | McHenry C. C. |
| 221. Quarandillo, L | Logansport, Indiana | Logansport C. C. |

| | Name | Address | Country Club or Co. |
|---|---|---|---|
| 222. | Ramey, Bill | Physical Plant, Lafayette, Ind. | Purdue University |
| 223. | Randby, C. H. | 1890 Waukegan Rd.LakeForest,Ill | Knollwood Club |
| 224. | Randolph, W. H. | Charleston, Illinois | Charleston C. C. |
| 225. | Reed, H. | 6601 Gennison St. Chicago,Ill. | Ridgemoor C. C. |
| 226. | Rees, Jim | Indianapolis, Indiana | Willowbrook G. C. |
| 227. | Remlin, O. | | Willett Lumber Co. |
| 228. | Reynolds, A. J. | Dayton, Ohio | Miami Valley C. C. |
| 229. | Reynolds, G. H. | Dayton, Ohio | City of Dayton |
| 230. | Riley, W. F. | Indianapolis, Indiana | Riley Golf & Lawn Eq. |
| 231. | Rinaldi, A. L. | Cleveland,O. 1915 WoodlawnRd. | |
| 232. | Roach, W. J. | Cincinnati, O. | Wyoming G. C. |
| 233. | Robellaz, C. L. | R. 2, Lafayette, Indiana | Edwood Glen G. C. |
| 234. | Rodgers, R. | Elyria, Ohio | Elyria C. C. |
| 235. | Roseman, W. J. | 2610 Ridge Rd. Evanston, Ill. | |
| 236. | Rost, Bert | Park Ridge, Ill. | Park Ridge C. C. |
| 237. | Runyon, C. R. | Cincinnati, Ohio | Cemetery of Spring Grov |
| 238. | Ryan, Jack | Louisville, Ky. | Big Spring G. C. |
| 239. | Scarseth, G. | 300 Schultz Bldg.Lafayette,Ind. | American Farm Research |
| 240. | Schultz, H. | | Wisc. Green. Assoc. |
| 241. | Schulz, W. J. | New Albany, Indiana | New Albany C. C. |
| 242. | Schurtz, Paul | Columbus, Ohio | Scioto C. C. |
| 243. | Schwab, H. A. | Dayton, Ohio | Community C. C. |
| 244. | Schwantz, W. | Hinsdale, Ill. | Hinsdale G. C. |
| 245. | Seaney, W. L. | 801 S.Wash. Crawfordsville,Ind. | Swift & Company |
| 246. | Seaton, J. P. | Ag Hall, Lafayette, Indiana | Purdue University |
| 247. | Sellers, E. | Glenview, Illinois | North Shore C. C. |
| 248. | Sharvelle, Eric | A.E.S. Lafayette, Indiana | Purdue University |
| 249. | Sheets, C. E. | 1301 Westoner Rd. Ft. Wayne,Ind | Ft. Wayne Pk. Board |
| 250. | Shock, E. | 2560 Berkley Dr. Dayton, O. | Community C. C. |
| 251. | Shockley, W. F. | P.O.Box 387,Terre Haute,Ind. | C. C. of Terre Haute |
| 252. | Siems, H. B. | Chicago, Illinois | Swift and Company |
| 253. | Simon, E. J. | | Rockford Park Dist. & Sandy Hollow G. C. |
| 254. | Simmons, H. | Cleveland 22, Ohio | Highland G. C. |
| 255. | Simpson, J. R. | Dyer, Indiana | Longwood C. C. |
| 256. | Skinner, J. R. | Cleveland, Ohio | Ohio Toro Co. |
| 257. | Skrdla, W. H. | A.E.S. Lafayette, Indiana | Purdue University |
| 258. | Slack, Wm. | Fort Wayne, Indiana | Fort Wayne C. C. |
| 259. | Slagell, H. A. | Fort Wayne, Indiana | Fairview G. C. |
| 260. | Slater, J. D. | Chicago, Illinois | Plant Marvel Labs |
| 261. | Slates, Ralph | Ravennia, Ohio | Meadowview G. Links |
| 262. | Smith, Colin | 18512Kings Hwy.Warrensville,O. | Shaker Heights C. C. |
| 263. | Smith, W. R. | Chicago, Illinois | Geo. Davis, Inc. |
| 264. | Sopko, Mike | 29007 Euclid Ave.Wickliffe,O. | Pine Ridge G. C. |
| 265. | Spencer, Geo. | Ag.Eng.Bldg.Lafayette, Ind. | Purdue University |
| 266. | Sprenger, Fred | Peoria, Illinois | Newman Golf Course & Peoria Pk. Board |
| 267. | Stafford, D. E. | 376 N.Holmes Ave.Indianapolis | South Grove G. C. |
| 268. | Stanley, W. H. | Hoopeston, Illinois | Hubbard Trail C. C. |

| | Name | Address | Country Club or Co. |
|---|---|---|---|
| 269. | Steward, E. N. | Hinsdale, Illinois | Butterfield C. C. |
| 270. | Stewart, Peter | Hinsdale, Illinois | Butterfield C. C. |
| 271. | Stichter, E. E. | A.E.S. Annex, Lafayette, Ind. | Purdue University |
| 272. | Strand, Don | Wilmette, Illinois | Westmoreland C. C. |
| 273. | Stupple, Wm. H. | Highland Park, Illinois | Exmoor C. C. |
| 274. | Szychowicz, S. | Brunswick, Ohio, R. 2 | Skyland G. C. |
| 275. | Sylvester, E. J. | Piqua, Ohio | |
| 276. | Talley, D. H. | 1319 6th St. Terre Haute,Ind. | C. C. of Terre Haute |
| 277. | Tankersley, D. R. | 351 E. KygerSt. Frankfort,Ind. | |
| 278. | Teuber, R. | 756 Elizabeth St.Flint,Mich. | |
| 279. | Tilges, Ed. | P.O.Box 830,Evanston, Ill. | Evanston G. C. |
| 280. | Thalheimer, W. | Batesville, Indiana | Hillcrest G. and C. C. |
| 281. | Thode, R. H. | 1853 Pine Rd. Homewood, Ill. | Chicago Pk. Dist. |
| 282. | Thomas, J. R. | Forest Park, Illinois | Forest Home Cemetery |
| 283. | Thompson, Jack | Canfield, Ohio | Tippecanoe C.C. |
| 284. | Todd, Nicholas | Montgomery, Ohio | Swain Fields G. C. |
| 285. | Torste, Clifford | Cincinnati, Ohio | Losantiville C. C. |
| 286. | Trees, E.E. | Box 222, Frankfort, Indiana | Armour Fertilizer Wks. |
| 287. | Tullock. L. H. | Brecksville, Ohio | Goodrich Res. Cen. |
| 288. | Turner, G. A. | Brook, Indiana | Hazelden C. C. |
| 289. | Tyson, James | East Lansing, Michigan | Michigan State College |
| 290. | Valandingham, R. | 1818-177th St.Hammond, Ind. | Woodmar C. C. |
| 291. | Vaughan, Ed. | 14 Grace St.Park Ridge, Ill. | Park Ridge Pk. Dist. |
| 292. | Vaughn, J. H. | 1016 Parker Ave. Indianapolis | Pleasant Run |
| 293. | Vaughan, J. L. | Homewood, Illinois | Vaughn's Seed Co. |
| 294. | Vial, F. K. | 312 S.Madison Ave.LaGrange,Ill. | Timber Trails G. C. |
| 295. | Vise, Cary J. | Virginia, Illinois | Virginia C. C. |
| 296. | Wakely, Ted | Toledo, Ohio | Chippewa C. C. |
| 297. | Warren, B. O. | 8400 W. 11th,Palos Park, Ill. | Warren's Turf Nursery |
| 298. | Way, J. H. | Cleveland, Ohio | Canterburg Golf Club |
| 299. | Wecks, H. F. | Ohio City, Ohio, R. 2 | |
| 300. | Whitcomb, J. E. | $134\frac{1}{2}$ W.26th St. Indianapolis | Riverside G. C. |
| 301. | White, Maurice | Peoria, Illinois | C. C. of Peoria |
| 302. | Wilson, Floyd | Nobelsville, Indiana | Forest Park |
| 303. | Wirt, James | Wheaton, Illinois | Arrowhead G. C. |
| 304. | Wolfe, Larry | Akron, Ohio | Rosemont C. C. |
| 305. | Wolfrom, C. | 11341 Chicago Rd.Warren,Mich. | |
| 306. | Wright, Alph | Sharonville, Ohio | Hamilton Co.Pk.Dist. |
| 307. | Wright, D. C. | Tipton, Indiana | City of Tipton |
| 308. | Wright, L. A. | New Castle, Indiana | Westwood C. C. |
| 309. | Wyman, Allan | Danville, Illinois | Danville C. C. |
| 310. | Yanaway, J. F | Charleston, Illinois | Charleston C. C. |
| 311. | Yearsley, Helen | Detroit, Michigan | Tranquil Gardens |
| 312. | Young, O. W. | 4075 S. Blvd. Dayton, Ohio | Moraine C. C. |

# TURF PROBLEMS FROM EVERYWHERE IN KODACHROME

O. J. Noer

I am happy to be here and keep a perfect attendance record. While I expected to see a large attendance I am really amazed because I understand there are over 280, which means that attendance will reach the 300 mark, which is a record attendance for a turf conference anywhere. There have been meetings with 150 to 175 but I am sure this one is the biggest ever. Last week I was at Ithaca along with Fred Grau. When I got there Charles Hallowell, County Agent at Philadelphia, greeted me with this statement. "I tried to get Eb Steiniger of Pine Valley to accompany me to this meeting. He looked at the program and saw Charles Hallowell, O. J. Noer, Fred Grau, H. B. Musser, along with other 'wheel horses' who are becoming 'has-beens.' He said, 'I can't see much point in going there, they tell the same old story so I know what they will say.'" Without saying anything more we will go ahead with the pictures and use them to illustrate some of the turf problems encountered during our travels around the country. Most of the pictures are from golf courses yet many have general application. We like to think that all grass problems have been solved. I don't think that is true and believe that as long as we grow turf there will be problems and maybe new ones will crop up from time to time.

The first picture was taken last June in Seattle, Washington. If you think you are the only people with turf problems that isn't so. I walked alongside the first green on a public course and this is what I saw on the sign. "Be considerate to other players. Repair your divot hole after putting." You see, they have problems.

The next two pictures were taken at Los Angeles during the recent GSA meeting. You see the two exhibitors' booths at the stadium in which the various exhibits were displayed. Out in front are the welcoming ceremonies which were opened the meeting and conference. (The question was asked, "Are those top-coats the men are wearing?") (O. J. Noer's reply, "That's right. Here is one of the Mascaros. See him in the spaghetti coat. Herb Graffis also has an overcoat.

Here is the mayor of Los Angeles along with other notables welcoming the group to the city and opening the conference.

Here's a turf problem and its solution -- a little female dog points the way to the solution of the problem on that lawn. It looks to me like nitrogen starvation. The grass is greener and taller in the urine spots due to the urea in it.

In the next picture the lawn looks bad. It proves that if a little is good, too much may be bad. The burned spots are urine burns from a large German police dog.

You have heard me talk about iron chlorosis. This is a typical example on a green in the Boston area. It is quite prevalent in that region during certain seasons of the year, particularly on velvet bent. I have seen damage from it in Oklahoma, Texas, Kansas City and even in other areas. The sickly, yellow color is evidence that there is something seriously wrong with the grass.

This is another example of the same kind of chlorosis. Some might mistake it for scald or brownpatch but actually the bad spot is due to this chlorotic yellowing of the grass.

Here is a very severe case of chlorosis on velvet bent. The chlorosis, in my opinion, was aggravated by the extensive use of peat. I think you can see the top layer of 3 or 4 inches of peaty soil which was used to topdress the green. The yellowing occurred immediately after a heavy rainy period and was due entirely to iron chlorosis, as we will show you a little later, because iron sufate corrects it.

This is an example to show the effect of iron. The green was sprayed the day before with a little bit of iron sulfate -- 1 pound of ferrous sulfate (copperas) 20 gallons of water used on the entire green. A fertilizer bag was placed over the rectangular area in the center of the picture. Notice that the grass under the bag which got no iron sulfate is much more yellow than it is on the outside. The difference was apparent in less than 12 hours. I saw iron chlorosis in Philadelphia last August which I am sure was produced by heavy liming. We will talk about that in on of the sectional meetings later in the day and tomorrow (Wednesday) also.

Ferguson and Grau call me "dry spot Noer." This is an excellent example of what occurs on localized dry spots which exist on many greens, particularly when the grass is shallow rooted. In this instance the localized drying is confined to the outside edge of the greens, probably due to the fact that during the dry period immediately preceding, enough attention had not been given to the banks. Unless they are kept moist they abstract water from the soil in putting green proper.

This picture shows two soil plugs, one is dry and the other is moist. Over to the right the soil is drying, but the grass is not dead. The dull, dark bluish color is evidence of wilting.

Here we have a picture taken quite a few years ago showing an extremely bad case of localized drying. The grass wilted first and then died in the brown spots. Localized dry spots and wilting occurs on many greens where the turf is very heavily matted. Many think that spiking is the answer. Once localized dry spots develop, spiking is not drastic enough to overcome the trouble. A few little pin pricks are not going to introduce water deep enough. Spiking helps prevent the condition but does not cure it after the dry spots develop.

Here is a good hand-forking method which is used particularly when the spots are only small and relatively few in number. The soil profile picture shows why it is important to make deep holes so as to thoroughly moisten the soil. The profile was taken from a dry spot after it had been hand-forked and then drenched with water -- drenched only once. You will notice that the water has started to moisten the soil. It is important and necessary to get all of the soil moist, then it takes water in a normal manner during sprinkling. After the soil is re-moistened it will accept water as it should.

This is Leo Feser's way of correcting localized dry spots. He has a little 9-hole golf course that he owns and operates. His daughter and son are the labor force, the greenkeeper; in fact the only workers on the place. When Leo's son told him that localized dry spots were developing he shuddered. He couldn't tell the boy to hand fork the greens, in addition to his other work. So Leo went down in the basement and appropriated the rubber roller on his wife's clothes wringer and made this contraption. The hopper, instead of holding fertilizer, carries water and has holes in the bottom. It is pushed back and forth across the dry spot. The rollers force water into the dry spots. Leo says it does an effective job and is usually truthful, so I think what he says is undoubtedly correct.

As for shallow roots in greens, I do not think that is altogether due to faulty fertilizer management. We must do something to increase the amount of air relationship in the soil. Roots need oxygen and stay near the surface to get it in compacted soil. If we can get a deeper root system throughout the green, it will be unnecessary to run out and hand-water during the daytime in hot weather, which is necessary now.

This is a terferator, which is a machine with drills for drilling holes in greens. The next picture shows the holes made by the drills. This is on the same green. We took out a plug alongside of a drill hole to show the depth and size of the hole made by the terferator. The terferator does a good job but is very slow. It will take a man anywhere from a day to a day-and-a-half to do an average green.

Here is one of Tony's Aerifiers being used in Milwaukee on a green by "Les" Verhaalen. He uses the half-inch spoons. The cultivating effect is an advantage to the extremely heavy soil which is underneath the green. In this case "Les" used an old putting green mower and basket to remove the plugs because the soil was so heavy. He wanted to topdress with the more sandy loam soil instead of the one that was used during construction. This work was done March a year ago and I know it has been beneficial and simplified maintaining the turf last summer.

I took this picture on the practice football field of the University of Michigan, Ann Arbor, last October. I saw these lines from a distance and asked Charley Mutter what caused them. He said that the University's band practiced maneuvers on that field one hour a day for 10 days. So you can see the terrific wear caused by marching back and forth for a total time of 10 hours. I think we sometimes overlook what traffic and soil compaction is doing not only to greens but also to other areas as well.

Here is an example of wear due to heavy traffic. Players wore the path bare as they walked from green to tee. Notice how all of them leave from about the same spot on the putting green proper. The bent has gone. In the spring and fall there is some Poa annua there and that's about the way it looks from June on until fall. Trampling and soil compaction are at the root of the trouble.

Here is something quite common on heavy courses. Frequently the fairway turf on the approaches is the worst on the golf course. In this case two traps on the left and right side of the green force the tractor operator to go over the approach many times in order to do a job of cutting. The compacting effect of the equipment is one of the reasons why the turf is so bad.

The next picture shows the turf condition. Notice the many bare areas. Clover is beginning to take over. The approach doesn't look too bad in the early spring when the Poa annua first starts out and grows but as the summer advances and the hot weather begins the Poa annua fades out and the clover takes over.

On my way to California I stopped in Houston, Texas, and visited one of the courses there. This is what I saw on the winter rye grass greens. All of you know that ryegrass is seeded into the bermuda for winter play. I believe you can see the wear around the edge which is undoubtedly due to faulty use of the power mowing equipment. When the rye grass is young and therefore rather tender it does not withstand abuse of heavy wear.

