California Turfgrass Culture

FORMERLY, SOUTHERN CALIFORNIA TURFGRASS CULTURE

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Present Status and Future Problems in Turf Disease Research

R. M. Endo

Although turf grass is reported to be subject to the attack of over 100 different fungus pathogens, only ten to fifteen are apparently capable of causing appreciable damage in the United States to lawns, golf greens, athletic fields, and other areas planted to turf.

Work is being carried out at Los Angeles and Davis to establish the prevalence, seasonal occurrence, and destructiveness of the various turf diseases occurring in the different climatic zones of California. Such records as are available on disease occurrence, largely for southern California from 1952-1958, indicate that the most common turn grass diseases appear to be Brown Patch, caused by *Rhizoctonia solani* Kuehn, Dollar Spot, caused by *Sclerotinia homeocarpa* Bennett, fading out, caused by species of *Curvularia,* melting out, caused by species of *Helminthosporium,* rust, caused by species of *Puccinia,* and damping-off, caused by species of Pythium.

Exact and detailed information is lacking concerning the seminal and nodal root systems, the anatomy of seminal and nodal roots, the seasonal growth cycle, the length of life of seminal and nodal roots, and the factors influencing their initiation, development, and distribution in the soil. In order to appraise the disease situation on turf grass roots, such information is urgently needed. Lack of basic knowledge of the various turf diseases has handicapped the development of control measures. At present the control of turf diseases is based almost exclusively on the use of fungicides. Other methods of control should be investigated. This can be accomplished only by means of a thorough knowledge of each disease and the factors affecting its development. Numerous factors such as temperature, moisture, soil fertility, soil type, light, pH, etc. have been shown to influence the development of plant diseases of crop plants. The factors affecting the development of turf diseases are extremely complex and very poorly understood. This complexity results from the very nature of turf culture and the use to which turf is employed.

The culture of grass plants for use as turf is unique. There is no system of agriculture that is more intensive and demanding. Once planted, turf is meant to be relativeiy permanent. And yet nearly all accumulated agricultural experience indicates that a monoculture crop system is detrimental to the growth of successive crops. In addition to the evils of continuous culture, turf is subjected to all forms of abuse and maltreatment, and yet is expected to grow and thrive. Some examples of this abuse are (1) regular removal of a large portion of the photosynthetic area of grass plants by frequent mowing, (2) soil compaction as a result of human traffic, cultivation machinery, vehicles, athletic activities, etc., (3) the continual accumulation of grass residues, (4) irregular watering practices, (5) irregular, infrequent, and sub-optimal fertilization, and (6) frequent application of herbicides, insecticides, and fungicides.

The relation of these factors to the maintenance of healthy and vigorous turf needs clarification. It is obvious that the majority of turf areas are not maintained in a vigorous, actively growing condition. The roots of most turf plants are very short and sparsely developed. As a result, the plants are in a weakened condition and are probably much more susceptible to the attack of parasites that thrive on weakened and dead tissue. Equally important is the fact that the ability of weakened plants to form new leaves, stems, and roots is greatly reduced compared with vigorous, healthy plants, and that this ability is still further impaired by infection. Although vigorous, actively growing plants are more susceptible to the species of rust and powdery mildew that attack grass, these pathogens generally cause relatively little damage in California and can be controlled rather effectively with fungicides. Thus, the maintenance of vigorous, actively growing turf appears to be the first requisite for disease control. It is therefore essential that the relation of the various factors mentioned previously to the growth or decline of turf be thoroughly established. The thesis that weak plants are more susceptible to the attack of facultative parasites should be thoroughly investigated and documented.

