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The Use of Physical Soil Amendments, Irrigation and Wetting Agent in Turfgrass Management

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Turfgrasses are grown for their beauty and ability to be used for recreational purposes. They are subject to soil compaction by foot traffic and equipment used in management operations. Soil compaction may have an adverse effect on root growth as a result of increased impedance to root elongation, adverse effect on soil-water relations or on soil aeration. There are indications of interactions between some of these factors, such as compaction, aeration and irrigation.

A study was undertaken at the University of California, Riverside to determine the effect of physical soil amendments, compaction, irrigation, and wetting agent on growth of turfgrasses in a greenhouse experiment.

Experimental Set-Up

Soil with poor structure stability was amended with 1/3 by volume sphagum peat moss, lignified wood (wood products treated with sulfuric acid and heat and neutralized with anhydrous ammonia so that the resulting product has a high content of lignin and lignin related products) and calcined clay.

Special containers were constructed from plexiglass for use in this experiment. They were 4 inches in diameter and 17 inches high. Tensiometer cups were inserted through holes on the side of the container at depths of 3 inches and 8 inches.

A hole was drilled at the bottom of each container for drainage, and a short piece of plexiglass tubing was sealed in the hole. Rubber tubing was used to conduct drainage effluent from the containers to bottles placed directly beneath the containers.

A 2-inch layer of coarse sand was placed in the bottom of the containers. The soil mixes were placed in the containers over the sand layer. Since the lignified wood contained 1% nitrogen, equivalent amounts of nitrogen were added to the other soil materials in the form of calcium nitrate which was added to the water used for the initial wetting.

Twenty common bermudagrass *(Cynodon dactylon)* sprigs were planted in each container and top dressed. Replanting was done as deemed necessary to obtain uniformity in all containers. The cylinders were wrapped with black polyethylene sheeting to keep light from the roots.

Treatments

Two compaction treatments, two wetting agent treatments and two irrigation programs were superimposed on each of the soil materials for a total of 32 treatments. Each combination of treatments was duplicated in a randomized block design.

The two compaction treatments consisted of no compaction and compaction as will be described. Compaction was accomplished by placing a circular hardwood plug cut to fit inside the cylinder on top of the grass. A spring-loaded tube requiring about 70 pounds of force to move to the end of a stop was pushed down three times on top of the wooden plug while standing over the cylinder. This was done daily for the first five weeks of the experiment and then four times a week for the remaining three weeks of the experiment. On days that water was required, compaction was done before water was added.

The wetting agent treatments consisted of a check of no wetting agent and a wetting of the dry soil initially with water containing 3 ppm wetting agent.

The two irrigation programs used were a set calendar schedule and irrigation guided by the tensiometer readings. One-half surface inch of water was applied three times a week under the set irrigation program. Water was

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applied to the containers receiving tensiometer guided irrigation only when the soil water suction was between 30 and 40 centibars. If the shallow tensiometer indicated need for water but the lower one didn't, only water sufficient to wet the upper part of the soil column was applied. When the lower tensiometer indicated water need, additional water was applied to reach the lower parts of the container. Water was never added in quantities sufficient to cause drainage from the bottom of the container under the tensiometer guided irrigation program.

One half way through the experiment, fertilizer was added equivalent to adding 1 pound of N per 1,000 ft. in the form of $Ca(NO_2)_3$ dissolved in 90 ml of Hoagland's solution. Containers with lignified wood received no nitrogen but did receive Hoagland's solution minus nitrogen.

The experimental period extended from May 25 to July 20.

RESULTS

Infiltration Rate

The infiltration rate was highest in calcined clay and lignified wood amended soil, next highest in peat and lowest in the unamended soils. The compaction treatment decreased the infiltration rate of peat and unamended soil but had no significant effect on the other two treatments. The wetting agent treatment increased the infiltration rate of unamended soil, but had no effect on the physically amended soils.