Here is a tee. Some of you have seen this picture before. When I came out to this golf course (it is No. 1 tee), the first question I was asked was, "What are we going to do?" "What grass can we get to cover the tee and give us a decent looking turf and a better tee for play?" I don't believe even Alta fescue would entirely answer the problem. Notice the benches placed along the backside of the tee. The players come down, step onto the stone and then they tramp back and forth just as the band did in Michigan, and officials wonder why there is no grass in the strip across the foreground. The area off to the left in the background is devoid of grass not only because of the wear but because of extreme compaction of the soil induced by the large number of tree roots in the soil. Shade is not the only thing at fault.

Courses with watered fairways which have been watered over a long period of time are necessarily going bent and have more creeping bent if watered heavily and frequently. This is a picture of a fairway which started to go bad in August, 1947. I believe you can see the spots where the grass wilted and is seemingly dead. You can also see the dark blue patches where the grass is wilting rather severely. The reason for trouble is the thick heavy mat of turf on the surface. Many of the Europeans use grass roofs to keep water out of their homes. We do the same thing to greens and fairways and then wonder why we have troubles such as this. The fairway was aerified and went through 1948 without a bit of trouble. It was aerified in the fall of 1947 and again in the spring of 1948.

This shows the three-section Aerifier being used at Olympia Fields at Chicago. The other course had only one unit. They use one Aerifier and do the job in the spring and again in the fall. Since doing this they have had a much easier problem of maintaining the bent on the fairway and it hasn't taken nearly the quantity of water that it did when they were trying to get water to go through that thick heavy mat of turf and not succeeding.

This is another implement that is used a great deal in the South. Several of them are used in the New York area. It is a rotary hoe and does a good job of thinning out some of the heavily matted bermuda turf.

When I arrived in Los Angeles on Monday morning about 9:30 from Houston it was raining and it continued to rain all morning. The exhibits were held out on the coliseum and on the football field. On Tuesday I went out and took a picture showing the standing water in this excavated spot alongside of the stadium turf. Note how the water is not seeping away. The next picture shows the reason. They undoubtedly went to great expense in order to prepare a good field, placed a thick layer of gravel in the subgrade and a very extensive tile system to carry the water away and then put adobe on top of it. Up to the point of top soiling everything was all right but the heavy soil placed on top defeated the purpose for which the tile and gravel were installed. The water seeps away gradually but during periods of heavy rain, movement isn't fast enough. I took this picture afterwards and to show the level at which the water stood. That light colored line is not due to a difference in soil but due to the clippings that floated on top of the pool of water.

This is a fairway in the Cape Cod area following inundation by sea water. Notice what the salt in the water did to the grass. It wasn't on there too long - a matter of several days - on the high promontories where salt water did not cover the area the grass is doing all right but is pretty sick in the low spots.

This is a picture taken last fall on an approach at Seaview, just across from Atlantic City. The ocean or a bay of the ocean is in the immediate foregoound. Every now and then at very high tide the area in the foreground is covered with salty water. The reason for the picture is to show the strains of bent in the green patches which can withstand higher salt concentrations than some of the others. I believe Dr. Grau has some of the salt resistant strains and is propagating them to see if a bent grass can be found, that will tolerate salt. As a matter of fact, salt accumulation is an extremely important problem in parts of Oklahoma and Texas.

A year ago I was at Superior Golf Course in Minneapolis. In the excavated area the turf was dead. Leonard Bloomquist asked me to explain what happened. I could see a slight glistening white sheen on the surface. I told him that it was an alkali spot; I was sure of that. Unfortunately we collected a soil sample and sent it to our laboratory. When the report came back with a reaction of pH 1.5, I called our chief chemist and said, "What is the matter with you fellows?" The results were checked and a sample was sent to Madison. Truog checked it and the pH was still around 1.5. The cause of the trouble was due to sulphur. When the area was excavated in order to take out the bad soil Bloomquist wrote me and told me that it smelled like rotten eggs, which means hydrogen sulphide. The bad soil has been removed, the tile was laid and covered with crushed rock. The outlet leads down to one of the main tile drains. Lime was added to neutralize the sulfuric acid being formed and good soil was used to level the surface. I am sure that with the tile so the area can be leached thoroughly, it will be possible to grow and keep grass in the future.

This is an Indiana picture. It is on a green down in a low spot. The turf is always bad in summer due to poor air drainage from surrounding trees, but I believed that the roots from the maple in the background was as big a factor as the bad location. When the two are superimposed on one another it makes for an impossible condition from the standpoint of keeping grass during July and August.

Here is the same kind of situation. The picture was taken at Pittsburg. The turf is Washington bent, which is a good strain of grass. The man on that course told me that the green didn't look that way on Friday but was like the picture on Monday. There had been a hot week-end; nobody had been there to syringe off the wilting grass. When the weather is extremely bad, this is what is going to happen, if the green doesn't get a little water when the turf wilts badly.

I might tell you that fertilizer was used on the right hand side of the sharp dividing line and none beyond, but that is not the case. The sharp line marks the line where a trench was dug to sever tree roots and was lined either with sheet metal or tar paper to prevent roots from going out into the practice green which is off to the right. Notice what a tremendous difference this has had in the behavior of that grass where the tree roots stop.

Some of you may have seen this picture when it appeared in Golfdom. It shows Jim Haines' ingenious tree root pruner which he built and uses at the Denver Country Club to prune the roots around greens and even along the edges of the fairways. The parts come from an old plow.

The next picture shows the Haines root pruner in operation. I heard roots snap when they were cut and several of them about the size of my thumb that were snapped off by that cutting knife.

Schread of the Connecticut station calls this the "strip tease" fairway. It's at Naugatuck, Conn. The Jap beetle is in that area. The fall before the club bought some lead arsenate. The greenkeeper went out and put it on the fairways. You see what a fine job he did. Where the lead hit the fairways there is no grub damage. We turned back the dead turf and found innumerable grubs underneath. Chlordane was applied the week before taking the picture to grub-proof this and the other fairways. The picture is striking evidence of the necessity for protecting turf in beetle infested areas.

The next picture shows DDT being applied as a liquid spray. Fifty percent wettable powder was used so that the fairways got 25 pounds of actual DDT per acre. It's in the Jap beetle belt where either DDT or Chlordane is doing a good job.

This is at Frank Dinelli's showing a bad case of dollarspot on one of the bent fairways at Northmoor. The next picture is of the adjoining fairway where there was almost no dollarspot. The only difference was that he applied a little lime to the fairway which did not get dollar spot but not to the other one. The pH of the fairway when we tested it (we tried to get a sample not contaminated with some of the lime) was 5.7 which isn't too bad.

This is an example of dollarspot on another fairway that was taken a good many years ago. It happened to be in a spot which was missed by the fertilizer spreader, showing that even on fairways fertilizer deficiency can make a difference so far as this disease is concerned.

Here we have a picture showing somewhat the relationship between fertility and drought. When I was at Philmont in the Philadelphia area last October where they had dry weather for 3 or 4 weeks; as I walked over the course I noticed these dark green patches out in the rough. They naturally aroused my curiosity, so I asked why the green spots were over in that rough. He said the rough was uneven. A green was reconstructed or abondoned and so the topsoil from that green was used to fill these depressions. Notice how the higher fertility of that soil enabled the bluegrass to continue to stay green when the impoverished grass around it was brown.

If you think you are the only ones who have problems we go back to Houston. It was awfully cold when I was there early in January. Here is a type of disease which hit St. Augustine under those conditions. They called it brownpatch. What it is, I don't know.

This picture shows somewhat the same situation. I don't believe that anyone of us knows the answer. Notice the area where the grass is getting the devil from some type of fungus.

This is the last picture. In closing I think it is only fitting that we go back to Seattle where we took the first picture showing their problems. If they haven't solved their grass problems they certainly have solved some of their horticultural problems from the planting standpoint. This was taken in June alongside the Broadmoor Country Club. It was a beautiful sight to walk in and see the rhododendrons which were there just in the height of their glory in that area. Gerald, I lelieve that's all. Take over.

# THE CONTROL OF TURF INSECTS

Glen Lehker

During the past few years progress in the science of Entomology has been marked by many a milestone. Changes are taking place almost daily as new organic chemicals are developed by chemists and tested by entomologists. The control of turf insects is no exception. One of our best authorities in this field is John C. Schread, entomologist with the Connecticut Agricultural Experiment Station at New Haven, Connecticut. The summary of the effectiveness of new chemicals which I will give later is based largely on his results. Much of the eastern work on grub control has been against the Japanese beetle, but greenskeepers in the middle west who have used DDT and Chlordane say they are also effective against our native white grubs. Good results with these materials for sod web worm control have also been reported, but in this case they must not be watered in too deeply as web worms feed near the surface.

## Effectiveness of New Chemicals

DDT - DDT is normally used at the rate of 25 lbs. of the actual chemical per acre. It is effective in controlling grubs for at least 2½ years, but is slower acting than some of the other organic insecticides.

Chlordane - Chlordane should be used at the rate of about 10 lbs. per acre. It is quicker acting than DDT and to date has protected turf for 18 months. It is also highly effective against all species of ants affecting turf in their area.

Toxaphene - Toxaphene has given satisfactory control of grubs at 8 lbs. per acre. At higher dosages it is superior to DDT and when used at the rate of 25 lbs. per acre it has been effective for 18 months.

Benzene Hexachloride - B. H. C., especially the low gamma preparations containing about 6 per cent gamma isomer may impart a musty odor to the treated turf and therefore has not been widely used. It has, however, proven effective for 18 months when used at the rate of 4 lbs. actual gamma isomer per acre.

Parathion - Parathion kills grubs very rapidly, but the residual toxicity presists for a comparatively short period of time. Good control can be obtained in 2 weeks and extermination in 6 weeks. It is used at the rate of 4 lbs. of the toxicant per acre. Fall treatments are longer lasting than summer treatments apparently because of the lower soil temperatures.

Compound 118 - This new chemical when used at the rate of 3 lbs. per acre is as good and perhaps better than chlordane for the control of both grubs and ants.

# FERTILIZING TURF

O. J. Noer

I propose to speak briefly and outline the important fundamentals of a fertilizer program.

All too often samples of soil are submitted with this brief statement, "What fertilizer can we use to give us good deeprooted turf?" Fertilization is extremely important but we must not forget that some other things come first. Some years ago I was at a club between Ottawa and Montreal. Their fairways were extremely bad - mostly plantain and clover. They were very much confused and wondered why their seeding and fertilizer program was not producing grass. They seeded large amounts of fescue each year and used some fertilizer but had only clover and plantain. I couldn't find a spear of fescue on any fairway as the result of seeding. The terrain was hilly and rough, poor drainage particularily seepage from the hillside made it impossible for fescue to survive. It was not a fertilizer problem but rather one of providing drainage first or of using creeping bent grass. It would have been a tremendously expensive job to install tile drains because of outcropping rock formations, so the only recourse for them was to use creeping bent. They planted native creeping bent stolons found growing in low wet places on the course. After doing that they were able to get results from fertilizer and develop a dense turf. This is one of many examples I could cite. The point that I am trying to stress is the importance of doing first things first.

On golf courses, soil and drainage problems should come first. Obviously we cannot make major transformations in the physical condition of the soil on fairways because at the acreage involved but on greens it is a different matter. It is important to pay particular attention to the soil in them and see to it that the soil used is of proper physical condition. Every dollar spent in that way during construction will be saved two or three times over in simplified maintenance. After all, it isn't a matter of growing grass on a green only. Turf must survive bad spells of weather, the green must hold a ball without the necessity of over-watering, etc.

The next thing to consider is the selection of a grass suited to the climate and one which makes the right kind of turf for play. On watered fairways, clubs are getting away from fescue and bluegrass from necessity because it is impossible to mow them as close as golfers demand. Northern courses are turning to bent grasses. They may not be the best answer but are the only kinds which will stand the close cutting demanded by the present day golfer.

Then there is the matter of mowing. When there is a thick mat on a green, the mower may be cutting an inch or more from the soil surface even though the mower was set to cut at 3/16 inch or less. It is not always how the mower is set but too often it is a matter of turf condition on the green.

There is a similar problem on bent grass. They must be cut short in order to prevent matting. Among other factors are harmful ones such as insects, diseases, tree roots, and so on. If we can take care of all of these things first then the matter of fertility is not a difficult one to solve.

Before thinking about fertilizers we should see what the soil reaction is and should correct acidity with lime if the soil is moderate to strongly acid. As I pointed out earlier in the afternoon, the use of lime can be overdone. I have in mind a course in Pennsylvania where lime has reduced the amount and severity of dollarspot and brownpatch. As a result large amounts of ground limestone and also hydrated lime are used every summer. Last August I saw a great deal of yellow chlorotic grass on greens at that course, the examples you saw in pictures early this afternoon. At that club lime is being used to excess. From now on striking effects on disease are unlikely.

For the past several years clippings from a green in Milwaukee have been weighed each time the green was mowed. The dry weight averaged about 100 lbs. per 1000 sq. ft. of green. They contained approximately 4% to 5% nitrogen. The phosphorus was just under 2% and the potash just under 4%. In other words, the equivalent of a 100-pound bad of 4-2-4 fertilizer was removed from each 100 sq. ft. each season. You will notice that the potash and nitrogen are about equal in amount.

In the old days manure was used in topdressing mixtures. The tendency was to topdress greens much more frequently than is being done today. Some clubs do not topdress at all; others topdress in the spring, or spring and fall, instead of every three or four weeks, as was the former practice. I believe the time has come when the old fertilizer mixtures of 8-5-2, 8-6-2, and even 10-6-4 are not going to do the jobs they did on greens when the topdressing practices were different. We must use more potash in the future than we have been using lately.

Grasses differ in their plant food requirements. Some of them for example, C-15 (Toronto) bent, are very fast growers and make a dense turf. They need more food than slower growing ones.

On fairways, need for lime comes first. Then it is a matter of taking care of phosphorus and potash requirements and after that nitrogen is the key to good dense turf.

Among grasses the bents probably use and need more nitrogen than either bluegrass or fescue. They react in that order with respect to nitrogen requirements. When it comes to phosphorus the situation is a bit reversed. Bent grasses and the fescues make good growth on levels of phosphorus which are too low for Kentucky bluegrass. On new seedings, particularly fairways, it is important to emphasize the relation between fertility levels and seeding rates, especially now that seed is up in price. Redtop, I believe, has a range of 80¢ to 90¢ a pound. We used to think that 10¢ and 15¢ was a high price for it. Today it costs about as much as some of the bent grasses.

I just want to mention the work done by Rabbitt in Washignton some years ago. He used seeding rates of 40, 80, 120, and 400 pounds per acre and fertilizer rates of 200, 400, 800, and 1600 pounds per acre of 10-6-41. In general from 40 to 120 pounds of seed with a high level of soil fertility gave a better stand of grass at the end of the year than 400 pounds of seed alone. The cost relationship was approximately $53 per acre for the low seeding rate plus the 1600 pounds of fertilizer as against 153 dollars for the 400 pound rate of seed alone. Before he made these tests it was the customary practice of the National Capital Parks to seed heavily and pay little attention to fertility. Everybody knows that grass comes from seed. Some think that the more seed used the better the stand of grass but that doesn't always follow.

There is a relationship between soil fertility and water economy. You saw a picture from Philadelphia where the bluegrass in one spot was green and the rest was brown, it was due not to moisture only but the combination of water and soil fertility. In the case of fairways, some of the cost for fertilizer will be offset by the lesser amount of water needed to keep grass green. In Milwaukee the unwatered but adequately fertilized fairways on one course comes back quickly after a light rain but the unfertilized rough stays just as brown as before the rain.

On unwatered fairways, spring and fall are the best times to use fertilizer. Many favor fall for several reasons. It minimizes crabgrass infestation. The good grasses take advantage of the fall growing season along with the following spring. These two seasons are the best ones for the growth of grass in the north. The permanent grasses prefer moist cool weather.

On watered fairways in the North the trend is toward the use of some nitrogen in summer. Fairways are fertilized liberally in the fall and early spring fertilization is omitted because grass grows very well during that season. Light rates are used during midsummer. Those doing this seem well satisfied and think that results are better than formerly when all the fertilizer was applied in the fall.

Weed control, with 2,4-D has solved the broad leaf weed problem on many courses in Denver. Last June I was told that 2,4-D had solved one weed problem but had brought on another at some clubs and that problem was clover. The results with 2,4-D were so startling that some clubs were quite content to use 2,4-D and nothing else. After several years of 2,4-D alone, clover became extremely bad. Fertilization was needed to stimulate growth of grass so it would occupy the voids left by the plantain and the dandelion. Clover increased instead and brought on a new problem. On watered courses chickweed may become bad. Increased rates of fertilization does not solve the problem. Fertilizer helps the chickweed, particularly the common chickweed, about as much as it does the grasses. In fact as duckweed spreads it chokes out the grass in its path. 2,4-D has not been too successful in combatting common chickweed and probably never will on the watered courses, because too many of them are going over to bent. The repeat applications of 2,4-D needed to kill chickweed are rough on the bent. In other words, when used enough times to kill the chickweed, 2,4-D damages the bent badly. There is a tendency to go back to the arsenicals for chickweed. They will be used until some other weed killer to take its place is develop.