The ultimate example of a demanding management regime that is imposed upon turf is found in a typical golf green. In California, golf is played the year round. Since the turf receives no respite from the continual wear and tear of constant play, this fact undoubtedly accelerates the decline and death of turf grass. From the standpoint of disease, the temperate climate undoubetdly permits the survival and perpetuation of disease organisms at a higher level than in regions that are subject to freezing and sub-freezing temperatures,

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Probably the most far reaching effect of a temperate climate is that the grass must be clipped the year around. The golf green is usually mowed six times a week to a height of 3/16 of an inch. During warm periods, the growth of the bent grasses (cool season plants) slows down and the greens may be mowed at 3/16 to 1/4 of an inch five or six times a week. Because the leaves and stems are removed in the mowing operation, the plant is left with only a fraction of its photosynthetic area, and therefore its ability to synthesize sugars, proteins, and foodstuffs is greatly reduced. A severe restriction of root growth follows, and the grass is greatly reduced in vigor and growth. This effect is most pronounced in the summer, since high temperatures are unfavorable for the growth of the cool season bent grasses. In view of this relationship, studies are being conducted on the relation of clipping height and frequency of clipping to a possible increase in disease susceptibility.

All areas of turf are subject to soil compaction. The problem is particularly acute on golf greens, polo fields, bowling greens, and athletic fields, and least severe on home lawns and cemeteries. Compaction results in unfavorable soil conditions in relation to oxygen, carbon dioxide, and water by reducing the number and size of pore spaces, and thus the infiltration of water, water drainage, and air exchange. In extreme cases, essentially anaerobic conditions may be established. From field observations it is obvious that turf grows poorly in compacted soil. It is surprising, therefore, that no one has established whether or not bent grass roots and other grass roots require oxygen for their proper functioning. Nor has anyone determined the extent to which the oxygen supply in soils under various conditions is sufficient for normal plant growth, (and) the activities of microorganisms that function in the decomposition of organic matter, the mineralization of organic forms of nitrogen, etc. Plants growing in compacted soil tend to be weak and non-vigorous and appear more susceptible to disease than healthy vigorous plants growing in well-aerated soil. It is also possible that severe oxygen deprivation may greatly impair the normal functioning of roots by altering the selective permeability of the cells, reducing water and nutrient uptake, etc. Under water-logged conditions in compacted soil, the roots of turf grasses and frequently brown in color and apparently dead. Many golf greens are commonly over-watered. The interaction of water and oxygen appears to be an important one, since the solubility of oxygen in water is low and decreases with increasing water temperature. Another problem that requires investigation is the influence of different levels of oxygen and carbon dioxide upon the survival and growth of the various pathogens in the soil.

A problem peculiar to turf culture is the continual accumulation of dead undecomposed stems and leaves at the soil surface. This undecomposed organic matter is called thatch. When the undecomposed *or* partially decomposed stems and leaves occur below the soil surface, it is called mat. It appears to be an accepted fact that the undecomposed layers are detrimental to the growth and culture of turf because they act as barriers to the movement of air and water. Unfavorable conditions exist in the layers of thatch and mat for organic decomposition by soil microorganisms. Such conditions may also be unfavorable for plant growth. If the unfavorable factors can be determined, it may be possible to correct them and establish conditions favorable for decomposition. It may even be possible to "inoculate" the thatch with organisms that are capable of utilizing the thatch as food and that are either parasitic or antagonistic to the fungus pathogens. This approach should be investigated as a means of securing disease control.

The literature contains many statements to the effect that different fungus pathogens are able to survive and maintain themselves in the thatch. Exact information is needed on this question. In addition, the effect of thatch on the microclimate at the soil and turf level, and its attendant effects on the epidemiology of the various turf diseases has received scant attention. Such information is (badly) needed in order to understand the factors responsible for the appearance and disappearance of the various turf diseases. For example. various investigators have studied species of *Helminthosporium* attacking cereals and those attacking rice. They found that they produced spores during a few hours of the day and during a few months of the year only. The species of *Helminthosporium* attacking turf grasses probably exhibit a similar phenomenon. If such knowledge were available, it should be possible to spray with fungicides only during these periods of the year.