Soil Compactability

The compaction treatment caused the soil mixes to become compact in the order going from greatest to least of unamended soil, peat, lignified wood, and calcined clay. For each soil material, the compaction was greater when the irrigating was done on a set schedule as compared to the tensiometer guided irrigation. The wetting agent caused the peat amended soil to become less compact, but had no effect on the other soil materials.

Evapotranspiration

The evapotranspiration was higher under set as compared to tensiometer guided irrigation. This result is probably due to the surface remaining much wetter under set irrigation. The only effect of soil mix was that the evapotranspiration was less in lignified wood amended soil than the others when tensiometer guided irrigation was used. This likely resulted from less top growth under this treatment.

Evapotranspiration was less when the soil mixes were compacted as compared to no compaction. This is also probably due to reduced top growth resulting from soil compaction.

Number of Irrigations

These results are closely allied with the results on evapotranspiration. The irrigation program had the biggest effect on evapotranspiration and number of irrigations. These results are strictly applicable to the calendar irrigation program adopted and the environmental conditions of the experiment. Had a set schedule of once a week rather than three times a week or had higher environmental evaporative demand been present, the results could have been different. The set schedule chosen was because it is similar to programs commonly followed in turf irrigation in southern California.

It is considered that tensiometers could be installed to guide irrigation so that the soil will not become too dry before watering. Field experience with turf, citrus, and avocados indicates that the general effect of tensiometer guided irrigation as compared to prevailing irrigation programs is to decrease the amount of water used for irrigation. It has been demonstrated that tensiometers are useful to guide irrigation so that the soil is neither allowed to become too dry nor remain too wet between irrigations.

Dry Weight of Clippings

Considering the clippings from the first half of the experiment, the top growth was greater when the soil was amended as compared to no amendment when irrigated on the set program. When irrigation was based on tensiometer records, the lignified wood amended and the unamended soil produced less top growth than the other two soil mixes. In comparing the two irrigation programs, top growth was less on the lignified wood treatment when watered according to tensiometer records rather than the set program. This was opposite to the other soil materials which had higher average dry weight (although not statistically significant) when irrigated on the tensiometer program. Compaction significantly reduced the top growth as compared to no compaction.

The effect of irrigation program on top growth over the last half of the experiment is the same as for the first half except that differences were large enough to be statistically significant. Lignified wood provided the most top growth when much water is used as under the set irrigation program. When tensiometers were used to guide irrigation, amendment with lignified wood was no better than unamended soil for producing top growth. Of all treatment combinations, peat under tensiometer guided irrigation produced the greatest top growth.

Whereas compaction treatment affected the top growth during the first half of the experiment, it had no significant effect over the last half.

Wetting agent had no effect on top growth.

Salinity Aspects

The electrical conductivity of the leacheate caused by

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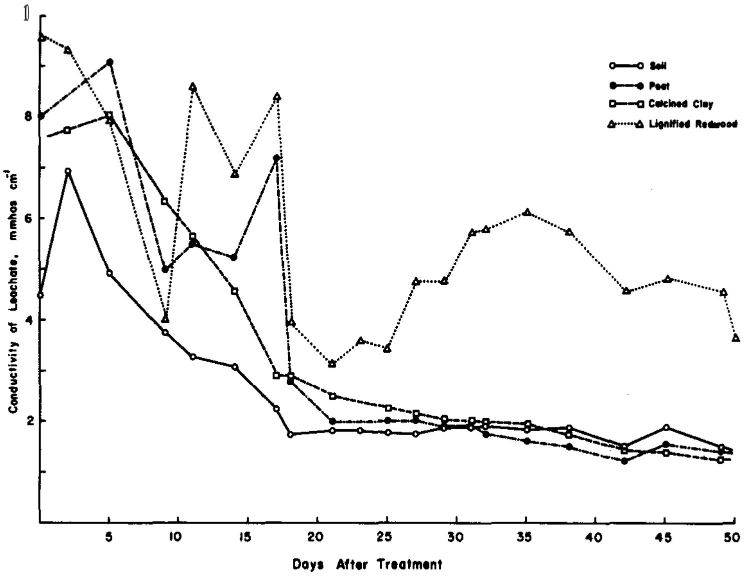
set irrigation is presented as a function of time for the various soil materials in the graph. The electrical conductivity is related to the concentration of salt in the water.

