Chelated iron compounds are new products which are finding some use on turfgrass areas. These materials work better on acid than on alkaline soils at the present time. Unfortunately much of the trouble with chlorosis in turfgrasses occurs on alkaline soils. This is a very fertile field for research and it is to be expected that scientists in the field of chemistry will not be long delayed in the development of chelated iron compounds which will be equally effective on alkaline as well as acid soils.

Irrigation is another important phase of management studies. Some of the most important preliminary work on turfgrass irrigation has been done at the University of California at Davis. Studies at this station have called attention to some of the fundamental principles involved in turf irrigation. Among these are the rooting capabilities of grasses in terms of depth; the water intake capacity of the soil; the water storage capacity of the soil; and the water use rate of plants in a particular area. Recommendations based on studies at Davis may be briefly stated in these words: "Water infrequently and water enough." There is a great amount of work to be done in connection with the irrigation of turfgrasses. It is believed that the statement of these principles underlying the practice of irrigation is a significant step in learning to irrigate more effectively and efficiently.

Soil managment as a phase of turfgrass management is relatively new. It has been customary to think that there was little one could do in the way of soil management under turf. Aeration, or the cultivation of soil under turf, has become a standard maintenance practice within relatively recent times. The relief of compaction, or the maintenance of good tilth, helps water infiltration, fertilizer penetration, and the diffusion of oxygen in the root zone. As cultivation is important to field crops so is aeration beneficial to turfgrasses.

There have been numerous studies which have made contributions to the building of synthetic soil mixtures for putting green purposes. The studies indicate that clay should fall within the limits of four to eight percent by volume of the total mixture. The peat content should be kept somewhere between 10 and 15 percent, by volume. The remainder of the mixture should be sand. Extremely coarse particles are not necessary in the sand, but the very fine sand and silt fractions should be eliminated if possible. Studies at UCLA indicate that the placing of a sand layer over soil will reduce compaction and will also facilitate water intake.

Thatch control is another phase of management which has received a considerable amount of attention. The principles which contribute to the formation of thatch are being studied and practical means of eliminating thatch are being investigated concurrently. The Rhode Island Experiment Station reports that Piper Velvet bent develops less thatch when topdressed with both lime and compost than when it is untreated or when either of the treatments is left off. The use of vertical mowing machinery has found a place on many golf courses and it is a practical method of eliminating or reducing thatch.

PEST CONTROL

Diseases

Considerable progress has been made in the matter of controlling diseases. Recent studies at the Georgia Coastal Plain Experiment Station have resulted in the positive identification of a disease which attacks ryegrass. This disease is

Pythium aphanidermatum. This station also reports that many of the southern turfgrass diseases which resemble northern turfgrass diseases insofar as symptoms are concerned, are actually caused by different organisms.

F. L. Howard, of the Rhode Island Agricultural Experiment Station, reports that malachite green, one of the components of the product Auragreen, is a specific control for pythium. The Rhode Island Station also reports the development of a fungicide for controlling a number of turfgrass diseases. This "broad spectrum" fungicide is a complex synthesized from several fungicidal materials.

The Washington Experiment Station reports excellent snow mold control through the use of phenyl mercury acetate at the rate of 2 ounces of 10% material per 1,000 square feet of turf. The New Jersey Experiment Station reports that mercury and cadmium fungicides have been most consistent for copper spot control.

Weeds

There have been no startling discoveries in the field of weed control in turf. However, significant progress has been made. Crabgrass control has become practical on areas of high value through the use of phenyl mercury acetate materials. Pre-emergence crabgrass control materials show considerable promise, though they are not yet used extensively. The Rhode Island station reports 100 percent crabgrass control through the use of phenyl mercury acetate and adequate fertility levels. At least two stations have reported that chlordane is an effective crabgrass control material. Chlordane, of course, is normally considered to be an insecticide but it appears to have some herbicidal effectiveness. Kansas State College has demonstration areas where compounds containing lead arsenate have controlled crabgrass. One of the newer herbicides for use in crabgrass control is disodium methyl arsonate. This material is likely to be used more extensively in the future.

Poa annua is another weedy grass which is receiving a great deal of attention. Studies at Purdue indicate that lead arsenate is effective in preventing the development of *Poa annua* plants when phosphorus levels are low. It has been suggested that arsenic interferes with the function of phosphorus in some manner. Workers at the Georgia Coastal Plain Experiment Station suggest that *Poa annua* may be kept vegetative by the use of growth regulators.

Comprehensive life history studies of *Poa annua* are being pursued at the University of Illinois. V. T. Stoutemyer, of UCLA, reports that he and his associates have collected numerous types of *Poa annua* and have found many variations. They report perennial forms of *Poa annua* and this finding is also reported by Daniel at Purdue.

Workers at Rutgers University have found that 2,4-D, used in small quantities, will increase the activity of potassium cyanate and sodium arsenite in controlling crabgrass.

Maleic hydrazide has found considerable use in turf management. It has been used in the vegetative propagation of grasses into existing turf. Workers at UCLA report that it reduces competition sufficiently to allow the introduced turf to become well established. It has been reported by workers at Rhode Island to be useful in controlling vegetation in hard to mow areas. Preliminary studies at the Texas Agricultural Experiment Station suggest that the use of maleic hydrazide may be a first step in the killing out of rhizomatous perennial species, such as Bermudagrass. The effect of maleic hydrazide is one of upsetting normal metabolic functions of

the plant. If leaf surfaces are subsequently destroyed by herbicidal oils, or by other contact sprays, plants will usually not recover.

Methyl bromide is an extremely useful material for the fumigation of areas where it becomes desirable to kill out all existing vegetation. Original research along this line was done by Elder at Oklahoma A. & M. College.

Substituted urea compounds have been used to some extent in controlling weedy species in turf areas. Their definite role, or place of usefulness, has not been definitely determined. White clover may be controlled by means of 2,4,5-T.

Insects

There has been a great deal of progress in the development of systemic insecticides and of organic phosphate insecticides. These are very powerful materials and are also quite dangerous. They have, therefore, not been recommended for use on most turf areas. Chlordane continues to be the most used insecticide in turf. Aldrin finds a place for control of sod webworms and similar leaf feeding insects. In alkaline soils, dieldrin appears to be more effective over a long period of time than chlordane for grub control or for the control of soil inhabiting insects.

A contribution that may be of rather extensive importance has been made by Polivka of Ohio State. He reports that Japanese beetles do not build destructive populations when pH is slightly acid or higher. This finding may lead the way to the control of other insects through manipulation of pH or through cultural methods.

Nematode studies are in progress at Florida and in Rhode Island, and in Georgia. The extent of nematode injury in turf is unknown. It is suspected that these pests may do considerable damage.

FOR THE FUTURE

A greater interest, awareness, and appreciation of good turf is evident throughout the country. It appears certain that demands for better turf, managed efficiently and economically, will increase. As these demands continue to grow, greater pressure will be exerted upon the research workers to provide new knowledge and new tools which the turf manager may use in practice. Let us expect turfgrass research to increase in volume and in quality in the immediate future.