The possibility that grass residues might have adverse influences on the growth of turf, particularly on the roots, needs investigation. That crop residues exert such effects on certain crops has been shown by various workers. Various causes have been advanced by investigators for this effect: (1) depletion of nutrients or immobilization of nitrogen by microorganisms during the decomposition process; (2) alterations of the microbiological balance in such a way that the survival of the pathogens is favorably effected; and (3) the adverse effects of toxins secreted from living roots and underground stems, or by the liberation from plant residues during their decomposition. Some evidence has been obtained recently by several workers that timothy and rye form such toxins during the decomposition of their residues. The possible role of toxins to root browning and root degeneration is being investigated at the present time.

Top dressing of golf greens has long been a standard practice on most golf greens. Top dressing consists of a prepared mixture of soil (usually containing a high percentage of sand) which is spread over turf areas for the purpose of smoothing the putting surface, adding to the nutrient-supplying ability of the soil, and to modify unfavorable soil conditions. Unfortunately, the

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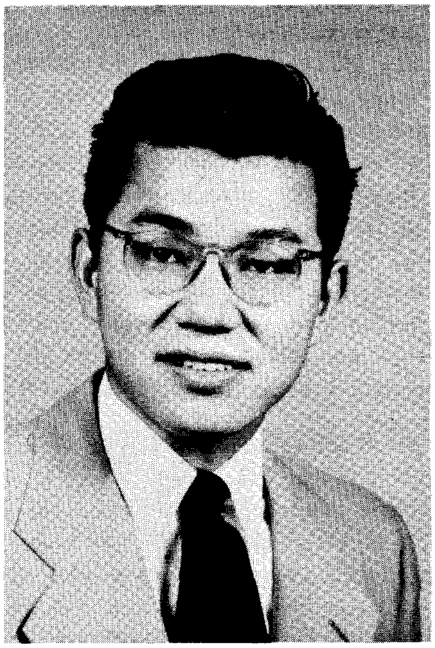
practice may do more harm than good if it results in layering and the introduction of plant pathogens. Layering consists of layers of top dressing alternating with layers of buried, partially decomposed stems and leaves (mat). These layers form an interface and may form an effective barrier to the movement of water and nutrients. The rooting depth of the grass appears to be seriously restricted in layered soils. Since weak, shallow-rooted plants appear to be more susceptible than healthy plants to the attack of grass pathogens, the role of layering should be investigated.

Very little information is available on the relation of nutrition, balanced or imbalanced, to disease incidence, disease susceptibility, and disease development in turf grass, Perhaps of even greater importance is the influence of the above factors on the ability of plants to initiate and maintain vigorous new growth following infection, i.e., on the ability of plants to recover from disease. Information is needed concerning the actual nutrient requirements of turf and the seasonal fluctuation in nutrient requirements that is associated with seasonal growth cycles. Turf nutrient experiments should consider the growth of roots as well as the growth of foliage and stems. It should be obvious that grass plants with roots close to the soil surface must be fed more frequently than plants with a deep root system. A method of applying nutrients should be devised that would supply the plants with a constant, even supply.

There is some evidence that certain herbicides, insecticides, and fungicides that are used commonly on turf may actually injure the turf and that this injury may predispose the plants to infection by plant pathogens. This problem is being studied at Los Angeles.

The previous discussion has emphasized the unique status of turf with respect to its cultural and management problems and their possible effects on turf diseases. One of the first requisites of a disease control program for turf is to determine the role of the various factors discussed to turf and its diseases. If weak, non-vigorous plants are found to be more susceptible to the attack of certain parasites than are healthy vigorous plants, a rational solution would be a system of growing whereby the maximum growth and vigor of turf foliage and roots can be easily established and maintained. This would mean growing turf in a certain type of soil mix (containing a high percentage of sand of a certain grade and size, a very low percentage of clay and silt, and a variable amount of organic matter in the form of either sawdust, peat, rice hulls, etc.) in order to reduce or eliminate soil compaction (thus assuring favorable oxygen and water relations), thatch accumulation, and salt accumulation. Such a system has been recommended for the past several years by Dr. 0. R. Lunt and Dr. V. Youngner. Regular bi-weekly or tri-weekly applications of very dilute liquid fertilizers by means of an injection-irrigation system would be a means of assuring a constant and adequate supply of nutrients, and it would also reduce the over-watering and salinity problems.