Salts from the unamended and the peat and calcined clay amended soils were leached out during the first 18 days. The EC thereafter remained fairly constant and equal for these three soil materials. The EC of leachate from lignified wood amended soil was in general higher than the others and particularly so over the last part of the experiment. These data suggest that the lignified wood has a source of ions which are slowly released and not immediately removed by leaching. The increase in EC from lignified wood after the twenty-fifth day was probably caused by a change in the weather. The weather up to that date was fairly cool and cloudy and then became clear and hot. A smaller fraction of the water added came through as leachate and therefore was more concentrated.



The electrical conductivity of the leachate from the containers irrigated on the set schedule at various times after the start of the experiment.

The original saturated soil extract electrical conductivity of the various soil mixes was 1.30, 1.97, 2.16 and 4.12 mmho cm^{-1} for unamended soil, calcined clay, peat, and lignified wood amended soil respectively. Under tensiometer guided irrigation there was no leaching so these values represent the approximate salinity of the various soil mixes.

The average pH of the leachate was 7.6, 7.1, 5.9, and 5.2 for the unamended soil, calcined clay, lignified wood, and peat respectively. The pH of leachates from unamended soil and calcined clay amended soil did not change much through the course of the experiment. The leachates from the peat amended soil during the latter part of the experiment had a higher pH than for the first part of the experiment. The opposite was the case for lignified wood amended soil where the higher pH values were measured in the first part of the experiment.

The better top growth of grass grown on lignified wood amended soil when the soil was subjected to much leaching, as was the case with set irrigation, is most likely due to the retention and slow release of nutrients (particularly nitrogen). The failure of the grass to grow well on lignified wood under tensiometer guided irrigation was due to high salinity.

Tissue Analysis

The concentrations in the clippings of all of the minerals analyzed were influenced by some of the treatments except for phosphorus which was not significantly affected by treatments. Even though the treatments influenced the concentration of the minerals in the tissue, all of the concentrations were higher than have been recognized as being deficient for grass growth except for nitrogen which was on the borderline.

The concentration of nitrogen was highest in grass grown in lignified wood amended soil. The concentration of nitrogen was lower when the soil materials were irrigated on a set schedule as compared to tensiometer guided irrigation except for the lignified wood which was not affected by irrigation treatment. The lower concentration of nitrogen in plants grown under set irrigation in soil, peat, and calcined clay was probably because the nitrogen was leached from the soil. The slow release of nitrogen from lignified wood kept adequate nitrogen available for the plant in spite of leaching. These results help explain the good growth of grass on lignified wood amended soil when irrigated under the set irrigation program.

Oxygen Diffusion Rate and Root Growth

The measured oxygen diffusion rate (O.D.R.) values from containers receiving irrigation based upon tensiometer readings were all higher than 0.40 μg $cm^{-2}min^{-1}$ These values are not expected to be deficient for plant growth. It is possible that if O.D.R. measurements would have been measured daily, that O.D.R. may have been in the deficient range for certain treatments for a period of time after irrigation.

In general, the O.D.R. under set irrigation were lowest in the unamended soil. Peat amended soil was next lowest with the other two amendments providing an environmental of fairly high O.D.R. Oxygen diffusion rate values measured in the non-compacted soil materials were higher than in the compacted unamended soil and peat amended soil. The O.D.R. in the other amended soils were not greatly affected by compaction. The toot growth was, in general, correlated with O.D.R. measurements. The lower O.D.R. limit for root growth was about 0.15 μg $cm^{-2}min^{-1}$.