Just a brief word about roughs. We never give them much thought. They are rarely fertilized. Yet there are some roughs where the soils are so extremely poor that there isn't good grass on them, practically no cover. Some greenkeepers plan to use lime and a little fertilizer in order to get decent grass coverage. Others will resort to one of the grasses that will grow at a low fertility level. The matter of low level fertility will have to be the answer. I wonder if we could not use annual lespedeza or some other legume to build up the soil and then grow grass. Dr. Hoffer and his associates have a really fine program. I shall stop and let them proceed. We can all profit and learn much from the demonstration and plant tissue tests which they are going to show.

# THE PLANT FOOD SUPPLY SITUATION IN 1949

Dr. H. B. Siems, Director of Research
A. H. Bowers, Agronomist

Discussing this subject with a group such as this is not an activity that people in the plant food industry can really enjoy these days. Why is this? Because at a convention people like to hear good news. If you could get all the plant food you want of the analyses you want, there would be no point in scheduling this talk on the program. The situation is improving. However, limited as the industry has been by nitrogen and potash raw material scarcities, it has produced tremendous quantities of plant food, though recommended grade substitutes were necessary.

Last year the plant food industry produced close to 18,000,000 tons of mixed grades. Compare this with the average of 7,000,000 produced in the years from 1935-39 and you can see that we have not been lying down on the job.

Greenskeepers are particularly interested in nitrogen, so let us consider what the future holds in regard to availability of nitrogen raw materials. Sadly enough, the most difficult aspect of the entire plant food materials situation in the immediate future relates to nitrogen. The amount of nitrogen available for use in the U.S. is allocated by the International Emergency Food Council. Were it not for our commitments toward furnishing plant food materials to the war ravaged countries, we would have more than enough nitrogen to satisfy current demands. On the basis of last years production of nitrogen, the United States has been allocated about 8% more. This is an overall figure and even if the estimates for this year should be realized, it does not follow that all sections of the country will get an increase in nitrogen. In fact it seems now that certain areas, particularly the Southeast and New England, will definitely get even less nitrogen than they had last year.

There are other sources of gloom. At least three factors have already curtailed nitrogen production during the fall and winter, namely, strikes, conversion of high pressure ammonia manufacturing equipment to the production of wood alcohol, and operating breakdowns in the plants. In fact, it would not be surprising if this year's supply should be only slightly in excess of last year - probably not more than 2% or 3%. But to put out a ray of hope to you, for the first time since before the war we see a break in this shortage of nitrogen. In 1950 the nitrogen story should be a much more happy one.

Superphosphate is again a bright spot in the plant food situation with 6% more available than the 10,000,000 tons produced last year. During the past few months in many instances superphosphate could not be moved out of the plant because sufficient nitrogen solutions could not be obtained to enable mixed goods or bases to be laid down. It is reported that a number of superphosphate plants were forced to reduce their rate of production and others even to close down for this reason. But phosphates are not the problem. The shortages are the nitrogen and the potash to mix with the phosphates.

It appears that potash production will be maintained at a slightly higher level than last year. Two of the principal operators have built or are building new refining facilities. Although the potash producers have been on a round-the-clock schedule, the demand for potash is still far beyond the supply. Contributing to this is the demand for many times the prewar plant food tonnage in the Middle West. So in order to make mixed goods available to more consumers, the industry has continued its policy of mixing 2-12-6, 4-12-4 and 5-10-5 in larger quantities than some of the recommended higher analysis grades. It is very possible that next year the potash situation will be much better in view of the new facilities coming into full production.

We need not worry about minor element supplies since they are not required in large amounts and supplies are adequate. Unless extreme deficiencies exist, it is best to supply them in ready-made complete plant foods. Otherwise it is an easy matter to apply toxic amounts of boron or manganese.

What do we see in plant food developments beyond 1949? Many predictions are strictly from gazing into the crystal ball. However, it is believed that with easing in the shortages of raw materials and desire to counteract constantly increasing freight rates, that higher analyses goods will soon be the rule rather than the exception. Natural organic nitrogen carriers such as cottonseed meal, dried blood, etc. will continue to bring a better price as animal protein feed supplement rather than as plant food ingredients.

The synthetic slowly available nitrogen compound, urea-formaldehyde, has shown great promise as an ingredient for turf plant foods in a number of USDA tests. As soon as it becomes available in large quantities, commercial mixtures containing it will probably be put on the market. The big advantage of this nitrogen carrier is that unlike the natural organics its nitrogen is released at a more constant rate. It is not nearly so subject to climatic conditions effecting its nitrogen release.

Completely water soluble plant foods which many of you would like to see on the market - but at a reasonable cost - are still quite unreasonable in cost. Only a few specialty plant food manufacturers have offered completely soluble products for sale. None of the regular commercial plant food manufacturers have believed that completely water soluble plant food would gain wide enough acceptance at present cost, to put them in demand. But again, water soluble materials may be well in the picture before many years have passed.

This discussion has been pretty much like having a carrot out in front of a donkey to keep him ever hopeful of obtaining it by continued forward motion. Yet there the carrot hangs - full of nitrogen, potash and all the other tasty elements. Let's hope that us donkeys can catch up with it in another year.

# SURVEYING TECHNIQUE FOR TURF AREAS

George Spencer

Surveying techniques for turf areas may or may not be the proper title for this part of your program for it is my hope to keep it practical in nature. I hope to show you various pieces of equipment used by surveyors and engineers and to demonstrate practical applications of each.

Many people have trouble distinguishing between linear measure and area measure. What is an area? I was talking to a man, recently, who had a small farm. He said to me, "How long is an acre?" and I replied, "It can be any length." "But," he said, "I mean how long is an acre? On my farm I have an 80 acre field and I just want to know how far from the road I should go before I have laid off a 20 acre field." I asked him how wide the field was and he said, "I told you it was an 80 acre field, and all I want to know is - how long is an acre?" The man thought an acre was square. I said, "There are 43,560 square feet in an acre, so just extract the square root of 43,560 and you'll know how long a square acre is. I could have a strip of land one chain wide and 10 chains long or I could have one 2 chains wide and 5 chains long or I might have an area of land that's shaped like a doughnut and still have an acre if the <u>area</u> is 10 square chains or 43,560 square feet.

Let us look at some tools for measuring distance. This is called a chain, it is really a half chain, it is only 33 feet long. Look at the bundle of weight you have, what an awkward thing to use to get an accurate measurement. I am told that back in the early days a surveyor had a friend who was in the business of making forms for hoop skirts. He was using steel wire to make those hoop frames. The surveyor said to his friend, "Why don't we just roll off 66 feet of that steel wire and then for every link we will put a little dot of solder on the wire and then I won't be bothered with that chain." The story is that was what they did. Eventually somebody got the idea that if you had a steel ribbon you would have a still better device. And that is what we use today, a ribbon of steel which is graduated in units of linear measure to suit your requirements. A land surveyors chain may be a ribbon of steel graduated in 100 links or 66 feet. An engineer wants a "100 footer," so he takes a hundred feet of this steel ribbon and graduates it in feet. Consequently, the catalogue says this thing is an engineer's band-chain -- but to you and me it's a steel tape and nobody can tell us any different. But we still do "chaining" with a steel tape, and it all probably goes back to this humble beginning. The engineer seldom keeps his "100 footer" on a reel, instead, he winds it up like this into a lovely figure 8, drops it together and flips it into a coil. I loaned one not long ago to a friend. I said, "Now, do you know how to put it up?" He said, "I'll bring it back without breaking it," When it came back it wasn't done up in a figure 8. It was coiled very neatly in a bushel basket.

The engineer measures distances with a 100 foot steel tape. He stretches the tape out and uses these pins to mark his tape lengths. He calls them chaining pins, the catalogue calls them marking arrows.

Yesterday afternoon one of the cemetery men said, "Those are good things to mark off graves with. I don't believe I realized where the idea came from until this afternoon. My boss is an engineer and he is the guy who provided these things for us."

The engineer marks points with the stakes of various kinds. He calls this one a hub stake. Ordinarily he drives a hub down until it is almost flush with the top of the ground. The hub stake is identified and protected by a stake slanted over it and driven to the side of the line. He puts a mark on the guard stake with lumber crayon and indicates the name of that particular point. This one is Station 8 ∤ 14. Why guard stakes? Well, it guards the hub - it tells you what the hub is and that number indicates distance. Why did he need to guard a stake? I don't know what there is about stakes in the ground but anytime anyone sees a stake in the ground the inclination seems to be to pick it up or kick it out of position. It is not always kids who pick them up, others pick them up just for the heck of it. On these stakes, marks like that indicate distance. We call it stationing and a surveyor understands that 8 ∤ 14 means 814 feet from the beginning of the line. All distances are horizontal. If slope distances are measured they are corrected to give the horizontal component.

The other afternoon one of the men here at the conference said, "Now, I've got a tee up here, and the green is way down there. How do I measure the right distance?" I said, "Now, as an engineer, I would get the horizontal distance." A companion suggested that the United States Golf Association says that the distance must be the <u>airline</u> <u>distance</u>, so I am sure it is the horizontal distance that is intended.

Another fellow came to me and said, "I had an argument about the length of my course so I got the city engineer to come out and measure it. He set up a transit at the green and told me to go way back to the tee with a level rod so I did as he asked. He looked at me and when I came back he told me how far it was and I said, well, would you put your chain out and chain it down there for me? It's hard to believe that. So he took the steel tape measure and he got the same thing. I want to know how he did it." He did it by stadia measurement. When you look through the transit telescope you see a vertical black line and a horizontal black line. Those are the things we call the cross-hairs. Above and below that center cross-hair are two more black lines. We call those outside lines - the stadia wires. Those stadia wires are mounted in the telescope with a space between the wires sufficiently wide so that you can measure distance by observing the amount of level rod included between the stadia wires. If the instrument stands here and you hold the level rod 100 feet away - look at it with the transit telescope the amount of rod seen between those wires is a foot. So that is what this chap did. After this explanation the questioner said, "That's all I want to know. It has taken all this time for me to decide that that guy wasn't kidding."

I think we should go from the horizontal distance, now, into the vertical distance. Suppose we wanted to know the vertical distance or drop between two points. We really want to know the difference in elevation. It is customary to base all our elevation on sea level, using it as the zero reference or datum plane. For instance, just out here at the corner of the campus, some of you may have noticed just inside of the iron fence, the top of a concrete post, the top of which is a brass plug. That's a U.S.G.S. bench mark. They tell us, if I remember correctly, that it is 618,585 feet above sea level. Now we can use that for a reference or base mark, something to tie to, and measure vertical distances from. Essentially, this is what it means. We need to have some kind of an instrument or device that will enable us to set up a horizontal line or level line. Suppose we first take the carpenter's level. If I lay a carpenter's level down here on the table and look at the air bubble and see that it is exactly between the little black marks on the bubble tube - the table is level. The elevation of one end of the table is exactly equal to the elevation of the other end. That worked pretty well on the table but we might want to get elevations on points that were some distance apart. So we developed the engineer's level. Instead of using a board or surface we will use a theoretical level line called a "line of sight," something we can direct our eye along to use as a horizontal plane. The engineer's level consists simply of a telescope in which is mounted a cross-hair ring, -- the intersection of the vertical and horizontal cross-hairs defines the "line of sight." The objective lens on the telescope is adjusted for focus by a knurled wheel to give us a picture of the thing we're looking for. Now what we're looking at is usually a level rod. A graduated board divided into feet, 1/10 ft. and the smallest divisions are 1/100 ft. If you want to be careful enough you can use the target. Right along here on the target is a small plate called the vernier, which enables you to read to a fractional part of the smallest division on the rod. In fact, this will enable you to read 1/10 of the smallest division on the rod. The smallest division on the rod if 1/100 of a foot - so the vernier enables you to read to 1/1000, but you won't often use it that close. The cross-hair in the level is located near the eye-piece. In most levels there are simply a horizontal cross-hair and a vertical cross-hair. Some levels have stadia wires but most of them now days have only the horizontal and the vertical. The vertical helps you to tell if the man is holding the rod straight up and down, the horizontal gives the point of reading for the vertical distance from the place the rod is held up to the line of sight. The eye piece, on the telescope must be adjusted in order to give you a clear view of the cross-hairs and also a clear view of the rod. So you are going to have to adjust both of the lenses to get a clear reading. How many of you have levels? Some of you can borrow a level when you really need one, but it may be increasingly difficult to borrow one. One man told me yesterday that he had a very good level and it worked fine but now when he goes to work it sorta sticks and the bubble goes this way and he gets it around here and it sort of sticks. I told him it sounded like the center spindle was bent and I asked how it happened. He said he didn't know but he had loaned his level. So I expect that's the answer. They may be hard to borrow so be sure you take care of them. You must focus the eyepiece in order to get a clear view of the cross-hair. If some of you have time -- come up and look through this telescope after while - try focusing the objective and turn the eyepiece. They are mostly arranged so that a spiral moves the eyepiece back and forth, others simply slide in and out. If you do that you will notice that as you turn the eyepiece the cross-hairs get black and sharp and then in other positions they are simply gone - you don't see them. I've had this happen. I loaned a level, a builders level, to an old carpenter friend of mine. He brought it back that night and he said, "George, you gave me a level without any cross-hairs." I said, "I'm awfully sorry, I have another one you can take take out tomorrow. I turned it so I could see the cross-hairs black. I didn't want to hurt his feelings. He didn't know that all he need to have done was to turn the eyepiece a little differently so he could see the cross-hair. Unless you get that focused perfectly you won't be able to see and get a good reading so if you borrow one, before you tell the guy you borrow it from that it doesn't have any cross-hairs on it and scare the heck out of him, try the eyepiece. As I said before, the intersection of those cross-hairs defines for us the thing we call the line of sight. If you would like to picture it as such, imagine it to be a long black thread that extends out through the center of the lenses in this direction and that it extends out through the center of the lenses in that direction. That is imaginary but that gives you something concrete to think about, a long black line sticking through the center of the telescope tube. We must somehow level up that line and to level up that line you make use of this bubble tube. The bubble tube is a glass vial filled almost full of alcohol. The glass tube is curved so that the air bubble rises to the highest point in the curve. If you were to look at the bubble tube on the carpenter's level you could actually see that the tube is curved -- like this. It is a short radius tube so we wouldn't expect it to be quite as sensitive as the one that you would find on this instrument. The tube on an engineer's level is a long radius tube -- the radius of curvature is usually something between 85 and 100 feet. As a matter of fact, the tube itself is straight. The inside of it has been ground out to give that curvature. So this is a supersensitive bubble. That's why when you look at this and start to adjust it the bubble moves with very little disturbance of the foot screws. You simply have a more sensitive instrument here. The next thing we need to know is how to center that bubble. To center that bubble we adjust the foot screw. There are 4 of those foot screws and they simply rock the instrument about a ball socket joint through the center of the instrument. Here is how the foot screws work. The telescope is turned so that it is directly above one pair of the footscrews and the screws turned, as though they were geared together, tilting the telescope until the bubble moves to the center of the tube. Then the telescope is turned 90° or until it is directly above the other pair of footscrews and the centering adjustment completed. If the instrument is in good adjustment the bubble stays in the center of the tube just as though it were glued there.

At another meeting a man called my attention to this. He said, "Hey, don't you have to have a pair of pliers sometimes, don't that footscrew get tight?" Now he was making a point that I think is a very important one. If you were to turn just one of these footscrews -- I've soon got down to where I can hardly turn it. See what's happened, the footscrew is just like a jack screw, it's trying to push up like this and if I don't release the pressure on the other side a tremendous stress is set up in the base of the instrument and the poor bubble doesn't know what to do - particularly if the instrument is in the shade and then the sun comes out. The idea is just to have those footscrews touching enough so there is not play but also so there is no stress.

And now that we have the footscrews all set we are going to use our level rod to measure vertical distance. That is called a Philadelphia level rod. It was made in Troy, New York and you can buy them from the Chicago Steel Tape Company also. The name refers to the type of rod and not where it was made. This is a jointed rod and you can see it can be extended in this way. It is in 4 foot sections.

When you are doing leveling the bubble should be exactly in the center of the tube all the time. Watch out for this. Don't be tempted to put your hands on the tripod in order to brace yourself. When the bubble is off the center -- what happens to your line of sight maybe 300 feet out? It is way off. So don't be tempted to lean on the tripod.