Dr. ENDO Joins Plant Pathology Staff



Dr. Robert M. Endo recently joined the staff of the Department of Plant Pathology at UCLA where he will conduct a program of research on diseases of turf and woody ornamental plants. He succeeds Professor P. A. Miller who retired in 1958.

Dr. Endo is a native of California and attended elementary and secondary schools at Los Altos and Mountain View, California. He received his B.S. degree from Rutgers University in New Jersey in 1950, and both his M.S. and Ph.D. degrees in Plant Pathology from the University of Illinois in 1952 and 1954, respectively. During the past four years, he was with the U.S. Department of Agriculture stationed at the University of Illinois, Urbana, Illinois. His work there was concerned primarily with virus diseases of cereals. Dr. Endo is married and has two children.

Southern California Turfgrass Institute

Approximately 250 turf-minded persons attended the Southern California Turfgrass Institute, held on Tuesday, October 20, 1959, at the Virginia Country Club in Long Beach, reports Richard G. Maire, University of California farm advisor of Los Angeles County.

Sponsored by the University of California Agricultural Extension Service and the Southern California Turfgrass Council, the meeting featured an excellent roster of speakers including nationally-known agronomists and research men. Fertilization of turf was the theme of this year's institute and each speaker approached the problem of fertilization in relation to various nutrient elements and cultural practices.

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Thirty Years of Turf Grass Soil Testing *

0.J. Noer
Milwaukee Sewerage Commission
Milwaukee, Wisconsin

Quick testing methods for soil reaction are accepted universally *as* the basis for lime usage. Some question and others champion the value of quick testing methods for measuring fertilizer requirements. The results can be misleading, or they can be useful tools, depending upon the method of sampling, the choice of solvent used to extract readily available plant food elements, and how the results are stated, which means the scale or way the amounts present in the soil are expressed.

The use of sampling methods which are satisfactory for farm crops and the use of very weak solvents are responsible for many erroneous recommendations. Tests may show low levels of phosphorus and potassium, yet their use in fertilizer may not have a marked effect on grass growth.

Since 1928 the laboratory of the Milwaukee Sewerage Commission has tested about three thousand soil samples each year. Samples have been from turf grass areas mostly. Tests include soil reaction, and amounts of readily available phosphorus, potassium, calcium, and magnesium. Soluble salts are determined on all samples from arid and semi-arid regions and otherwise where saline or salt damage is suspected. Nitrogen is not determined because existing quick tests are not satisfactory for grassland areas. Need for it can be judged by turf performance. Poor color, thin turf, slow rate of growth, and the presence of weeds and clover are the customary signs. Grass tissue testing may be the better answer for nitrogen. At best, this test can only disclose an approaching shortage by several days at the most.

Aside from reaction, quick soil test results serve as an inventory of soil fertility levels. Used that way they can be a useful guide in devising an effective fertilizer program.

Soil reaction can be determined in the field by any one of several good, inexpensive test kits. Solutions should be reasonably fresh. Unless the bottles used for the solutions are weathered by the manufacturer, the pH will be too high. The indicator solution must remain in contact with the soil for a sufficient time to develop maximum color before it is matched with the color chart.

Most of the field tests for soil reaction depend upon a dye which changes its color based on reaction expressed as pH (potential of hydrogen). The scale is from 0 to 14 with 7 representing the neutral point. Figures below 7 denote increasing acidity, and the higher ones increasing alkalinity. Differences are in units of 10, so pH 6 is ten times, pH 5 is one hundred times, and pH 4 is one thousand times more acid than neutral. The same differences prevail for figures above pH 7, which are in the alkaline range.