The photographs illustrate the roots grown in the various soil mixes for various compaction and irrigation treatments. It can be noted that the lignified wood and calcined clay tended to eliminate the effects of over irrigation and compaction on root growth. Tensiometer

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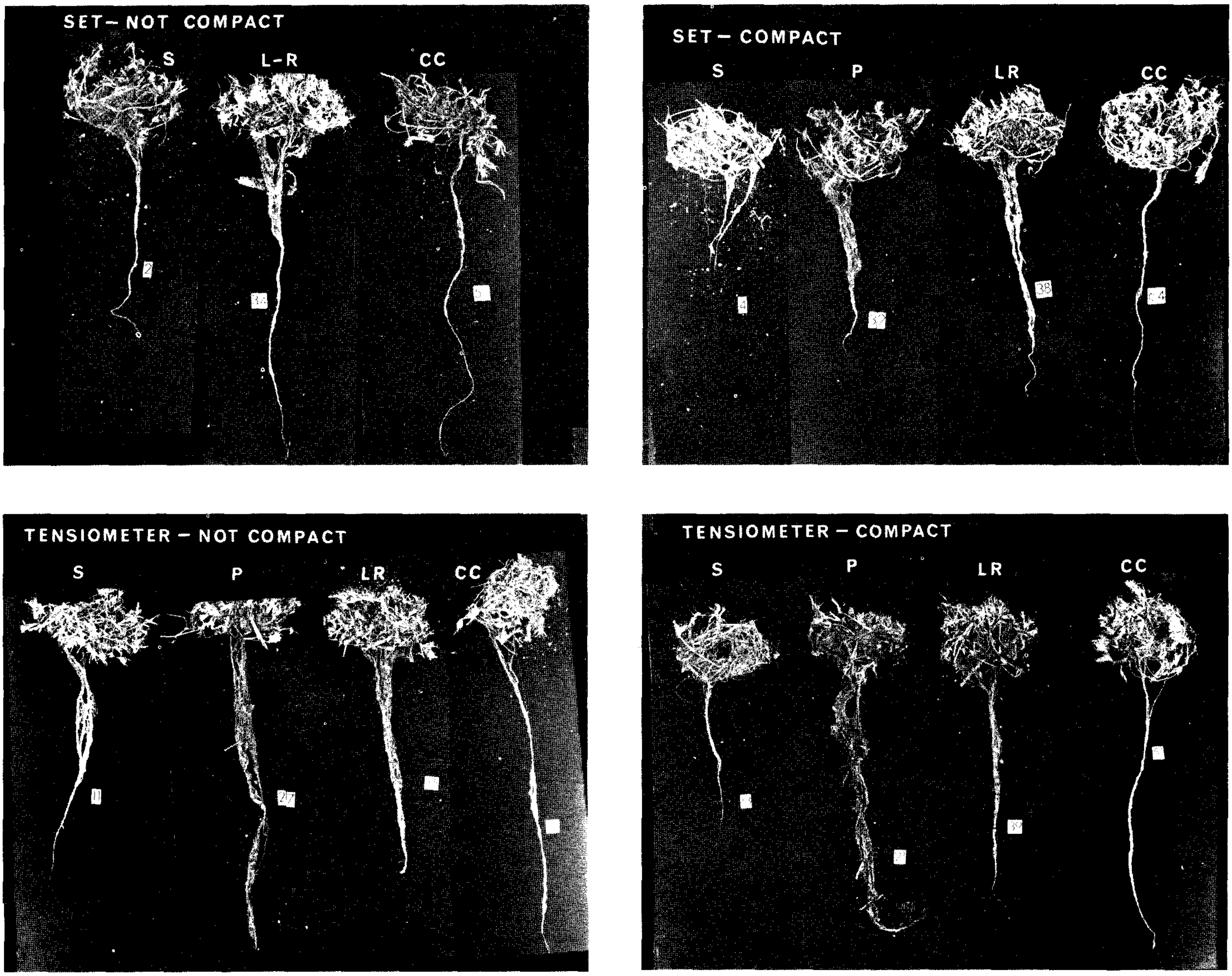

Typical root systems of grass grown under the various irrigation and compaction treatments in the different soil mixes. The abbreviations on the photographs are: (S) unamended soil, (P) peat, (LR) lignified wood, and (CC) calcined clay amended soil.

guided irrigation tended to reduce the ill effects of compaction on root growth in unamended soil. (The roots grown in peat under set irrigation and no compaction are not shown in the photograph because there was considerable difference between replications so that no one root system could be chosen as being representative for the treatment.)