But is it necessary to buy a high priced instrument like the engineer's level to do ordinary type work? You can do this type of work using exactly the same principle right here. Setting up this instrument, leveling it up, getting the horizontal line of sight, reading the rod - and after all, all we are interested in is just reading the rod and getting the difference in elevation. If we intend to take sight distances less than 100 or 200 feet we can fix up a pretty good leveling instrument with a carpenter's level. For instance, the first level that I can ever remember seeing was when I was just a kid in a small town. I saw a carpenter and his helper setting some form boards for a concrete sidewalk. They used a carpenter's level for this and they had it on a sawhorse and the carpenter was down on his knees sighting across the top of this thing at his helper who had a board on which there was a mark - and he'd say, "Down a little more - drive a couple of more - now that's OK" He was getting the elevation - he was getting the forms leveled up. We could do that same thing right here. Take this carpenter's level and put it on (I don't have a saw horse) this rather elaborate tripod. This tripod is made by simply hinging some legs onto a board with strap hinges. Now I don't have any foot screws, so I'll take that little wedge of wood and I'll slide the wedge under the end of the level and keep moving it until the bubble is centered. Now I can sight down across the top of the level and sight on the level rod. The Stanley Company, who make excellent planes, carpenter's hammers and chisels and all carpenter's tools, make a pair of sights that you can put on that level for the eye-piece which you don't have to focus at all. It is simply a pin hole through this disc. The cross-hair is a steel wire. These cross-hairs, if they get dust on them you can blow it off. I saw some students one day blow a piece of lint off the cross-hairs -- they said that there was a little piece of lint on the cross-hairs and it bothered them, so they unscrewed the eyepiece and blew the cross-hairs right out of the telescope. Let's put the cross-hairs on one end of the level and put the eyepiece on the other end. If you look down towards the light you will find these cross-hairs just show up swell. It is not a bad outfit to do simple leveling with. I don't suppose you would want to pay $35.00 for a level rod to go with that instrument, so we made a rod. All it took was a piece of 1 x 4 board and a couple of yardsticks tacked on it. Now that doesn't seem bad at all. We've got the foot and the half foot marked with heavy lines so if I want to read distances more accuretely when the instrument man sights on me I'll put my finger across the rod and read to the nearest inch. It works out pretty well.

I think that brings me to something that I don't believe I've exhibited yet. This home-made rod would read in feet and inches. The engineer wants to read his vertical distances in feet, tenths and hundredths. So we get into an argument about units of measure. In fact, if he were to set construction stakes for you, you might find the stakes set up like this and marked C-cut 3.8 - 3 and 8/10 feet. Well, occasionally someone wonders - now 8/10 of a foot, now what is 8/10 of a foot. Twelve inches to the foot means that 8/10 = 9.6 inches.

A number of companies that make folding rules make an old familiar, one that is graduated in feet and inches, 1/2, 1/4, 1/8 and 1/16 inches. That is usually the way we like to measure distance, but we turn it over on the other side. They put two red stripes on that side so you won't get mixed up because "inches" over here look a little big. They are not inches, they are tenths of feet. So on the side with the red stripes on we have feet, tenths and hundredths. Now let's see how that works. Here we had C-Cut to be 3.8 feet. Now put your fingers on there and turn it over and you will find it is 3 feet 9½ inches "strong." So you've got a rule there that satisfies both of you. The name for this thing is an "Irish rule".

There is yet another leveling instrument that engineers use quite a lot -- a hand level, one you can hold up to your eye. You have the telescope, eyepiece, objective lens, which in this case it is just plain glass. The bubble tube on the top has an opening below so that the light goes right through the tube and hits a mirrow set at a 45° angle inside the telescope tube. When you look through the telescope at the mirror you are looking upward through the bubble. Now you raise or lower the end of the telescope until the bubble is on the cross-hairs and your line of sight is horizontal.

I think the Forester should get credit for developing the hand level called the Abney. They took the bubble off the tube and put it on an arm which moves along a graduated arc. If the arm is set at zero, and the Abney held as an ordinary hand level, we are looking along a level line. Abney level arcs are graduated in percent of slope to use with linear measurements in feet and in topographic units of slope to use with linear measurements in chains and links.

There is still one more instrument used in construction and that is the line level. I'll bet a lot of you have used it already and called it a string level. If you want to establish a horizontal line just attach the string to a grade stake, then attach this line level to the string and stretch the string, raise your string or lower it until the bubble is exactly in the center and you have a horizontal line. After all, we are doing essentially the same thing that we do with the engineer's level, simply on a smaller scale.

A man told me yesterday afternoon that he had leveled a number of greens "by eye" and he said I did a pretty good job too, but I got one that really fouled my up. It was on the side of the hill and I finally sent for an engineer with a level to straighten me out. I wouldn't have had that trouble if I'd have had one of those line levels, would I? So there are a lot of these applications that you can use in one way or another.

I will be glad to have you look over all the equipment I have arranged for you here.

Thank you and I will be happy to answer any questions.

# THE REPAIR AND MAINTENANCE OF TURF EQUIPMENT

George Purdy Carson

To my knowledge this is the first time an equipment maintenance program has ever been introduced in your Turf Conference here at Purdue, and we will try to be of some assistance to you in helping with some of the major, minor or indifferent problems that arise from time to time.

Most of the maintenance problems on mowing equipment that confront you from time to time are the results of not having the proper information available. This information is always contained in your instruction manual that is received with each piece of mowing equipment, but I dare say in 90 per cent of the cases, this manual is laid away on a shelf and entirely forgotten. This manual is very important for maintaining this piece of equipment and should be read several times by all persons who are interested in this equipment, and then kept in a place where it is easily referred to.

I have had the privilege of visiting golf courses, municipalities, etc., throughout the United States and Canada, and in a large majority of cases the lack of proper equipment barns and adequate tools to take care of their equipment in which thousands of dollars are invested, is really astounding. I would venture to say that at least 25 per cent to 50 per cent do not even have a work bench where a power mower can be taken to perform minor adjustments; furthermore, they do not even have a vise. Therefore, I would suggest that if you do not already have any tools, that you invest $10.00 or $15.00 in the necessary tools that are used almost daily on any mowing equipment.

Several weeks ago I happened to visit a club where they were tearing down their equipment for a complete overhaul. As I walked over to the grinder where they were trueing up some fly knife reels, I happened to notice a 5 gallon can of grease that was underneath the grinder without the cover on the can, and the metal and emery from the grinder was falling in this open can of grease which would eventually be used to lubricate bearings on their equipment.

At another golf course I visited the tool shed was almost like a hotel. The floor was as clean as any home. All the tools were in the proper place and everything was very clean and orderly. I noticed a 50 gallon drum of oil in one corner that had its own pump. This was cleaned and polished like the rest of the shop, but as I examined the measuring can that was used to put oil in the engines or tractors, I found an accumulation of grit and dirt in the bottom of this can that would eventually end up in a crankcase. However, if this can had been covered or turned upside down this grit would not have accumulated.

The two instances I have just stated are examples of what takes place in too far-reaching conditions, and I merely recite these to bring out the point that in lots of cases these minor details that are overlooked cause premature wear and costly maintenance of equipment.

I would like to suggest that you keep a record sheet of each piece of equipment that you are using, whether it is a hand mower, power mower, tractor, gang mower, etc., in order to maintain a check on your maintenance procedures. In all probability you have a part of a day a week set aside at which time the different operators check the equipment for tightening screws and bolts and nuts, and lubrication. This sheet should contain the work that you want checked periodically, such as draining the crankcase, checking battery for water, checking air filter, adjusting points, lubrication etc. As these operations are done on the particular machine, they should be checked off and the date when they were done, so that you who are responsible for this equipment can refer to these charts and check the person whose duty it is to perform these operations.

Another important maintenance procedure is keeping your equipment clean. Most all equipment is so protected that it can be washed off with water without damage to bearings or seals. I would recommend that this be done so as to clean off the accumulation of grass clippings and grit that forms on the mower, to prevent it from building up and forming a grinding compound that eventually works into the bearings and gears and causes premature wear. A small piece of hose and a little water will really pay you dividends. If you are fortunate enough to have an air compressor, I would certainly recommend cleaning your equipment with air.

Another important maintenance problem that has been pushed and kicked around (and I think everybody has his own version), is the proper adjustment of a reel type mower. I am going to give you my version of an adjustment of this type mower and the way I think it should be done. First, we all know that any type of reel mower should not be adjusted too tightly. This has a serious effect on the mower in that it causes premature wear, not only on the reel blades and the bottom blade, but it follows through the gears and bearings down to the traction wheels that carry the mower. The proper adjustment is that you should have the fly knife reel and the bottom blade making slight contact, or in other words, the clearance between the two should be zero-zero. This will give a self-sharpening effect, which is nothing more than a wear that is created between the bottom blade and the fly knife reel. We know that the principle of cutting grass is nothing more than a scissors action. For example - take an ordinary pair of shears and if they are adjusted properly, you can cut a piece of paper or grass cleanly. Loosen up the adjustment on these same shears and you find that it does not cut, but pinches. This is the same condition that happens with your mower when you are cutting grass, but it will go a little further. As the grass is pinched off, it will injure in most instances and cause a mechanical injury which is very noticeable on the fairway and greens, especially during the dormant season in July and August when the grass is tough. This loose adjustment will also cause the mower to become dull. As the grass is pinched off and drawn across the cutting edge of the fly knife steel and bottom blade, it will remove the sharp edge and will cause a rounding effect on these two surfaces. When this condition exists, you have to do one of two things to get the mower in adjustment. First, using extreme care, adjust the mower tighter than you ordinarily do and cause the two edges to wear, bringing back the sharp edges - or lap the mowers in with emery.

I have been asked on several occasions, by various club officials, the question, "If we maintain proper adjustments of our mowers throughout the cutting season, why will we have to sharpen our machines before the season is over?" You are all well aware of the fact that the fly knife reel is ground almost to a flat surface with a slight radius on the blade. The bottom blade is ground perfectly flat on the face and also the front edge of the steel. As the mower is adjusted and worn, this front edge of the bed knife steel is worn away, down to the point that invariably it has reached a knife-edge instead of the square surface. As the reel travels across this knife edge, the tendency for this knife or feather edge on the face of the steel, is to carry back across the bottom blade, particularly if you should be cutting turf where there is an accumulation of abrasive such as sand, worncast, etc., then the mower has the appearance of being dull - which it really is. To eliminate this condition you should take a mill file, and filing straight and square across the edge of the bottom blade, remove this sharp edge to about 1/16" square surface, and this will again bring back the shearing effect.

Another phase of grinding mowers - and again most everybody has his own ideas and theories - is how much bevel or clearance to grind on individual fly knife blades. The reason for grinding this clearance is primarily to ease the drag between the cutting surfaces. On tractor drawn equipment, where you have plenty of power to pull the gang of mowers, I do not think that this is such a problem because the more clearance you grind on the individual blades, the quicker the fly knife reel will wear out, and it is to your own advantage to have these blades conform to as near a perfect cylinder as possible. However, in the little hand machine where power is the human element, it is quite noticeable how hard a machine pushes, depending on the width of the two surfaces, and your blades should be ground accordingly. This is not quite so noticeable on a power mower as the reel blade is driven by an engine, but again if this surface is allowed to get too severe, you will begin to notice a lack of power in the engine. In the three applications that I have just mentioned I would like to caution you, each and every one, not to make the mistake and grind a bevel entirely out to the cutting edge of any machine. This is purely a waste of time and material. When this sort of grinding has been done, you will notice that in a very short time - in a matter of one or two days - you will find this sharp edge worn away and the machine will be back to 1/16" or 1/8" of a cylindrical surface.

Installing a new bottom blade to the backing or bed shoe of any type of mower is a very important procedure. First, after removing the worn out steel from the bed knife backing, the backing should be thoroughly cleaned of any accumulation of grit, grass clippings or rust particles, and the new steel wiped clean in order to have two smooth surfaces bolted to the bed knife backing. The next important procedure is to grind the bed knife steel after it is assembled to the bed knife backing before it is installed in the mower. To my knowledge, all lawn mower grinders are equipped with a bottom blade grinder, but are not generally used. The reason for grinding the bed knife steel after it is assembled on the backing and before assembling in the mower, is to remove any imperfections in the cutting edge of the steel. After the backing assembly is installed in the mower and the finger guide, that is used to true up the reel, has a true surface to work from, you are not grinding imperfections in each individual fly knife blade. In all probability, when the mower is removed from the grinder, you can eliminate the process of lapping in the mower with emery as so many are doing at present.

Another problem that fits very closely into the maintenance of mowing equipment, and I can say has certainly been kicked around a lot, is the speed of mowing. This speed depends on the type of machine that you are operating. Of course, I do not think that this has much to do with the hand mower. I have never seen an instance where an operator has pushed a hand mower at an excessive speed, but the little power mower, due to the fact that it has an engine on it, has certainly been abused. Again I would like to call your attention to your maintenance manual in regard to the proper speed, and I think that you will find that most power mowers are not designed and built to run with the throttle wide open at all times, but at a speed that is convenient and comfortable for an operator to walk. In regard to tractor drown equipment, this is an entirely different problem where you have horsepower enough to mow at excessive speeds. For fairway mowers - and I do not know of a high-speed fairway mower - I would like to state that in my opinion, the top speed should not exceed 6 miles per hour - that is, provided you want the type of cut with respect to smoothness that the fairway mower is designed for. Of course, if you are not particular if the mower does not follow the contour of the ground and cut out the little undulations and you want a choppy cut, then your speed can be stepped up to, in some cases 10 to 12 miles an hour, but again you may run into trouble inasmuch as your maintenance and repair bills on your fairway mowers will exceed tremendously your friend's across the street who is mowing his fairway at a much slower speed. There are, however, mowers built for other applications such as golf course rough and airfields where the machine is designed for speed, and in these cases the ground conditions have got to be your governor of speed and the comfort of the operator taken into consideration.

There is another small phase in the maintenance of mowing equipment that from time to time causes small maintenance bills which over a period of time, certainly amount to quite a figure, and that is that it is very worthwhile to police your areas where you travel from one fairway to another to remove stones, roots, etc. that will cause damaged reel blades and broken wheels. Don't overlook the entrance to your garage where you transport your mowers to store them after they are finished with each day's operation. In all probability, in some of these places you will find some sort of an obstacle that is causing you minor repairs from time to time.

The greatest enemy of mowing equipment or any equipment is fire. It is surprising enough to know how many park departments, golf courses, municipalities, etc. throughout the United States lost all their equipment last year through fire alone. If they were fortunate enough to have their equipment covered by fire insurance, it isn't a chore to dig up another $10,000.00 to replace this equipment, but if they haven't, it is really a problem and maybe somebody is going to try to mow their grass this coming year without any equipment. If you have fire insurance, have it studied by a reliable insurance company and be sure you have adequate coverage. If you haven't any insurance, get some. A fire extinguisher located in a convenient position in your barn, may decide whether you will have equipment to take care of your course for the tournament that starts tomorrow.

# TURF DISEASES AND THEIR CONTROL

Eric G. Sharvelle and Willis Skrdla

All species of plants from the lowliest moss to the largest flowering shrub are subject to the ravages of disease. Turf is no exception to the universality of plant diseases. Just as there are gremlins in the grain, vandals in the vineyard, and robbers in the roses, so also there are troubles in the turf. Altogether there are 55 distinct turf blights caused by as many different molds or fungi — the turf blighters. Fortunately, all of these turf blighters do not attack turf in the middle west where only five major diseases afflict fine turfs. However, it must be emphasized that plant diseases like human maladies generally increase in prevalence and severity with increasing age of the population or industry. In other words, in a young industry, in young turf, we may not have serious disease problems, but as the industry or turf becomes older new diseases may appear and well known troubles may become more widespread and more damaging.

In the middlewest dollar spot or small brown patch is a perennial visitor to many western golf greens causing concern and often times marring the appearance of well kept greens.

Another constant visitor to many greens in the middlewest is large brown patch universally feared by every greenskeeper as the turf tyrant that may sneak in some night to leave the "smoke screen" that is the warning of extensive damage that may result from this disease.

Snow mold is another middlewestern turf trouble that requires annual attention for its prevention and may be the cause of serious damage to fairways and greens.

Less prevalent is the fairy-ring disease that causes characteristic rings or semicircles of dark green turf which soon wilts, turns brown and dies.

On blue grass, zonate eye spot or Helminthosporium leaf spot and crown rot in a frequent destroyer of susceptible stands of blue grass sod. These are the five common "Turf Tyrants" in the middlewest — Dollar spot, large brown patch, snowmold, fairy-ring and Helminthosporium leaf spot of blue grass. Other problems may occur such as damping off of nursery greens and growths of slimemold during the summer months. Finally, the greenskeeper must constantly be on the watch for destructive diseases such as copper spot which as yet have not been reported as turf destroyers in the middlewest.

The diseases of turf, like human ailments, are caused by specific organisms, and no two turf diseases are caused by the same fungus. Just as "flu" is caused by one thing, mumps by another, and diphtheria by still another, so are the turf troubles caused by different specialized molds or fungi. Similarly, the public is well aware that sulpha drugs will offset certain bacterial human ailments, but penicillin, streptomycin and aureomycin are required for other human ailments. By the same token there is no one panacea for the cure of all turf ailments.

The prevention of any plant disease is not merely a problem of applying chemicals for its prevention. The use of chemicals for plant disease control is only one useful weapon in the arsenal of defense against these problems, and I think a plant pathologist who is broad-minded would concede that the control and successful prevention of diseases of turf can be only attained by the coordination of all of the new practices outlined in a turf conference. In other words, fertilizers play their role in the prevention of plant diseases. The use of the correct strains of grass will influence the extent to which a turf disease develops. So you see, disease prevention consists in the application of all the best turf practices, and finally the use of fungicides or disease preventing chemicals is merely a very good supplement to these mearsures of preventing plant diseases.