Soils which are more than moderately acid, that is, below pH 5.7, definitely need lime and its use is justified without regard to any other factor. Lime may be beneficial when the soil is slightly acid, in the range of pH 5.7 to 6.2, especially when Kentucky blue grass predominates.

When lime is needed, a determination of available calcium and magnesium is desirable. If calcium is low (below 4,000 to 5,000 pounds per acre) heavier liming is justified. The rate should be 25 to 50 per cent more than is suggested in the table. The determination of magnesium is important also. Some acid soils may be so deficient in available magnesium (less than 1,000 pounds per acre by the Truog method) that grass growth is retarded as a consequence. Then a dolomitic type of limestone should be used. One containing not less than 20 to 30 per cent magnesium, reported as the oxide should be applied.

There are several kits on the market for soil nutrient testing. Solutions must be renewed frequently, otherwise results will be erroneous. The safer way is to send representative soil samples to a qualified soil testing laboratory. Their trained technicians use good equipment and freshly prepared uncontaminated solutions. Results should be interpreted by an agronomist who is familiar with soil testing methods and experienced in turf grass management.

The big difference between the various soil testing methods is in the strength of the solvent used to extract the soil nutrients. A small amount of soil is extracted with agitation for a definite period of time. The extracting solution dissolves all the water soluble nutrients, and the easily soluble ones which become readily available for use by grass. Some extracting solutions are too weak. Then the test does not distinguish between a soil which is deficient and one which contains phosphorus and potassium in adequate amounts.

Fairways at Pickwick in Chicago responded to an application of phosphate fertilizer. Those at nearby Evanston Golf Club did not. Soil samples were collected to a uniform depth of 3 inches from three fairways at both places. Phosphorus was determined by the Truog, the Purdue, and the Spurway methods.

Purdue and Spurway report results as very low (V.L.), low (L.), medium (M.), high (H.), and very high (V.H.).

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**Part of a talk presented at the 1959 Southern California Turfgrass Institute.*

Truog uses pound per acre designations with 75 being adequate for fairways. The results were as follows:

		Truog	Purdue	Spurway
Pickwick	Sample 1	10 lbs.	V.L.	L.
Pickwick	Sample 2	10 1 bs.	V.L.	V.L.
	3	25 lbs.	V.L.	L.
Evanston	Sample 1	90 lbs.	H.	None
Golf Club	Sample 2	90 lbs.	H.	None
	3	100 lbs.	H.	None

The Truog and Purdue methods showed need for phosphate fertilizer at Pickwick and an ample supply at Evanston. Tests agreed with grass response to fertilizer. The Spurway method made no distinction. Testing with this method makes every soil need phosphate fertilizer, excepting possibly those with an unusually high amount of available phosphorus.

These results show the necessity for using a good method, one which distinguishes between a soil of low and one of high phosphorus content. The Spurway method does not do this. Likewise, the Morgan method, the one used most, fails frequently on grassland soil samples because of its weak extractant. It spots the low ones, but often indicates a need for phosphate not verified by actual field response.

Existing methods are not too satisfactory for testing soils containing carbonates, because the calcium or other carbonates exhaust the acid in the extracting solution. Several other kinds of solutions have been proposed and may be the answer for calcareous soils.

The Truog and Purdue methods have been satisfactory for potassium also, but that was not true of the Sputway method and of Morgan method in many instances.

Amounts of phosphorus and potassium decrease with soil depth on grassland areas because the soil is not disturbed after turf coverage is obtained. Both are fixed near the surface. Failure to appreciate this fact has been responsible for misleading results even with the better soil testing methods.