SUMMARY

Consider first the advantages and disadvantages in using a particular soil amendment. Peat has the advantages of promoting a very good top growth and dense root system when properly irrigated to avoid poor aeration. It has the disadvantages of not withstanding compaction and can become excessively wet if proper irrigation practices are not followed. Lignified wood has the advantages of withstanding compaction, providing high infiltration rates, allows good aeration, maintains an extended supply of nitrogen under leaching conditions, and promotes a good root system under high O.D.R. It has the disadvantages of contributing to soil salinity and apparently requires a higher O.D.R. for maximum root growth. Calcined clay has the advantages of withstanding compaction, provides high infiltration rate and allows for good aeration. Its disadvantage is that although it promotes deep roots, they are rather sparse with few roothairs.

It is fairly obvious that the choice of amendment to use will depend upon the results expected and the conditions to which the amended soil will be subjected. It should be pointed out at this time that the amount of lignified wood used in the mix was greater than recommended by the manufacturer and this could have exerted an effect upon the results of the experiment. Not one of the tested amendments had universally good characteristics as compared to the others.

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As for the other treatments, no benefit was found from compaction on the soil. This is a fairly obvious conclusion, but compacting forces cannot usually be removed from a turf area.

Irrigation based upon tensiometer records is superior to irrigating on a set calendar schedule. The advantages over the set program chosen for this experiment were a savings in water, improvement in soil aeration, and reduction in soil compactability. The differences between tensiometer guided irrigation and irrigating at a set specified time interval would, in general, depend upon the set program adopted and the environmental conditions. The one caution required in irrigating by tensiometer records is that excess water needs to be applied periodically to cause leaching if salinity becomes too high.

The wetting agent treatment applied increased infiltration rate of the unamended soil and reduced compactability of peat amended soil. It also had some other minor significant effects. It should be pointed out that the application rate (3 ppm) was extremely light. Other research in progress indicates that the relationships between wetting agent and plant growth are extremely complex and no general concluding statement on their use is likely to be achieved for some time.

Dichondra; Past, Present and Future

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Dichondra first appeared as a lawn weed in Southern California in the early part of this century. It was reported as a weed in Golden Gate Park about 1916.

The first intentional use of dichondra as a ground cover was about 1935. A few years later many nurseries were growing dichondra in flats for sale to home owners. Seed was still difficult to grow and harvest, so most propagation was by vegetative means. In the next ten to twelve years dichondra had a remarkable growth in popularity throughout Southern California.

As seed production and harvesting methods were gradually worked out a new industry developed in this area. Today very little dichondra is established vegetatively as seed is inexpensive and easier to use.

Dichondra belongs to the Convolvulaceae (morning glory) family, and the cultivated form has been called Dichondra repens for many years. However, the dichondra that has limited use in the Southeast is usually called Dichondra carolinensis. Some taxonomists believe that our cultivated form is actually D. micrantha not repens. There is thus some question as to what species we are using and whether or not we may be actually growing more than one for lawns.

In fact, the entire dichondra picture is quite confusing. In addition to the above species there are several that may be native to the Southwest. D. occidentalis and D. donelliana are two distinct species found along coastal California. D. argentea is found in the mountains of Southern Arizona and New Mexico and D. recurvata occurs in parts of Texas. The presence of true D. repens in the United States may actually be in doubt. All of these species with the exception of D. occidentalis look much alike in their vegetative characters.