Recognizing that fungicidal chemicals are supplimentary disease control measures that must be co-ordinated with good turf maintenance practices, let us now consider the value of some of the newer chemicals for turf disease control. Thirty years ago the greenskeeper had little difficulty in deciding which chemical he should use for the prevention of common turf troubles for there was little choice. Thirty years ago the only fungicide available for disease controlwas a mixture of copper sulphate and lime generally referred to as Bordeaux mixture. Following the first world war the mercurials were introduced as substitutes for Bordeaux mixture and quickly supplanted the latter as the greenskeepers chief defense against the "Tyrants of the Turf." For many years mercurials reigned as king of the Turf Blight Busters.

Within the past few years we have seen the introduction of many aspirants to the title of "Super-duper Blight-buster for Better Turf." In other words, just as the entomologist and the physician have been introducing the wonder drugs and wonder insecticides like DDT, streptomycin, penicillin and sulfa drugs, so the plant pathologist is striving to develop better fungicides. Thus, at the present time, we are seeing the introduction of many new chemicals, so now instead of having but one choice, the poor greenkeeper is confronted every spring with the question of which blight-buster should I use on my greens, and his choice has been increased from one to 15 at the present time. Recognizing this situation, two years ago there was established at Purdue an annual turf guinea pig.

In the Purdue turf plots all of the chemicals that might have some promise for turf disease control were tested side by side in 48 square foot plots using four replicates for each chemical. The chemicals are applied with a power driven estate sprayer using a three-nozzle broom and arc used at the rate of ten gallons per 1000 square feet of turf. A portable wooden frame 18" in height was used during the applications of the different chemicals to prevent wind drift to adjoining plots. The chemicals used, together with their chemical composition, manufacturer, and rate of application are summarized in Table 1.

Table 1. Fungicidal chemicals tested for turf disease control - Purdue University, Lafayette, Indiana

| Trade Name | Manufacturer | Chemical Composition | Pct. Active Ingredient | Dosage per .1000 sq. ft. (10 gals.) |
|---|---|---|---|---|
| Calo Clor.<br>Calo Gren | Mallinckrodt Chemical Works, St. Louis 7, Mo. | Mercuric & mercurous chloride | 100 | 2.0 ozs. |
| Calomel | " " | Mercurous chloride | 100 | 2.0 ozs. |
| Cadminate | " " | Organic cadmium | 20 | 1.6 ozs. |
| Crag 531 | Carbide & Carbon Chem. Co., 30 East 42nd St., N.Y.C. | Calcium zinc copper cadmium chromate | 100 | 3.0 ozs. |
| Dithane Z-78 | Rohm & Hass Co., Bristol, Pa. | Zinc ethylene bis-dithiocarbamate | 65 | 3.0 ozs. |
| F-531 | E.I. DuPont de Nemours & Co., Inc., Wilminton, Del. | Calcium zinc copper cadmium chromate | 100 | 3.0 ozs. |
| Merch H.258 | Merch & Co. Research & Development, Rahway, N. J. | Organic cadmium | 20 | 1.6 ozs. |
| Phygon | U. S. Rubber Co. Naugatuck, Connecticut | 2-3 Dichloro 1,4 naphthoquinone | 97 | 3.0 ozs. |
| PMAS | W.A. Cleary Corp., 314 Cleveland Ave. New Brunswick, New Jersey | Phenyl mercury acetate | 10 | 0.1 pints |
| Puraturf | Gallowhur Chem. Co. 801 Second Ave., N.Y.C. | Phenyl mercury triethanol ammonium lactate | 5 | 0.2 pints |
| Puraturf 177 | " " | p. amino phenyl cadmium dilactate | 20 | 1.6 ozs. |
| Puraturf GG | " " | Organic cadmium compound | 2.4 Hg.<br>6.0 Cd. | 0.05 pints |
| Spergon W | U.S. Rubber Co. Naugatuck, Connecticut | Tetrachloro-para-benzoquinons | 48 | 3.0 ozs. |
| Tersan | E.I. DuPont Co. Wilmington, Delaware | Tetramethyl thiuram-disulfide | 50 | 3.0 ozs. |

Summary of the 1949 performance of new fungicides for the control of dollar spot disease (Sclerotinia homeocarpa).

Good Control (90-100 pct. disease free turf)

- Cadminate
- Crag 531 (f.531)
- Cadmium H. 258
- Puraturf 177
- Suspension Calo Clor
- Puraturf
- PMAS

Fair Control (70-80 pct. disease free turf)

- Tersan
- Puraturf GG

Poor Control (50-60 pct. disease free)

- Dithane Z-78
- Phygon
- Spergon

PMAS and Puraturf definitely injured turf resulting in poor color.

In the 1948 experimental work a natural infection of dollar spot was well established before any of the chemicals were applied. A total of four applications at 7-10 day intervals were made of all of the chemicals, unsprayed plots being left for the purpose of comparison. Of the chemicals tested the organic cadmium and Crag 531 gave the most effective control of dollar spot. Two weeks after the first applications of these chemicals were made, most of the dollar spot had been cleaned up and four weeks later these plots had completely recovered. The Puraturf products were quite effective for dollar spot control, but certain of them had a tendency to result in off color. Calomel and Calo Clor, while effective, resulted in injury especially when applied during hot weather. Tersan was only moderately effective for dollar spot control. Phygon, Spergon and Dithane Z-78 had little value for eliminating dollar spot in these experiments.

Large brown patch disease did not become established in the Purdue experimental plots in 1948, and it was not possible to test the new chemicals against this disease. However, in large scale demonstration Tersan gave excellent control of large brown patch.

In conclusion, national workers agree that the organic cadmiums are the most effective materials for dollar spot control, Tersan is the most widely used chemical for brown patch control, and fall applications of mercurials such as Calomel, Calo Clor, Etc. are the only effective preventatives for snow mold disease.

The Purdue Fungicide trials on turf will be continued in 1949 and will be coordinated with national trials in other states to serve as a better basis for determining the relative values of the new fungicides for turf disease prevention.

## SOIL COMPACTION AND AERATION

Fred V. Grau

Today I am going to discuss very briefly the matter of soil compaction and what to do about it. We know that soil becomes compacted even if we have a nice sandy loam, which most of us agree is the ideal soil on which to grow grass, particularly if we have at least two feet of it over our drainage system. Whether or not there is a base of gravel there is beside the point at the moment.

First we have the impact of water falling either as rain drops or irrigation, since rain drops falling free have considerable force. You know that in the summer time when you are out with our shirt off and the rain comes, those drops sting and they bounce. I have seen pictures of a falling drop of milk taken in a hundred-thousanth part of a second right at the moment of impact and you can see a tremendous force there. The rain drops compact. It is worse on a bare soil because there is no protection. The better the turf the less the compaction from falling rain.

The second thing is the action of the players using the area. We can't discount that because its going to be continuous; otherwise we'd be out of a job and if we didn't have turf in use there wouldn't be any use in maintaining it. So the players are going to compact the turf and that is a continually recurring situation. Like the drunk in the back of the room who got up and just wanted to know, "What's the difference between temporary and permanent?" He said, "I'm drunk and that's temporary; you're a jackass and that's permanent." All nature is continually in a state of flux, - moving, changing all the time, and of course we have to maintain this turf and use machinery. Heavy machinery has a definite effect on compaction. We don't know yet just where that worst compaction occurs. It may be a very thin layer. We know that on a bare soil surface the greatest compaction occurs right at the soil surface and even though it is only a fraction of an inch thick it very effectively prevents the inward movement of water in the soil and that's one of the things with which we are most concerned, -- the penetration of water into our soils quickly so that the plants can use it. That's more important in the arid regions of the country than it is in the humid regions because of the high rate of evaporation. We have a rain or we irrigate turf and the water remaining on the surface does not go in and evaporation has a chance to take a lot of that water away. When the water bill of an 18-hole golf course is $1700 a month and they throw a million gallons of water every day of the year that's a water bill. If you can cut that in any way then you are doing something. We maintain that water conservation today is one of the most important factors with which we are concerned. We already have good evidence that a water bill like that can be cut right square in half by proper manipulation or cultivation of the soil by aeration practices which break up that compaction so that the water gets in.

In Denver, for instance, they had to water their fairways once a week but since they've been cultivating those fairways they can now water once in two weeks and still have better turf at the end of two weeks than on the fairways that were not aerated and watered every week. That's cutting the water bill right in half and we're getting that also in the humid regions. We're studying compaction and irrigation through a research fellowship at Penn State and it's tying in with work at Michigan, Oklahoma, Purdue, and other stations. They are using an X-ray spectrometer to study compaction and it's looking very good. For instance, most of the soils there are quartz and quartz has a certain pattern on this X-ray spectrometer. With the pure mineral quartz, which has no compaction, it has a definite pattern that can be reproduced everytime they run that machine. The quartz in the soil also shows the same types of the pattern typical of quartz, a little different steepness to the slope. Then when that soil is compacted, then the curve changes. And now we can measure compaction to find out what has occurred and now I think we're beginning to get somewhere. I think, due to the lateness of the hour it might be better to run through these slides that I have, which I think will show most of the things that I want to say.

Here are the areas of compaction and wear. Noer showed you a picture in the session yesterday. This is the athletic field setup at Penn State. This is the field that is used only for the major games, maybe 3, 4, or 5 times a year. It's coddled, it's watered heavily, it's soft grass, it can't stand up under heavy traffic and even though it isn't used very much you still have that thin turf and compacted soil. Of course, when you get into the heavy-wear areas it indicates that we have a real problem. Here is the football field a little closer up showing where the grass actually is completely worn out. Still they have some grass out here where the compaction has not been so severe. By and large, the country over, the athletic fields of the major colleges and universities are a disgrace. A lot of them don't even have any grass on them, most of them are more weeds than they are grass. Yet, we are talking better turf, resilient turf, turf that will provide play free of injuries. We've got a big job ahead of us.

Here's a golf course tee in Washington. One that gets 50,000 rounds of golf a year, and to date, with the type soil they have, compaction, lack of aeration, improper selection of grasses, they have not as yet been able to hold grass under those conditions. This particular tee is going to be planted in bermudagrass this spring and will be frequently cultivated and much more heavily fertilized than ever before. Occasionally fairways go bad. Part of it is lack of aeration, water may have stood here, a number of things may have occurred, but it illustrates that we do have these problems and they are mostly tied up with the soil, such as soil aeration, relieving compaction and getting oxygen down to those roots. But occasionally some of these grasses come through and a lot of us have been missing a bet by not selecting those grasses that are best adapted to those particular conditions. They can be taken out of there, increased and planted back in the same area and you know that they are adapted because they have stayed there through these bad periods.

On many unwatered fairways, the soil is so hard that you flinch every time you try to make a shot with an iron because you know if you don't pick it off pretty clean, you are going to break the shaft or break your wrist and that is not fun in golf. The turf is thin, its been fertilized, the last fertilizations that we know of was nearly 250 pounds of 2-9-5 to the acre. I'm not trying to ridicule anybody, but on a lot of these unwatered courses we must try to overcome that hard, dense compact soil by growing a denser turf. Incidentally, I want to say that on that particular golf course, unwatered fairways, mostly crabgrass, -- the only crabgrass-free-areas there were the bent patches which came in there either accidentally or by design. I think it was accidentally. The bent patches were crabgrass-free. They were just as brown as anything else during the drought but they greened up in the fall when the rains came and they stayed free of weeds.

Here is a grass that can grow on extremely compacted soils. You see, we are approaching this from several different standpoints, -- not only the cultivation and the aeration of the soil to improve the relations for grass growth, but we are also selecting some of these grasses that can grow when soil is compacted. Bermudagrass is one. This is a very heavy, silty soil there at Beltsville. This is U-3 bermudagrass. It was sprigged and made a solid cover in 4 weeks. It would have made an excellent fairway 4 weeks from planting, planted about the middle of July.

This is the kind of turf we get from closely-clipped, well-fertilized bermudagrass, cut at 1/4-inch regularly and fertilized with a total of six pounds of nitrogen to 1,000 square feet for the season, plus lime, phosphorus and potash.

Here is another grass that has great possibilities. It's growing in Philadelphia, Louisville, Ky., Madison, Wisconsin, Amherst, Mass., Cornell; and pretty well going north covering the entire crabgrass belt. It can grow in very compacted, heavy soils. This is <u>Zoysia japonica</u>. You can see one of the reasons why it can do it. It has a terrific underground root system and provides resiliency even when the soil is hard and dry.

There you see a two-year old turf of <u>Zoysia japonica</u> with its mat on the surface which provides a cushion and a resilient shot and yet even though you try to take a divot not very much divot comes up. That soil is extremely dense. You can disc it; you can aerify it, and in just a little while it runs back together and is just as tight as it was before. So we have to approach this thing in at least two different ways.

This is the type of turf you get from Zoysia - - closely cut, 1/2-inch, and just fairly well fed (about 2 or 3 pounds of nitrogen to 1,000 square feet for the season).

This is very difficult to see with the light shining on it but this is a crop of <u>Zoysia japonica</u> seed, about which I've been telling you. We have our greenhouse in Beltsville pretty well filled with it and the seedheads are so close they are almost touching. We predict a great future for this seed crop. We predict a great possibility for the Zoysias (1) because they do produce seed (2) because they will grow over such a wide climatic range and provide the kind of turf we are looking for.

This is one of our selected Zoysia japonicas - the parent; and this is one of the seedlings. This is only one season's growth. That was a single tiny seedling we set out in May and this picture was taken just before it started to go dormant. That's the same terrifically compact silty soil which we could hardly get a knife blade into when it was dry.

Here are the Zoysias and winter grasses. Most people wouldn't care for them because they are brown - straw-brown during the winter but this is a bluegrass path. It's been there for a long time and the Zoysia has crept clear across here and its out into these plots. There is just as much Zoysia in this path as there is here but its a combination of bluegrass and Zoysia which maintains a year-round green color without irrigation and with very little fertilization.

Another bluegrass we are talking about is the B-27 bluegrass, which is fitting in with both Zoysia and bermuda. This is the strip of B-27 bluegrass. The common commercial bluegrass is right alongside of it but you can hardly see it. When I looked at those plots just before I came out here the leafspot was beginning to take the common bluegrass out of the picture, while with the B-27 you can just find a leafspot here and there. It is highly resistant to leafspot. 3500 pounds of seed were produced last year. That's going to be increased and before long you will be able to buy some B-27 bluegrass.

Zoysia matrella on the Audubon Country Club tees at Louisville are virtually weed-free. It produces remarkable resilient turf. He fertilizes well, cuts them very closely, and they are doing a beautiful job. Poa annua makes a very good winter grass with Zoysia which can grow in these compacted heavy soils. I've seen it also in tees, - bermudagrass and Zoysia standing right together and neither one could invade the other.

Mismanagement of our grasses increases our problems. This is mismanagement of Zoysia -- allowing too much of a mat to develop.

Alta fescue is another of those grasses that is proving itself under very difficult conditions, - - rather dense compacted soils, - because for some reason or other those roots are able to penetrate many of those dense soils. This is Alta fescue. This is the common type of lawn that we have had to put up with at Beltsville on our gravels and sands and clays.

Here is an Alta fescue lawn at College Park a few blocks from my home which has been quite satisfactory. It's not the perfect turf grass but this clay material is one of the worst things I have ever seen on which to grow good grass and yet this Alta fescue is thriving in just that kind of material. Not one teaspoonful of topsoil was put on that lawn. The man didn't have the money - he's a college professor. So he selected the grass and fed generously. He's pleased with the lawn even though the grass is coarse and fairly open; yet it's practically weed-free. But he is pleased and that's what counts.

Here's B-27 bluegrass again, - a late fall seeding in Beltsville, compared with commercial bluegrass. That's the way it looks with us there. We have replicated tests at 24 experiment stations and about 25 golf courses scattered over the country to find out if B-27 is the grass we want to push.

Here's B-27 in this little triangle, overseeded on closely clipped bermudagrass (U-3). On this piece of turf at our Field Day last October at Beltsville, Roger Peacock, one of the leading Pros in that district, hit full 8-iron shots off that turf and you could hardly see where he hit the shots and he was really pushing that iron down through that turf. It did not take any divots, it was that tough. That's what we are looking for. It is well fertilized, cut at 1/2-inch all year. Here's bent and bermudagrass together. It looks as though we are getting somewhere with these combinations of grasses on our extremely unfavorable soils. I believe that our climate and our soils in the Washington area are a little bit worse than anything I've seen anywhere.

Bowling represents another type of compaction and needs aeration. Bowlers are even more critical of their bowling surface than golfers are. It's got to be hard, it got to be fast, and the bowling ball has to roll absolutely true and so it presents a real problem. Here's a bowling green at Denver Country Club. Washington bent, beautifully maintained, and perfectly true.