Samples were taken on a fertilizer plot at Blue Mound Country Club in Milwaukee. Sampling depths were 1 1/2, 3, and 4 inches. Available phosphorus readings by the Truog method were as follows:

1 1/2 inch sample	65 pounds
3 inch sample	35 pounds
4 inch sample	25 pounds

On the basis of 75 pounds as adequate, phosphorus supply is reasonably good in the 11/2 inch depth sample, but would be considered low in the other two samples. Yet samples were collected from the same spot, sampling depth being the only difference.

Superphosphate, 20 per cent grade, was used on two plots at Tuckaway Country Club in Milwaukee at 600 and 1,200 pounds per acre. The original turf was exceedingly poor, but no noticeable improvement occurred as a result of phosphate or potash applications. However, heavy nitrogen feeding made a vast difference in turf density and growth.

A year later samples were taken representing depths of O-inch to l-inch, I-inch to 2-inch, and 2-inch, to 3-inch. They were tested by the Truog method. Results below show that most of the phosphate was fixed in the top two inches of soil.

Sampling Depth	Available Phos. lbs. per Acre		
	Check	6000 S.P.	1200# S.P.
O-inch to l-inch	70	100	140
l-inch to 2-inch	40	65	80
2-inch to 3-inch	25	45	55
O-inch to 2-inch (from above)	55	82 1/2	110

By averaging figures for the top two inches, results conform to grass response and to phosphate usage. These and other similar results are the basis for our decision to collect samples to an exact depth of two inches.

For simplicity and convenience, most laboratories report results as Very High, High, Medium, Low, and Very Low. These terms appeal to the layman. As ordinarily applied, they are misleading. Fertility levels should be higher in greens than fairways because clippings are removed, and growth is fostered by more generous watering and more liberal fertilization with nitrogen. By reporting the amounts as pounds per acre, it is possible to establish different levels for fairways and greens.

Our laboratory expresses results as pounds per acre for the above reason. With the Truog method fairway samples should contain 75 pounds of phosphorus, and 175 pounds of potash per acre. The corresponding figures for greens are 200 to 300 pounds per acre for phosphorus and 300 to 400 pounds per acre for potash.

Soil testing becomes a useful tool in turf production when done properly. Samples must be collected carefully, to a uniform depth of two inches. The testing method must employ a satisfactory extracting solution and interpretation of results should be made by somebody who is familiar with quick testing methods and well versed in turf management.

Many golf greens are becoming low grade phosphate mines. Ordinarily our laboratory does not show amounts above 800 pounds per acre because of the extra work involved.

Exact amounts were determined on samples from two city owned courses in Cincinnati, Ohio. When tested by the Truog method the amounts found were as follows:

Green No.	California Golf Course	Avon Fields Golf Course
1	1,875 lbs.	3,300 lbs.
5	2,700 lbs.	1,250 lbs.
9	2,800 lbs.	3,900 lbs.
13	2,875 lbs.	3,775 lbs.
17	2,000 lbs.	4,050 lbs.

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Avon Fields is the older of the two courses.

Soluble salts may cause serious damage. Chlorides, sulphates, and carbonates of sodium mostly are responsible. Their presence in irrigation water may be the cause, or their accumulation in the soil of arid or semi-arid regions may be responsible. Occasionally they come from other sources. When soluble salts are high, grasses have trouble absorbing water and nutrients especially in hot weather.

At Southern Hills in Tulsa tests showed high content of soluble chlorides in the greens. Backwash from the clubhouse water softener was found responsible. It was being discharged into the pond from which water was used for greens. The backwash was diverted elsewhere. The difference in salt content after two years is shown in the following test for chlorides:

Green No.	Soluble Chlorides (lbs. per acre) 1949	1951
2	4,000	1,500
7	4,000	2,000
9	4,500	1,500
12	4,500	1,500

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University Receives Grant for Turf Research

At the recent Southern California Turfgrass Institute a grant of money was presented to the University of California for use in further turfgrass research. Mr. Elmer Border, president of the National Golf Superintendents Association, made the presentation to Dr. Victor Youngner of the Department of Floriculture, UCLA. This is the third such grant presented by the National Golf Superintendents Association for this purpose.