Our cultivated dichondra produces one to two seeds on a short stem (pedicel) hidden below the leaves. As the seed matures, the stem curves downward until the seed is in contact with the soil. Thus the mature seed lies on the soil surface often covered with dead leaves. The seed has a hard seed coat and usually lies in the soil for a year or longer before it will germinate. Seed produced for the trade is scarified to give more rapid and uniform germination.

Dichondra flowers in the spring from March through May or June. A medium day length appears to be conducive to maximum flowering. Extreme temperatures, either hot or cold, during the flowering period will greatly reduce flower production and seed yield. Moderate temperatures of 60° -70° F are optimum for flowering and seed set.

The appearance of dichondra plants is changed by changes in its environment. High temperatures stimulate long stems (petioles) on its leaves and rapid elongation of stolons. When temperatures are cool and days short dichondra will have small leaves on extremely short petioles so that the plant is less than one-half inch high. Other adverse environmental conditions such as compacted soil or inadequate water and nutrients produces a similar plant response. Plants grown in shade are taller with larger leaves than those grown in full sun.

Dichondra has long been considered to be highly self-pollinating or even cleistogomous (self-pollinating before the flower opens). However, this has not been definitely established experimentally as yet.

A large amount of variation has been observed in dichondra grown at the University from commercial seed sources. This is somewhat surprising in light of its supposed self pollination. The most obvious variations

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are for plant habit, size of leaf, length of petiole, and shade of green. However, variation less readily observed might also be expected.

All sources of genetic variation are now being studied as possible roads to dichondra improvement. It is hoped and anticipated that disease tolerance, salinity tolerance, increased cold and heat resistance and better growth habits will be found for the future in these studies.

Dichondra is a major component of 50 percent or more of the home lawns in Southern California. Often dichondra invades and soon dominates grass lawns, seeds being carried by birds, water and lawn equipment.

Despite its popularity, dichondra is not a "lazy man's lawn" as it requires quite exacting and constant care. It is subject to a number of disease and insect pests and is difficult to keep free of weeds: It will not tolerate traffic as well as most turfgrasses.

Spring and early summer are the best time for seeding dichondra. The long warm summer days are favorable for rapid germination and establishment. A clover "nurse crop" is not necessary unless the lawn is planted during the cool season. One pound of seed for each 1000 sq. ft. of area is the best planting rate. As little as one-half pound may be used but a slightly longer time will be required for full cover.

Seed bed preparation may be the same as that recommended for any lawn but special attention should be given certain steps. Dichondra grows poorly on compacted soils lacking drainage. Therefore, the soil must be thoroughly worked as deeply as possible before the final grade is established. Liberal amounts of organic matter and a complete fertilizer should be worked into the soil at this time.

Because of the difficulty to control weeds in an established dichondra turf, good preplant weed control will save much future work and produce a more satisfactory lawn.

Methyl bromide fumigation by a licensed applicator is best. However, if that is not possible, Vampam, Mylome and some other fumigants will give nearly as good results and may be applied by any experienced gardner. Calcium cyanamid may be used also, but at least 30 days must be allowed between application and seeding.

In warm weather dichondra seed will germinate in about a week. The seedlings grow rather slowly until they reach the three to four leaf stage. From then on growth is rapid and a dense turf may be had in 6 to 8 weeks. Fall plantings will require a longer time for establishment because of the lower temperatures and shorter days.

A new lawn may be fertilized at 2 to 3 week intervals with 1/4 to 1/2 lb. of actual nitrogen per 1000 sq. ft. Ammonium sulfate, ammonium nitrate or urea may be dissolved in water and sprayed onto the lawn. This must be followed by a few minutes of sprinkling to wash the fertilizer solution into the soil.

Mature dichondra lawns may be fertilized in exactly the same way with excellent results. Organics, synthetic organics or other "slow-release" fertilizers will be as satisfactory and need not be applied as often. A total of 6 to 10 pounds of actual nitrogen should be applied annually regardless of the source.

The important point to remember about fertilization of dichondra is that is must be kept well fertilized, but should never be over-stimulated with nitrogen. Too much nitrogen at one time will cause the turf to become tall, loose and open, especially in warm weather.