And now just a little bit of what George Hoffer has been showing you and a few of the things that we find. This layered condition on putting greens represents the problems that the boys have got set up right there on the table with that sand layer about 3 inches down. It is a "bum" mixing job. They used plenty of sand in the green but they wouldn't mix it with the soil and so they have a very unhealthy situation. Here's a green where the plug broke in those many segments because there's been sand layers put in there. And here they put in an inch layer of raw sewage sludge to hold the moisture so they wouldn't have to water so much and wondered why they couldn't even grow bermudagrass. You know that stuff will grow on a fence post and if you burn it, every place the smoke touches the ground, it will begin to grow again. (So they say.)

Here's a green where the superintendent didn't have enough water to water it as much as he thought it ought to be watered but that whole plug held together by the mass of roots in it and you could hardly shake it apart. Roots are deep because the roots are seeking the water and what we want to do is to invite those roots down as deeply as possible because we can relieve the soil compaction by growing deeper roots and heavier turf because the roots have a decided effect. You heard Willis talking about that this morning, explaining his research, and how roots can loosen up compacted soil. There is another situation where there is another heavy sand layer and it broke. Here is the finest sandy loam topsoil I've ever seen, 5 inches of it, built upon an impervious clay, exactly as they have set up here in the demonstrations and the green was always extremely difficult to maintain because below that was 100 feet of sand which would have provided excellent drainage if they could get it into the sand.

And here is a perfectly uniform soil column with the roots broken off at the bottom - this is one foot long. The roots broke off at the bottom.

We need more cover on our roadsides, on our some 3,000,000 miles of roads and highways in the United States. And it is a real problem. Here's an attempt. The gullying had already progressed for a year and about the only place they have got any grass are in the gullies where there is some moisture. This is the Pennsylvania Turnpike. They put hordes of men up there and absolutely smoothed those slopes so that when the rain fell it would run off with the greatest possible velocity. The least amount of it to go into the soil and, of course, there was no place for the grass seed to stay, and covering those slopes with vegetation was extremely difficult. Leaving them rough as nature would leave it provides pockets and crevices for those materials to stay.

Here is compaction in the extreme. This is U. S. Highway No. 30 on this side of Grand Island, Nebraska, and along the roadside is solid knotweed. That situation exists all through Kansas, all through Nebraska, and a number of midwestern states. Solid knotweed grew where the compaction is the greatest and it was very attractive. The temperature was 110° as we were driving through Kansas last August and knotweed was the only green thing that we saw. But the only grass in this particular area that can compete with knotweed and grow under those compacted conditions was buffalograss. Buffalograss is not adapted here, but in its region of adaptation it is the turf grass to grow on these dense heavily compacted soils.

Here is another plant that's being used on highways and can be used on certain areas like parks. It is crown vetch. You will hear more about it in time to come. It grows on sterile, hard subsoils and stays green and crowds out weeds and is becoming a factor for highway covers. Here's crown vetch in bloom. Cars will line up 10 or 12 in a row, people getting out and picking posies and putting them in their lapels, as it is simply beautiful for about a month or six weeks in the season.

Here's <u>Zoysia japonica</u> in its winter dress on Highway No. 50, outside of Washington, D. C., doing a fairly good job without any maintenance whatsoever except maybe mowing once or twice a year. That soil is compact because cars and trucks continually cross that strip.

And here is a patch of Alta fescue, seeded on Highway No. 50, just outside of Fairfax, Virginia. The vegetation is mostly weeds. Cover grasses have been sown there, I don't know when this was established, I just happened to see it one day and its doing the best job of any grass we've seen under those conditions. Here is another view of it, doing an excellent job, here in just mostly trash and weeds and that is continually crossed by cars.

Just a quick view of some of the attempts of relieving the soil compaction. We've been thinking about it a long time. A number of you in your shops started to build special types of equipment to relieve this condition. These solid tines have been used for a long time, sinking them in and wiggling them to get some air down in the soil, yet a certain amount of compaction occurs everytime you sink a solid implement down into the soil. You have to displace soil thereby increasing compaction, at least in part of the soil. These little pin pricks that Noer talked about, a motorized spiker used in Omaha, it does some good but certainly is not the final answer. The disc is being used on some fairways to loosen the soil, cut the turf, it has its place but the effects are rather temporary because quite quickly those slits close up again and you don't have the cultivating effect that you want to have. Noer showed you the picture of the rotary hoe which is a factor in use on many courses in the south for renovating bermuda turf and it does considerable cultivating.

And then the Aerifier, perhaps the newest tool on the market to revieve compaction to cultivate the soil. We have 125 acres of lawn and turf at Beltsville Gardens, Beltsville Station, and we aerify spring and fall just ahead of fertilization as those soils become so extremely dense and compacted we lose a lot of rainfall and lose quite a lot of fertility from heavy rains. Here they are using it on putting greens. The condition of the soil is the reason for this extremely poor condition of the putting green and now we are beginning to relieve that condition and improve it.

Clover, one of the reasons why the rack had to be put on the Aerifier so far as I can understand it, it is because there is so much shallow-rooted turf in the United States. Immediately you use the Aerifier the turf wanted to roll up, because there were no roots in it. Clover would do the same thing and the reason that clover is there is the reason we are using some type of cultivating equipment now to improve it and to grow grass. The action of the spoon actually cultivates underneath the surface and leaves a pocket, improves free interchange of air, and I believe that this getting air into the soil is doing about as much good as actually mechanically relieving compaction. By the entrance of air into the soil we're growing deeper healthier roots and the roots are beginning to relieve that compacted condition.

This is bermuda turf on which bent has been overseeded and the only place we got satisfactory establishment of the bent was in the Aerifier holes. The seeds made contact with the soil and send the roots down into that heavy soil.

Here the fairways are completely aerified and from what I can understand, we are reducing water consumption and growing better turf by doing something to the soils.

Now the mole-drain is beginning to come into the picture. It has been in use on those heavy brick-clay soils of St. Louis. Al Linkogel has been using it on his greens and it is providing another way for getting drains into these soils and I don't believe with a mole-drain we'll have to worry about layering with sand and topsoil. How effectively it is going to work, I don't know, but it certainly has looked good under Al's conditions. Here is another view of it, you probably know the principle, the rolling coulter cutting a slit and then the knife coming into the slit with a bullet down at the bottom with adjustable depth and then a roller pressing the turf back into place. I've seen that operated now for several years. Here's some of the tree roots cut off by the mole-drain as it operates around the green. Some of those tree roots were almost as thick as my wrist.

# THE TURF BREEDING RESEARCH

Kenyon Payne

We are very happy to bring to you this morning a very brief cross-section of our turf research work here at the Purdue University. Although we know that most of you already are acquainted with our projects through our Field Days and former Turf Conferences.

Most of the fundamental principals of plant greens have been developed by breeders of other crops, mostly corn and the small grain cereals. In the United States there was little concentrated effort on grass breeding, as such, with the possible exception of some breeding work on timothy, up until about 15 to 20 years ago. Turf grass breeding is even much more recent than that. The past 10 years covering most of the concentrated effort on these species. As a matter of fact, it has taken most of these 10 years for the turf grass breeders to find that many of the methods used by the cereal breeders probably aren't the most direct approach to our problems. But we must look to those fundamentals for long-range program when breeding for special objectives.

In different parts of the world, grasses have developed through the centuries according to their ability to compete with other plants and to compete with the environment. Civilization, as we have covered the world more completely, has introduced and domesticated new species to other areas of similar climate, but in general, it has been very difficult to transport a species bodily from one climate to another, from one place in the world to another, and have it do well at this new place from the very start.

Now it is up to science to select the superior strains of those adapted to our own areas. We are attempting to increase the range of adaptation of desirable species of other areas. This we can do more readily by applying what we call our basic genetic fundamentals, the principals of inheritance that we learned about in the classrooms. As many of you know, corn, which is the major crop in the United States, had its origin down in Southern Mexico and in Guatamala. By the time Columbus got here it had already been brought up by the cliffdwellers to the Pacific Northwest. When the Pilgrims arrived in 1620 they found that the Indians in New England had corn. Now we have strains of corn that can even mature in Alaska, yet if we go down to Mexico City and pick up a few kernels of corn and bring them up to St. Paul and plant them in the springtime, this corn will grow to the height of 15 to 20 or more feet, but it will never put out an ear shoot or a tassel. We know that corn can't grow by itself, it must be planted and harvested by man. It is a child of civilization. So we know that man has been responsible for changing the adaptation of that tall corn that grows in Mexico to the fine corns we have growing in our cornbelt further north.

There are several methods that are available to the turf grass breeder. In the first place, simple introduction, is of course, most important. We have many sources for simple introduction here in our own area. This has been used most successfully with the bent grasses. We can get the maximum values and the quickest results when we start with strains which are already adapted to local conditions and that have proven themselves under those conditions. But the local kinds and species won't fill all the requirements. We can introduce and attempt to develop new adapted species. We can't usually do this in transferring stolons in our bents. We must have seed to accomplish this change. Clones are all the same so far as their heredity is concerned. If the green is Arlington on one side it is Arlington on the other and the plants on one side have the same genes or determiners of heredity that we find in the plants on the other side. If disease will knock it out on one side of the green it will knock it out on the other side of the green. It's only by getting plants from seed that we have a range in variability and range from which to attempt to alter the adaptation of our strains. From seed, we are able to follow one or more of several different practices.

In the first place we can do what we call "self-pollinate". We can go out to our bentgrass plots where we are getting some seedheads, we can put a little bag on the seed head and allow it to self-pollinate, or we can take the clone out in an isolated area and allow it to self-pollinate in that area. By this self-pollination we narrow our range very little and at the same time we are able by self-fertilizing to stabilize certain characters such as disease resistance, texture, density, etc. We are able to grow a plant and know that its progeny will produce the same kind of plant. We may be able to cross these inbred lines and use the hybrids as we did with our corn. This hasn't been done on a practical basis successfully with any of the forage crops yet but it certainly is a potential that we must keep in mind.

In the second place we can grow seed from open-pollinated plants and get a wide range of differences. Those of you who were at our Field Day last fall saw our nursery at the Soils and Crops Farm in which we had some plants that were 6 inches in diameter and some plants that were 3 feet in diameter. They had all been started at the same time. That's the type of variability we get when we plant single seeds from open-pollinated plants.

In the third place we can grow two clones together out in isolation. We can take Washington and Arlington and put them in a plot by themselves where no pollen can come in from other bents, and allow them to cross with each other. We get a broader range of variability when we plant the seed from a cross such as this.

In the fourth place we can select several good clones, evaluate these clones, select the best ones, and grow them together. Seed from these plants will also produce plants which vary considerably. This has two possible approaches. We can either grow the seed from these mixtures and start our single plant nursery or we can develop what we call a synthetic variety and just grow several good clones together and then use the seed from the mixture as a variety.

In the fifth place we may cross an introduced species that has different desirable characters with a locally adapted species of an undesirable type and then we may either study the progeny of the cross back to one or the other of the parents and select for the characters that we desire. This is called the back cross method and it has been used very successfully in corn, cereals, and other crops. In some measure we hope to use all of these methods in our breeding program here at Purdue.

Turf breeding was started as such here at Purdue by Dr. Herb Albrecht back in 1945. Many of you knew Herb. Herb took an extended trip through this area collecting grasses, particularly bents, and most of our work here so far has been with the bent species.

Since there is a real need for a good fairway type the boys studied 66 introductions when they were maintained under fairway conditions in 1947. They found that Old Orchard, Arlington, and 8 other clones did very well on quality, disease resistance, weed competition, vigor and color. In the summer of 1948 this same area of 66 clones was maintained under putting green conditions and here again the Arlington as well as Old Orchard, Congressional and several other clones were the same in both years, whether maintained under fairway or under putting green conditions. This to us is an indication that the additional fertilizer, watering, topdressing increased the number of clippings per week, etc, didn't greatly influence the evaluation. If we can evaluate clones with less work, as we can when maintained under fairway conditions, then it's logical that we can test more clones; so we are very much interested in this relationship as it was brought out by this study.

We are interested in the seed setting of these bents. If we are to use creeping bent for fairway use, as you all know, and if we are to use them in establishing greens from seed, we must have seed from them. Dr. Musser at Penn State this past summer established permanent golf greens from seed. They were established very quickly and very economically.

A study of seed production with strains including Norbeck, Old Metropolitan, Old Washington and Old Orchard, gave up 50% seed set, while some of our clones gave up to 67% seed set. As you all know, creeping bents are not usually propagated from seed because of a lack of seed and also because of variability of plants as the result of the seed that has been talked about. A strain which produces a good seed crop and a progeny of fairly uniform texture and density would of course be very valuable to us. Some greenkeepers would welcome a variety in color. They say that if they have plants of different color in their greens, as long as they are of the same texture and density, they give you something to line up your putts on and some of them seem to think that the trend is away from the solid one-color green. We have a single plant nursery, as I mentioned, set up out at the farm to study this.

Unfortunately, thus far, we have no way of evaluating plants until we get them under turf conditions. This is slow process. It takes at least two years before we can get any results. To quote Eric Sharvelle, "We get the experiments all set up and then they sell the damned farm." So that slows us up a little bet more. In general the corn breeder or wheat breeder is pretty happy if he can get a new variety of wheat or corn out in 10 or 12 years. Corn and wheat are relatively simple crops to work with as far as inheritance and breeding are concerned. As you can see we have a pretty good problem and hope to have something for you in less than 10 to 12 years, but it is a slow process and we were informed this year that we have to move our nurseries to the new location; this won't help hasten our work.

At this point we have some pretty fair greens strains. I think you will all admit that. We do need better strains for tees and better ones for fairways, however. Those of you who have seen Fred Grau's U-3 Bermuda and his Zoysia plots, or who have seen his pictures, and you all will see them if you attend your sections religiously, or of those of you who have seen Gill Grant's Zoysia tees down there at Audubon in Louisville, firmly wish that stuff would grow up here, further north. We are starting a program to get seed from various Zoysia strains and hope to bring them up north like the Indians brought that corn up from Mexico.

We plan to study U-3 extensively and use it in crosses with Bermuda strains which have survived in Northern Indiana for many years. Fred says that this U-3 Bermuda has survived at Penn State for several years where the temperature gets as low as 28° below zero. So we won't have to work for winter-hardiness, but we are going to be somewhat surprised if we can transplant U-3 out here and have it do beautifully right off the bat. So we want to be prepared for all possibilities.

Don Likes, graduate student, who is acting as a section leader in these sessions, is working in particular with these tee grasses and he'll have something for you before too many more meetings roll around. We plan to continue studies on seed production and hope to have some results on cross and self fertility in bents in the near future. We have some selfed seed germinating now and with this we will start an inbreeding program of bents.

We mentioned our progeny testing program from open pollinated seed which we will continue to carry on. We plan to cooperate fully with Fred Grau; Jim tyson, Michigan State; Bob Livingston, Missouri University; Burt Musser, Penn State and any of the plant breeders with whom we can exchange materials and ideas. In order for us to plan intelligent breeding programs, however, we must be thoroughly familar with what you want. We want you to feel completely that this is your program and we very earnestly invite your suggestions. Thank you.

# NUTRITIONAL STUDIES OF TURF GRASSES

Richard Davis

My part of the program this morning will be devoted to a brief discussion of a bentgrass nutrition experiment that was conducted in the greenhouse. The purpose of this test was to study the reaction of four of our better known strains of creeping bent to various levels of the fertilizer elements. We were interested in what happened in the roots as well as the above ground portions of the grass. In addition we wanted to study the physiological differences in strains. Congressional, Arlington, Old Orchard and Toronto were the strains that were used in this study. Closely clipped sod was brought in from the field, allowed to green up in the greenhouse and torn apart into individual sprigs. Ten sprigs each were planted into crocks containing white silica sand. Twelve different solutions containing various amounts of fertilizer elements were used to feed the grass. Five hundred ml or about a pint of the solution per crock was applied twice a week.

These treatments were set up as you see here on the blackboard: high nitrogen, medium, (not only medium nitrogen but medium phosphorus, potassium and calcium, too) a low proportion of nitrogen, high phosphorus, low phosphorus, no phosphorus, and so on. To explain how the solutions were made up, the high nitrogen solution, for example, contained a high proportion of nitrogen and a medium rate of phosphorus, potassium and calcium. So you see only one element is varied at a time. In a similar manner the low phosphorus treatments, for example, contained a medium amount of everything else but a low rate of phosphorus. So much for the preliminaries to make you understand how the treatments were made up. Keep in mind that we vary only one thing at a time and everything else is what we call the medium rate.

In addition to nitrogen, phosphorus, potash and calcium, sufficient magnesium, sulphur, iron, boron, manganese, copper and zinc were added to the plants. The pH of all the solutions was adjusted to about 6.2. Throughout the test the grasses were clipped twice a week to a height of about 1/2 or 3/4 inch. A special photo electric technique was used to measure the degree to which the grass covered the white sand in the crocks. Estimates were also made to more or less check this method and they compared favorably with the measurements. The measurements were considered more accurate and so they were used as the basis of our conclusions.

So much for the preliminaries. We will show what we found. May we have the slides.