EXTENSION COURSE IN TURFGRASS CULTURE

The University Extension Course in Turfgrass Culture will be offered again during the spring Semester of 1960. The Class will meet Tuesday evenings from 7:00 to 9:30 PM starting February 9, 1960. The meeting place will be the University of California Ornamental Horticulture Area, 300 Veteran Ave., Los Angeles.

The course is open to anyone interested in the culture of turfgrasses, but is planned especially for the professional. The instructor will be Dr. Victor B. Youngner, Assistant Professor of Ornamental Horticulture, UCLA.

Students may register in advance at the University Extension Office building 5A, UCLA, or they may register at the first meeting. If you plan to attend the class, pleaseattend the first meeting or if this is not possible, notify the instructor. A minimum enrollment of 15 is required in order to offer the class.

All aspects of turfgrass management will be covered, including grass varieties, soils, fertilization, watering, diseases and insects, weeds and weed control. Emphasis will be placed on practical methods, however background fundamental information will be included when possible.

SOUTHERN CALIFORNIA TURFGRASS INSTITUTE

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The meeting was opened by Frank Steward, president of S.C.T.C., with acknowledgments and introduction of special guests. Talks on pin-pointing our fertilizer problems set the stage for the all-day meeting. The following speakers discussed briefly their individual turf problems:

William Nuessle of Los Angeles Country Parks and Recreation, representing golf; Gilbert D. Marshall, Los Angeles City Schools, representing schools; parks were represented by Richard E. Bullard of the Los Angeles City Parks and Recreation; and cemeteries were represented by John Stark of Inglewood Park Cemetery.

What we should know about various elements in fertilizers and their value was next discussed by two speakers...Dr. 0. R. Lunt, covering the role of nitrogen in turf fertility, followed by Dr. J. J . Oertle, evaluating the other nutrients such as phosphorus, potash, etc. Both of these men were from the Department of Irrigation and Soil Science, UCLA.

Dr. Roy Branson, soils specialist with the University of California Extension Service on the Riverside campus, presented a surprisingly long list of soil ammendments and conditioners, stating some had proven their worth while others had not been too successful.

0.J. Noer, agronomist with the Milwaukee Sewerage Commission, the final speaker in the morning session, discussed "Thirty Years of Turfgrass Soil Testing." He stated that "Some turf men question and others champion the value of quick testing methods for meas- fertilizer requirements. The results can be misleading or they can be useful tools, depending upon the method or sampling, the choice of solvent used to extract

Mr. John Gaughenbaugh, Superintendent of the Virginia Country Club, explaining the fertilizer test plots located on the clubs bentgrass nursery.

Part of the large group which attended the institute listening to the speakers during the morning session.

readily available plant food elements, and how the results are stated." He gave valuable direction for collecting soil samples, but stressed the point that soil testing was not the complete story and many other factors are involved and are of vital importance.

Dr. Robert Endo, Department of Plant Pathology, UCLA, opened the afternoon session and stressed the importance of a good fertilizer program as a means of reducing incident of disease in turf. He explained that a vigorous turf will resist invasion by some diseases. The best way to maintain a vigorous turf is by adequate feeding,

The importance of timing in your turf management practices was then discussed by Dr. Victor Youngner, turfgrass specialist at UCLA. He was followed by Richard G. Maire discussing, "How to Figure Your Costs." He explained how to figure the actual cost per pound of your major element, nitrogen, phosphorus, and potash in various fertilizers, but stressed the fact that the cost was only part of the picture when choosing a fertilizer. The value of other factors must be figured in, such as organic matter, residual release of elements, safety from burning, and many others.