Here is C-19 which is used to represent the other strains receiving the high nitrogen treatment, the medium nitrogen (as well as medium phosphorus, potassium and calcium), and low nitrogen. Notice that the crock receiving high nitrogen is almost completely covered with grass. The medium is not quite so well covered and the low nitrogen is much less covered.

Here is how the grass looks in a closeup when it gets a low rate of nitrogen. Notice the red stems and the yellowish-green leaves. I know you greenkeepers wouldn't let your grass get that low in nitrogen but that is what it would look like if it did.

Here is how the grass looked when we varied the rates of phosphorus. Upper left, high phosphorus, medium phosphorus, as well as nitrogen, potassium and calcium, low phosphorus and no phosphorus. Notice there is very little growth where no phosphorus was applied. Contrast this with the low phosphorus where only five parts per million phosphorus was applied.

Here's a close-up of the phosphorus deficient grass. Notice the purplish-green color.

Here's how the grass looks when varying the rate of potassium. This happens to be Old Orchard. The same holds true for the other strains. Notice there is very little difference in the amount of coverage as the rate of potassium is varied.

Here's a close-up of potassium deficiency. The leaves are yellow and dying. This happens to be Toronto (C-15).

Here's a close-up of the calcium deficiency on Toronto.

Here is another strain contrasted with the previous one. The previous one, Toronto (C-15) showed a very bad calcium deficiency, where this C-19, or Congressional, showed a calcium deficiency but not nearly so much as the Toronto. That is just one of the differences in the strains.

Here is a comparison of the type of growth of the strains. They all received the same treatment. This particular treatment was the high nitrogen treatment. Notice that Arlington, which makes a stringy type of growth than some of the others, didn't make as good a cover. You can see quite a bit of open area contrasted to Toronto (C-15) which made a very close, compact growth. There was not much difference in the coverage of Old Orchard, Congressional or Toronto but Arlington was considerable slower than the others in making a cover.

Here is another comparison of the strains. I use this particular picture to point out the differences in color. Notice the Toronto and Old Orchard at the top are a little lighter green than the Congressional and Arlington on the bottom. This matter of color is a personal preference but the Arlington and the Congressional are a darker green than Toronto and Old Orchard.

When the experiment was concluded the sand was washed from the roots. Pictures were made and then the roots was cut from the stems and the roots were weighed.

This is what happened to the roots with varying the rates of nitrogen. On my left is a plant getting a high nitrogen solution. You can't see it very well but as the roots increased the top growth decreased. There is less root growth on the high nitrogen solution than we got with the low nitrogen solution. As the root growth increases, top growth decreases with the various rates of nitrogen.

Here's what happens to the roots when we vary the rates of phosphorus. On my left are high phosphorus, medium, low phosphorus and no phosphorus. Notice that a low rate of phosphorus produced the greatest amount of roots.

This shows what happens to the roots when we vary the rates of potassium. There is very little difference in root growth so long as a little potassium is present.

Here's what happens to the roots when we vary the amounts of calcium. On the left high calcium, medium, low calcium and no calcium. Again the low calcium level was slightly favored as to root production.

Here's the comparison of strains receiving high nitrogen treatment. Notice that all of them have relatively a small amount of roots but the Congressional (C-19) produced more roots than either of the strains, and Toronto (C-15) less. That same relationship held throughout the experiment.

This is another comparison of strains, only this is a high phosphorus level. On the left we have C-19 (Congressional), C-1 (Arlington), Old Orchard and Toronto. Notice that the Congressional produced more roots than any of the others; Arlington and Old Orchard are just about the same, whereas Toronto definitely has less roots. We want to contrast this with the next slide which is the low phosphorus level. Again C-19 is inclined to produce more roots and Toronto less roots than the other strains.

In this hurried discussion I hope I succeeded in bringing out two points at least. If there is something wrong with the fertility of a green it is not necessarily a lack of fertilizer; it may be an excess. Another point I hope I have brought out is that you can't afford to lose sight of what may be happening to the grass roots when you fertilize your greens.

# TURF RESEARCH IN MISSOURI

R. B. Livingston

I wish, first of all to express the regrets of Dr. Brown who was unable to attend the conference to present this report. As it was impossible for him to be away from the University at this time I have been asked to substitute for him.

An organized turf research program has long been needed in Missouri, especially with regard to the development of suitable fairway turf. Kentucky bluegrass has proven unsuitable for fairway turf for it will not withstand the close mowing required to produce a suitable playing surface, and furthermore it may enter a dormant period during the later part of the summer and loose color. Because of these undesirable characteristics crabgrass and other weeds invade the unthrifty turf to form a still less desirable playing surface.

Last spring a program was initiated in the St. Louis area to carry on research work on the improvement of fairway turf. The research was made possible through grants from the Midwest Regional Turf Foundation, the U.S.G.A. Green Section, from several clubs in the St. Louis area, and from the Greenskeepers Association of St. Louis. The investigations have been carried on for the most part by myself, under the direction of Dr. E. Marion Brown, and in cooperation with greenskeepers from several of the St. Louis clubs. Most active in this letter group has been Mr. Al Linkogel, greenskeeper at the Westwood Country Club, Clayton, Missouri.

At present we have little to report. Briefly I shall outline the work completed to date, and will indicate what our program for the coming year is to be.

Last May we established a test plot on a gentle northfacing slope on the grounds of the Westwood Country Club in Clayton, Missouri. The first slide will indicate the general aspect of our test plot area. Since Bermuda grass, especially such strains as U-3 from Beltsville, have shown real promise in other parts of the country, the greater part of our test plot area was planted with selections of Bermuda. In all, about 70 selections were planted, including about 20 from Dr. Grau at Beltsville, a similar number from Dr. Burton at the Tifton, Georgia Station, and the remainder from local collections. The Bermuda selections were planted as indicated here, in plots 5 x 5 ft., square, with one-foot walkways between plots. Initial plantings were made on May 5. All Bermuda were planted from sprigs or plugs in the center of the plots. Margins were trimmed at frequent intervals to maintain the Bermudas in their respective plots.

In addition to the Bermudas several grasses were planted from seed, including Astoria and Seaside bent, Alta and red fescue, and seeded Bermuda, as well as combinations of the fescues with seeded Bermuda. We also planted B-27 bluegrass, and adjacent to that, a strip of commercial

Kentucky bluegrass to compare these grasses. Our seeded plots occur adjacent to the Bermuda plantings.

This was essentially all the plantings made last spring. No attempt was made to establish any of the selections in the existing fairways during the first season of our studies.

Last summer observations were made on all grasses, and certain characteristics were recorded. We recorded the vigor of growth, the quality and texture of turf produced, and the inhibition of weeds by each selection. Those grasses which exhibited desirable characteristics last year, and which survive the winter will be used in our tests during the coming year. Our work during the coming year will consist of the following phases.

Those grasses found desirable last year will be propogated, however, propogation will be limited in extent until we have proven the desirability of the selections under actual playing conditions. Illustrated in this photo is a plot of U-3 Bermuda indicating the success encountered in one method of propogation. This U-3 Bermuda was planted with stolons laid on the surface of the ground, covered with a very light top-dressing, and watered for two or three days. The planting was made on the first of August and had made a complete cover by the last of August.

Before making extensive propogations of any selection we shall test the selection under actual playing conditions and in competition with existing fairway grasses. To gain this information we are going to plant cup-cutter plugs of promising selections in the existing fairway. The plugs will be planted both in an upland fairway and in a lowland fairway. Thus we shall gain information on the various promising selections under actual playing conditions, in competition with the existing bluegrass, and under varying topographic conditions.

Another phase of the work will be carried on in the Bermuda test plot area, and can be illustrated in the following photo. The one-foot walkways between plots will be sodded with a bent and Kentucky bluegrass; the bent will be planted in the walkways in one direction, the bluegrass in the walkways in the opposite direction. Observations on the reaction of the Bermuda selections, both with a bent and a bluegrass should provide useful information. Bermudas, with otherwise desirable characteristics, which are too vigorous and thus invade the bent would be undesirable as fairway grasses for they would over-run greens in a short period of time. Secondly, let us consider the bluegrass strips planted adjacent to the Bermudas. Since we plan to establish the Bermuda in existing bluegrass it follows that the Bermudas must compete with, and ultimately over-come the bluegrass. If they cannot compete successfully with the bluegrass there would be no reason to attempt to establish them in the existing bluegrass fairways.

A third phase of our work will be carried on in our adjacent plots of B-27 bluegrass and Kentucky bluegrass. U-3 Bermuda will be planted into a portion of each of these plots early this summer. Since the U-3 Bermuda - B-27 bluegrass combination has shown real promise at Beltsville it may well serve as a standard on which we may rate other combinations or selections. Further, we can compare the U-3 Bermuda - B-27 bluegrass with the adjacent U-3 Bermuda - Kentucky bluegrass.

A fourth phase of the work will be to investigate those methods which are most practical for establishing our selections in the existing fairway turf. We must develop a method which is reasonable in cost, and one that will assure good establishment of Bermuda. Suitable methods for seeding grasses in the established turf must also be sought. In addition to satisfactory methods, we must also investigate the season of the year when the greatest success can be attained in obtaining a good stand. Our investigations last year indicate that Bermuda must be planted early in the summer if good stands are to be obtained.

A final phase of the work will be to investigate the fertility requirements necessary to establish and maintain suitable turf in the St. Louis region, for there has been little experimental work on fertilizer requirements for fairway turf in Missouri. Different turf combinations may well require different fertilizer treatments, just as different problems will be encountered at different clubs and in different parts of the state.

Needless to say, we cannot at this time predict what our success will be in developing a fairway turf in Missouri that will be more satisfactory than that now provided by Kentucky bluegrass. It is indicated by results obtained elsewhere that we must ultimately adopt a turf combination made up of a warm season grass, such as U-3 Bermuda, together with a cool season grass, such as B-27 bluegrass. The establishment of a satisfactory turf will require time and concerted effort.

The initial development of a turf more suitable than that supplied by Kentucky bluegrass will not solve all fairway turf problems in the region. It is probably that the maintenance of any turf we may adopt will require as much or more care than has been given to the existant, yet unsatisfactory bluegrass turf. The additional maintenance will be especially noticeable with regard to the application of fertilizers. It has been indicated that some of the clubs do not wish to spend money for fertilizing fairways. Yet proper fertilization must be practiced if suitable turf combinations are to be maintained on fairways.

The information gained in these investigations will be made available not only to clubs in the St. Louis region, but to clubs throughout Missouri and in adjoining states. Ultimately we hope to expand our program to include clubs elsewhere in the state, for example, Kansas City, Springfield, etc. We will not, however, be able to carry on the work at the Experiment Station at Columbia for no land is available for such work. Furthermore, we do not have the equipment and personnel required to carry on the work. It appears logical to us that the work should be done on golf courses where it can be observed by men trained specifically in turf work.

We at the University of Missouri admit our limited experience in the field of turf culture. Dr. Brown, of course has a wealth of experience in pasture work, but not in this type of turf work. We do believe, however, that we can be of real assistance in the development of a suitalbe turf. We could not, however, hope to establish a suitalbe turf in a reasonable period of time if it were not for the knowledge we may gain from the work being done here at Purdue, at Beltsville, and elsewhere.

In closing I wish to take this opportunity to express our appreciation for the financial and technical assistance received from the Midwest Regional Turf Foundation, the U.S.G.A. Green Section, and the participating clubs in the St. Louis District. I also wish to express appreciation to those greenskeepers who have done most of the physical work. Without the technical, financial and physical support this work would have been impossible.

# TURF RESEARCH IN MICHIGAN

J. Tyson

A turf research project was started on the campus of Michigan State College in 1930. The college recognized the importance of golf as a recreational sport and the need of research concerned with the problems of growing turf on golf courses. The problems of producing turf for lawns, parks, cemeteries, athletic fields, roadsides, and airports were included in this project, although the problems of golf course turf received the most attention.

The early studies consisted of (1) a test of the quality of turfs produced by several strains of colonial, creeping, and velvet bent selected by the U. S. Golf Association Green Section; (2) the effect of varying amounts of peat mixed with soil on the production of putting green turf; (3) the effect of varying sources of peat mixed with soil on the production of putting-green turf; (4) a study of the effect of varying proportions of phosphorus and potash with uniform nitrogen on the growth of Seaside bent grass; (5) the effect of varying sources of nitrogen with uniform phosphorus and potash on the growth of Seaside bent grass; (6) the effect of high calcium, high magnesium, and dolomitic limestones, sulfur, aluminum sulfate, borax, manganese sulfate, copper sulfate, zinc sulfate, iodine, and iron sulfate on the growth of Seaside bent grass; (7) the comparative effect of various mercurial fungicides on the prevention of snowmold, dollar-spot, and large brown patch on Seaside bent grass; and (8) a comparison of the lawn turf produced by varying mixtures of Kentucky bluegrass, Chewings fescue, redtops, Astoria colonial bent, and white clover in the open and under shady conditions.

College expansion necessitated the abandonment of this area in 1940. A new turf garden was started in the fall of 1941 in a more remote section of the campus.

The problems under investigation in this area were (1) the effect of various fertilizers on the growth of Chewings fescue; (2) a comparison of the effects of fertilizers containing organic and those containing inorganic nitrogen on the growth of Kentucky bluegrass; (3) the effect of various fertilizers on the growth of Kentucky bluegrass-white clover mixtures; (4) the effect of various maintenance methods (brushing, raking, and topdressing) on the production of putting green turf with Washington creeping bent; (5) a study of the production of turf with Emerald and Rantan velvet bents mowed at $\frac{1}{4}$ and $\frac{1}{2}$ inch heights; (6) a comparison of putting green and lawn turf produced by strains of creeping and colonial bents selected by the U.S. Golf Association, Green Section; (7) a comparison of the putting green and lawn turfs produced by a selection of bent seedlings resulting from accidental crossing of Washington and Metropolitan creeping bents and Piper velvet bent; (8) a study of the management, including fertilization, of Astoria colonial bent for fairway and lawn purposes; (9) a study of the turf produced by strains of Kentucky bluegrass and red fescues selected by the U.S. Golf Association

Green Section; and (10) a study of various chemical methods of weed control, both preplanting and vegetative spraying.

This area was abandoned in the fall of 1944 by further expansion of the college building program. Some plots have been maintained on the Soil Science section of the College Farm in which several strains of bent have been increased for future planting. All of the U. S. Golf Association Green Section selections of grasses were lost.

A new turf garden was established during the summer of 1948 on an area known as the River Farm. This is located four miles from the college grounds and should make a more or less permanent site.

Two areas were selected, one on Hillsdale coarse sandy loam and the other on Connover loam. Strips of Kentucky bluegrass and of creeping red fescue were planted on the Hillsdale area; and strips of Kentucky bluegrass and of Alta fescue on the Connover loam. It is intended to add strips of Astoria colonial bent to the area on Hillsdale soil.

Mr. Daniels, the fellow in charge of the Detroit District Golf Association - U.S. Golf Association - Midwest Turf Foundation fellowship, is studying the effect of various systems of irrigation and rates of applying water on the production of fairway turf with the four grasses on these soils. Moisture levels and times of application are being controlled through the use of the Bouyoucos soil moisture meter. Kentucky bluegrass, creeping red fescue, and Astoria colonial bent are growing in the greenhouse at the present time. Four levels of soil moisture are maintained through the use of the Bouyoucos soil moisture meter. Two levels of fertility are used for each grass at each moisture level.

A second area on the Hillsdale coarse sandy loam has been planted with Kentucky bluegrass, creeping red, Chewing's, and Alta fescue, and bent grasses to compare the types of fairway turf produced by each. Various strains of each and seeds from various growers are being compared in this test. The grasses are being maintained with three heights of cut and three levels of fertility. Strains of Bermuda grass which have been found growing year after year in this region are being tested for fairway uses alone and in combination with other grasses.

Two more areas are ready for planting this spring. One of these is to be used to test various strains of bent grasses for putting-green and fairway purposes. Approximately thirty crosses of Washington and Metropolitan creeping bent and Piper velvet bent have been selected from an area where they grew in turf maintained at lawn height. No fertilizer, water, or fungicides were used on this area. The grasses under these conditions were drought resistant and disease resistant. These grasses are to be tested in comparison with Washington creeping bent, the most commonly used putting-green grass in Michigan, the best strains selected by the U.S. Golf Association Green Section, and promising selections from golf courses in Michigan.

The other area is to be used to study the fertility requirements of putting green and fairway turfs. Varying levels of phosphorus and potash plus varying applications of nitrogen will be used. Levels of fertility will be controlled through the use of soil and plant tissue tests. Attempts will be made to correlate these with growth so that accurate standards of control of fertility can be developed. The fairway turfs will be maintained with two heights of cut.

New areas are to be prepared during the summer of 1949. One area is to be used to study the effect of soil reaction and of several plant food elements other than nitrogen, phosphorus, and potash on bluegrasses, fescues, and bent grasses. This is a continuation of the early experiment started in 1930 but during the past few years we have obtained much information about the behavior of crops to some of these elements. This knowledge is to be used in studying their effects upon the grasses.

The next area is to be used for studying the soil conditions in putting greens and fairways. Various mixtures of soils, peats, mucks, and other sources of organic matter are to be used for the surface six inches. Kentucky bluegrass, creeping red fescue, Astoria colonial bent, Washington creeping bent, and Arlington creeping bent will be planted in separate strips. The grasses will be maintained with varying degrees of compaction similar to that which it would receive under actual playing conditions. Studies will be made of the effect of compaction on the various soils upon the parosity, aeration, and drainage; and the resulting effect of these on the available plant nutrient supply and the growth of the grass. The effects of various preforating and aerifying machines will be studied to find what, if any, effect they have upon aeration, water and plant food penetration, drainage, nitrification, and the growth of the grass, including root penetration and ramification.

In addition areas of turf both for fairways and putting greens are to be maintained for the cooperative use of the Entomology department to study insect problems and for the Botany department to study diseases and weeds and their control.

In addition to these fine turf experiments the Soil Science department is cooperating with the Michigan State Highway Research Laboratory and the Michigan State Highway Soils Engineers on a study of the growing of turf on four sands and gravels with twelve different soil mixtures available for shoulder stabalization, and the resultant effect of the mixtures and turf on the stability of the shoulders. Studies are being made of existing road shoulders and of turf established to determine the best soil mixtures to use and the grasses most suitable for road shoulder turf.

The Farm Crops department has conducted and is continuing to study time of seeding, rates of seeding, seeding mixtures and management of turfs for lawns, airports, and general turf. The production of turf grass seeds in Michigan is also being widely studied. There is a comparatively large acreage of Chewings fescue seed now being produced in the state as the result of these experiments. The Farm Crops department are cooperating with the Soil Science department in the administration of the Turf Fellowship and in general studies of grass varieties and weed control projects.

Chemical weed control experiments with golf course turf were at one time conducted by the Soil Science department but since 1945 the major part of this work has been done by Dr. Grigsby of the Botany department. Dr. Grigsby has been conducting extensive experiments and demonstrations of weed control in turf as well as in the important economic crops of the state.

# PREDICTIONS FOR THINGS TO COME IN TURF MANAGEMENT

Fred V. Grau

I didn't have a great deal of time to prepare any notes for this particular talk, so we are just going to sort of discuss things this morning. I just got a letter handed to me, I was scheduled on the program at Iowa five times and here I have just received an invitation to give another 30 minute talk, making the 6th time. But I can't tell you how much I enjoy being like this. Feeling your enthusiasm, your desire for information and we are in this business to give you all the information we are able to gather from any place and every place. Part of that information comes from research and an awful lot of it comes from you fellows yourselves. We're able, through our travels, to study your conditions to help set up some of these research programs for coordinating information and to bring you the results, the information from all over the country. We have lots of confidence, you are a wonderful group and it is just a real pleasure to talk to you any time and everytime. I certainly want to give a great share of the credit and a pat on the back to Gerry Mott and his boys who have set up such a wonderful program and are really working for your interests. We are happy to be able to cooperate with Purdue, with the Midwest Regional Turf Foundation and to help you in every way we can, as we do.

At the present time we are actively cooperating with 24 State experiment stations. Not all to the same extent that we are cooperating with Purdue, Pennsylvania, Rhode Island, New Jersey, Michigan, Missouri, Tifton, Ga., Texas and Oklahoma, but in small ways and significant ways. And that is quite different than when I came in in August 1945. We've set this thing up in a rather short period of time and I think we have dug it on sound ground. We have been in a particularly fortunate position to integrate and coordinate this work on a national basis. Somebody has to do it and I am awfully glad that we're in a position where we can help. We would like to do more than we are doing but we're hampered by limitation of funds and limitation of personnel and some times we try to do more than we should and are happy to do it.

These cooperating research programs going on all over the country are investigating your problems and that is one reason why I am so glad we have designed these programs to answer your most pressing problems. After all the research program wouldn't be much good if it wasn't designed to answer the most pressing problems which you have.

There is a very weak link in our whole program. In our national program and in our state programs, and the weakest link that we have today is the extension teaching basis. I am going to bring this right out in the open because I know something of what I am saying. In February, 1935, when I left the University of Maryland and went into the Extension Service in Pennsylvania, I believe I became the first extension agronomist in turf in the United States. I spent all my time for about 10 years traveling the State of Pennsylvania, meeting the local association groups, meeting with garden clubs, service clubs and farmers in the interest of turf, taking the results of research from the college out to people in the State who were interested in turf of lawns parks, cemeteries and other turf interests and everything else and I saw, I have seen better since I left there, what happened during that 10 year period, the tremendous stimulation that it gave to the better turf program. The extension teaching phase of this turf program is just as important as the research phase. We can do research time on end but until that is taken out to the people who can use it it isn't of much value. It gets into files, it it gets into publications, much of that research is written in entirely technical terms and is not immediately useful by many of you who need it. So I am going to continue to press for an expansion of extension teaching facilities. There is just one key to that. You don't get a damned thing until you ask for it and that was exactly why our program was set up in Pennsylvania because members of the Turf Research Advisory Committee went to the Director of Extension and asked for that service because they knew they had it coming to them because they were tax payers. Extension Service is set up on a basis of tax funds. You're paying for that service whether you use it or not and there is a great deal of information there available to you if you ask for it. I don't want to put any extension service on the spot by what I am saying and I don't believe I am, because they are public servants, ready to serve those who ask for the service.

The next big thing we have to do, and we have a very good start on, is to train the leaders. I look at you, most of you are leaders in your communities, in the regions from which you came. One of the reasons why you are leaders is because you can come to the conferences and pick up more information than the boys who stay at home and you are looked to as leaders.

We have another job and that is to develop leaders in the research, extension and teaching fields. You can't do research on turf until you get some training. You can't teach turf courses until you've had some good sound training. So one of the things that we've set out to do is to train young men in this specialized field of turf and in the related sciences. You've seen Willis Skrdla and the rest of the boys here at Purdue and Bob Daniels from Michigan. We've got three boys in Pennsylvania, another at Oklahoma and we have 10 research fellowships set up over the United States where we are training men in this specialized field.

The first research fellowship that we set up soon after I came into the Green Section was at Penn State. The young man is all ready to sign his contract at a good salary to have a turf research program in Texas a year before he gets his degree. I think that is pretty swell for the soundness and the validity of the program we set up to train young men in this specialized field.

One reason we are able to get this kind of recognition at the Arricultural Experiment Stations today is because turf is recognized as an integral part of agricultural research. It is recognized as such primarily by virtue of the fact that the American Society of Agronomy has recognized turf and has set up a Section in the Society for the development of turf considerations. That has happened in the past three years. O. J. is a member of the Turf Committee of the American Society of Agronomy and we have a number of greenkeeping superintendents who also are on that Committee. Today you can walk into any experiment station in the country, talk to the Director about turf and he knows what we are talking about and is willing to listen because it today is accepted. I think we have made significant advances in that direction. We have at the present time some of the leading agricultural experiment stations engaged in this work and at the present time we are doing a pretyy good job of solving some of the fundamental problems. We do not have enough money behind us as yet for many of the states to go into this program and at the moment it isn't necessary so long as we have schools like Purdue, Michigan and Missouri here in the midwest working on this we are going to get a lot of work done. We are going to find, and this is one of my predictions, that we are going to have more and more tax money devoted to this phase of agricultural research because people are waking up to the fact that turf is big business. We've made a study in the American Society of Agronomy, it is very incomplete, as to the size and scope of the turf industry and just from memory I am going to cite a few figures. Conservatively, we estimate that there are 20,000,000 lawns - covering well over 1,000,000 acres. There are about 1,000,000 acres of cemetery turf, half of which has already been developed into turf. There are between 5 and 7 million acres in airfields and military establishments. We don't know as yet how many acres of turf there are on highways but we know roughly that there are some 3,000,000 miles of highways in the United States, some of which run 10 to 12 acres to the mile. Now that begins to run into tremendous figures and we have a real problem ahead of us there. There are some 20,000 individual athletic fields in the country - running from 2 to 15 acres in extent. We don't know yet the whole extent of that picture. So we can begin to see that we are in something a lot bigger than any one of us. The importance of grass to international economy is emphasized by the new United States Department of Agriculture Yearbook entitled "GRASS" and if every single one of you do not have a copy of that on your library shelf then you are not up to snuff. That is one of the required books in a greenkeeper's library today. The U.S.D.A. Yearbook entitled "GRASS" and you'd better talk fast to your congressman and get a copy through him if he has any left. I believe the Superintendent of Documents is already out - he had 30,000 copies - I believe they are all sold and there is going to be a squeeze and there will not be a reprint of that particular year.

I can predict this with a great deal of satisfaction, that within the year there will be a book on Turf Management of Golf Courses, the first one to be written since 1923 when Piper and Oakley published their book on Turf for Golf Courses. I'm predicting it because the United States Golf Association has provided the money for it, Prof. Musser from Penn State was hired as the editor during his sabbatical leave and O. J. Noer, Herb Graffis, Marshall Farnham and myself constitute the editorial board on that book. We think it is going to be something, not only for practical turf superintendents, but also as a college text book. I think it can be used in both capacities because it will be based on sound principles of turf management. It will be just about the end of 1949 before we can get that to the publisher because they are so terrifically busy.

We see in the discussions here and elsewhere in the country that one of the things we are going to be studying very seriously the next few years is soil physics and soil mechanics. We never have studied our soils under our specialized turf to the extent that we should. We've worked too much on the top and now we're getting down to the real fundamental root of things and we are going to see a lot more discussion and study on soils. It is very evident in the Session here that so many of the sound fundamental principles of soil physics and soil mechanics simply are not understood. I confess to a great deal of ignorance on soils even though I studied under some of the best soil men in the country and still I don't know as much about soil as I should. And many of you have not had that same opportunity to study under leading soil specialists. So you are going to have to do a lot about it the hard way and we are going to help you all we can - by we - I mean all of us in turf work all over the country.

We are going to see a big development in grasses. The plant breeders in the country have just begun to study grasses for turf. The emphasis has been on forage and pasture and that is as it should be. Unless we have these rich beefsteaks to eat we are not going to be quite so happy at these conferences because we like good beefsteak now and then and we want those critters to have plenty of good nutritious grass and that is the basic economy of our country - good agriculture. If we didn't have good agriculture our jobs wouldn't be worth a plugged nickel. So we have got to work with them, and the forage and pasture work, especially in plant breeding, is coming closer and closer with the breeding of grasses for turf, because today some of the outstanding turf grasses that are showing promise in the entire south have come by as a result of outcasts from a pasture breeding project. And that is exactly what we want to do. We want to get more of those highly trained plant breeders, and you have seen Kenny Payne, one of those who has been highly trained in the grass breeding here at Purdue and others like him scattered over the country. Those boys get together every American Society of Agronomy meeting, they compare notes and they discuss techniques and methods and all of that and we are going to go a long way in the next few years in grass breeding. It has already been pointed out to you that any breeding program is a slow, long-time procedure. In the breeding process, in the selection process of these grasses we're going to find the grasses that are more highly resistant to disease and through our soil mechanics and soil physics and controlled moisture, we are going to find that we can grow many of these grasses virtually without the necessity of frequent applications of chemicals for the control of disease, now developed as the very necessary thing because so many of our grasses and soils were sick. We are learning that some grasses are highly resistant to the attacks of various insects. The use of insecticides has come about because of the particular problem at hand and we're learning as we go along that some of these grasses and some of these combinations virtually require no insecticides in order to keep them free of insects. That is quite a bit in the future and I'm looking ahead now, it is not here with us yet, but we see indications and we can predict that these things will come about.

One of the big things we've got to study in the future is wear resistance of grasses. You saw some of those pictures I showed, some that Noer showed, how the grasses wear out. Why, we don't know, maybe it's in the grass itself, maybe its in the soil, maybe its the fertilizer program and we're just beginning to piece together a lot of that information. And if we can develop a turf that is highly resistant to wear and can recover rapidly after wear takes place, then we're going to be really producing better turf. You fellows are going to gain in stature and recognition as you extend your influence, not in your particular field of greenkeeping, but as you go outside of your field and help others not so fortunate as you. One of the things I want to stress particularly is that you fellows are possessed of the greatest fund of practical knowledge of growing grasses of anybody in the country. A great many of the superintendents and gardners or even janitors on athletic fields - they just don't have the information that you do and that is one of the reasons why the athletic fields are an utter disgrace, even on some of our leading colleges and universities - the athletic field turf is an absolute disgrace and we fellows can do a lot to correct that situation because, by and large, the people in charge of athletic fields do not have a national association or local and regional association such as you whereby they can gather that information, and furthermore, they don't have the kind of men in charge of those fields that can use that information. So I am asking, and actually predicting, that you're going to be busier and busier outside your particular field extending the knowledge that you have and giving it to others. That is the only way you can have more of anything is to give it away. The more you give away, especially if it is knowledge, the more you have because if you work with other people and with other types of turf you are going to learn something you don't know.

I predict quite a future for the mixture of the cool-season and warm-season grasses. I have been talking quite a bit about that and am glad to be on the program for the prediction of things to come because we're not there yet and every place I go I see evidences of natural mixtures of cool-season and warm-season grasses. Among the cool-season grasses with which we're most familar are the bermuda grasses and the Zoysia grasses. When we were in California for the 20th Annual G. S. A - the National G. S. A. Conference & Show, we saw all through California natural mixtures of cool-season and warm-season grasses. I don't believe anyone out there actually realized what they had because there was very little evidence of anybody doing anything about it in order to improve that situation. In Nashville last November, we saw one golf course with fairways of bermuda and at that time the bluegrass was coming in naturally and was providing that green winter color that all of us want. We have been telling you about some of our mixtures we've been putting in at Beltsville. Mixtures of bermudas and Zoysias with bents, fescues and bluegrasses and they look awfully promising. I cannot predict here how fast they'll spread, how we should manage them, how we should fertilize them in order to maintain that desirable balance of those two different grasses. We do know that at the Nebraska station they have been studying the warm-season and cool season grasses for many years in ralation to pastures and it is working out. Every once in a while we pick up an article from one of their agronomists out there showing some new evidence of further progress in those desirable combinations whereby we have a much longer season of use regardless of what that use is. That is one thing in which we are particularly interested, and that is to extend the use of any of our turf areas.

A great many of us have a lot to learn about management, the actual management of the turf itself. We see so much evidence of indifferent management even by intelligent men. I am not trying to hurt anybody because we point them out in an impersonal way in our pictures and in our articles. There is a great deal to be learned about management, such as fertilization and all that goes with it. We talk about management and you talk about men. I think Herb Graffis puts his finger right on the problem in that letter to me in connection with my article in Golfdom in which we poke a finger at the club officials when we said that the problem today is not necessarily grass but it is management and man-power. None of us grow any younger - a lot of us have been in this business for a long time. Do we have men who are better than we are following us to take our places? Ask yourself that question and find out what kind of an answer you've found. Do you have somebody following you that you're training, telling him all you know, sending him to school so that when he takes over your job when you retire he knows more than you do? That is an ideal situation and that is what I hope to do with my assistants and I am sure that Gerry Mott feels the some way and so does Jim Tyson, that when his boys get through they'll know all he knows and something besides.

We are seeing tremendous developments in the machinery line. You just can't help but be impressed that this is the machine age and it is going to continue to be so. The golf course architects finally are recognizing it and are building their courses so that golf is not only enjoyable but the actual physical plant can be maintained by machinery with the minimum of man-power and the maximum of efficiency through the use of machines. We have to do a lot of things mechanically simply because the level of salaries, the level of pay is not sufficient to attract the best men in the field and we are forced to mechanical devices to cut down on the number of men we have to hire in the hopes that we will have better men to do the work. I could spend a lot of time on it. I'm sorry I didn't get into the machine demonstrations and talks here because from what I hear they have been very helpful and enjoyable.

I touch on this item of incentive. We've got to provide incentive so that better men than we are will follow in our footsteps. I want to leave you with that thought because when I started in this work in 1927 at the University of Nebraska, one of the first questions I asked my professor, Dr. Keim was, "What are my possibilities if I follow in this type of work, what can I expect in the way of remuneration, salary and living advantages?" Well, he didn't know too much about it but he said, "I hear that some of the better greenkeepers in the east are getting around $5,000 a year." I remember that figure because it was a round figure. I didn't think at that time that there was that much money in the world. But that provided on of the incentives to get into this work. Because it offered something better than I ever hoped to be able to get because I was farm born and raised and we just didn't think in those terms at that time. But as I got into the work I virtually forgot about the monetary incentive because the work was so tremendously interesting. Recently I talked to a man who is representative of many who just wondered why he ever stayed in the greenkeeping racket, especially during the war when he couldn't get help, he couldn't get machinery, he couldn't get fertilizer and he was just run ragged but he's still in it. Why? Because he loves the work and you can't be a success in anything unless you absolutely and sincerely love what you're doing. So we can talk about monetary incentive, and it is important, but the reason most of you are here, I'm sure is because you love what you are doing and so do I. Thank you.