The rest of the afternoon was devoted to comparing the fertilizer plots established at the Virginia Country Club and examining a wide variety of turf equipment displayed by numerous commercial firms,

The evening session was held at the clubhouse and Don Rodvold, superintendent of Torrey Pines Country Club in San Diego, discussed the results of a similar set of fertilizer plots established in his nursery. Dr. John Madison, Jr., Department of Landscape Management, University of California at Davis, commented on similar plots in the Bay area. The final portion of the evening was devoted to a question and answer session involving all speakers on the program.

As in the past, the institute was most informative and many attending expressed their appreciation and approval.

Weed Control Recommendations for 1960 Fairway Turf

As with any new management practice, the following recommendations should be tried on a limited scale under your conditions before the materials are used on large areas.

CHICK WEED (Common) CHICKWEED (Mouse-ear) CLOVERS OXALIS	2,4,5-T Propionic at 1 1/2 lbs. active ingredient in 5 to 25 gals. water per acre. Apply during fall, winter or spring when plants in active growth.
SPOTTED SPURGE YARROW	With Mouse-ear Chickweed and Yarrow, 2 or 3 applications at 2 week intervals probably needed. Spot treat best,
FOXTAIL	Disodium methyl arsonate at 10 lbs. active ingredient per acre. Apply in spring or fall. 2 or 3 treatments necessary at weakly intervals.
CRABGRASS (Large or Hairy)	Sodium arsenite 2 to 4 lbs. in 100 gals. water per acre. 3 or more applications needed. First one early August with following ones at weekly to 10 day intervals. Expect temporary discoloration (first treatment usually most severe) of permanent grasses. Use lower rate of application when temperatures are high and/or soil moisture levels low.
CRABGRASS (Smooth or small)	Sodium arsenite as described above. Add wetting agent. Disodium methyl arsonate, 6 to 8 lbs. active ingredient in 100 gals. water per acre. Late spring. Apply when soil moisture is good and air temperature moderate (70 - 80). hlay discolor other grasses. 3 to 4 treatments at 10 day intervals often necessary. Potassium cyanate at 8 lbs. in 100 gals. water per acre. Late spring or early summer. Apply when soil moisture is good and air temperature moderate (70 - 80). Expect discoloration. 3 to 4 treatments at 10 day intervals probably needed.
SILVER CRABGRASS DALLISGRASS	Disodium methyl arsonate, 10 lbs. per acre or a mixture of 4 lbs. disodium methyl arsonate plus 1 lb. actual 2,4-D plus 1 pint wetter-sticker in 40 gals. water per acre. Apply in spring or summer (temperature range 70 to 85). Two and possibly three treatments at weekly intervals may be necessary, Pre-emergence control of Silver Crabgrass with 80 lbs. actual chlordane per acre has been reported. Apply in late winter or early spring before germination.
OX-EYE DAISY	A mixture of 2 1/2 lbs. actual 2,4-D plus 20 gals. kerosene per acre reported as giving good control with no turf loss, Apply in fall, winter or spring. 2,4-D at 2 1/2 lbs. actual ingredient per acre also reported as effective.
DANDELION NARROW PLAINTAIN BROAD PLAINTAIN BURR CLOVER BRASS BUTTON CURLED DOCK	2,4-D at 1 to 1 1/2 lbs. actual ingredient in 5 to 25 gals.. water per acre during the fall or early spring. Most effective when plants are in active growth. With Curled Dock, repeat treatments at 3 week intervals.
KNOTWEED	2,4-D at 1 to 11/2 lbs. actual material in 5 to 25 gals. water per acre. Must be applied when plants are seedlings and repeat treatments may be necessary.
KIKUYUGRASS	Some success with Dowpon at 40 lbs. per acre during spring, summer or fall. Repeat treatments as often as necessary and as soon as recovery becomes apparent. Methyl bromide at 10 lbs. per 1000 sq. ft. effective. Be sure to treat area well outside of the 'infected zone'.
NUT GRASS	Amino triozole (50%) at 12 lbs. per acre in June or July. Methyl bromide at 10 lbs. per 1000 sq. ft.

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