If a dichondra turf, adequately fertilized with nitrogen still looks yellow, it perhaps needs iron. An iron chelate may be used or the lawn may be sprayed with iron sulfate at two ounces per 1000 sq. ft. as often as needed.

A complete fertilizer, containing phosphorus and potash as well as nitrogen, may be used once a year to assure adequate supplies of these nutrients.

Dichondra lawns should be mowed at least once every two weeks. Weekly mowings will give the best results in summer. Dichondra will do well at one-half inch cut in cool coastal areas. In interior valleys, during summer, cut at 1 1/2 inches. Clippings should be removed.

A regular mowing schedule together with the fertilization program recommended above will be an important weed control measure. Clover and many upright growing weeds can be eliminated in this way alone.

Commercial preparations containing monuron or neburon are effective controls for oxalis and will not harm the dichondra if used as directed. Neburon will prevent many crabgrass seeds from germinating as well.

Crabgrass may be controlled also by pre-emergence applications of herbicides containing standard lead arsenate. Diphenamid is a new pre-emergence herbicide which will control many annual weeds without harming the dichondra.

Post emergence control of crabgrass is most easily and safely accomplished with commercial formulations of disodium methyl arsonate (DSMA). Some dichondra leaf burn may result if temperatures exceed 80° F but this is usually only temporary. Two to three applications of DSMA seven days apart are usually required.

Perennial grass weeds, such as bermuda, may be con-

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trolled with Dalapon. Grass leaves should be sprayed to wet, without runoff, at rates recommended by the manufacturer. Repeated applications at 3-6 week intervals will be required for bermuda control.

While dichondra does require more frequent irrigation than many grass lawns, the daily watering schedule frequently followed is not the best. A saturated soil encourages a shallow root system and may lead to poor nutrient relationships and an increased danger of disease.

One-half to one inch of water applied every 5 to 10 days, depending on soil and weather conditions, should be adequate. There is no hard and fast rule that can be given. Dichondra is moderately drought tolerant and will not be damaged by slight wilting and drying. It will come back quickly when watered. By careful observation any gardener can learn to judge when to water.

The soil sampling tube is a tool that should be in the hands of every person responsible for the maintenance of dichondra or any turf. With it the moisture conditions of the soil can be quickly determined at any time.

If thin yellow spots develop in the turf during the summer, first check the condition of the soil. Is it moist throughout the root zone but not saturated? Has the surface of the soil become hard and compacted? If soil conditions are not satisfactory, they should be corrected by aerification and changing the watering program.

If you are satisfied that the cause of the trouble is not in the soil, check for insects or diseases. Cutworms are common pests of dichondra in summer and early fall. They may be controlled with DDT, toxaphene, or mixtures of the two in preparations especially designed for turf.

Several fungus pathogens may attack dichondra during the summer, causing yellowing and spotting of the leaves and a general thinning of the turf. Fungicide formulations containing Captan and terraclor have been the most effective control. Other commercial fungicides may be used also with success. Don't wait until disease is widespread before control measures are adopted. Alternaria leaf spot is becoming an increasing problem. Fungicide formulations containing zineb give satisfactory control. (See California Turfgrass Culture. Vol. 15, No. 4, Oct. 1965).

There are many reports of serious nematode infestations of dichondra lawns. More study of this problem is needed. Methyl bromide fumigation prior to planting will alleviate this difficulty at least for a time.

Mites may damage dichondra in summer, causing a white speckling of the leaf where they suck out the plant juices. Control is with Dimite or Kelthane sprays. Diazinon has been reported to be effective also.

Two or more applications about two weeks apart are required for control. Applications must be thorough and the undersides of the leaves should be wet by the spray.

Slugs and snails are always common pests of dichondra lawns. The usual control is with baits containing metaldehyde. Zectran, a new pesticide, may be a superior material for the control of snails and slugs in dichondra and other ornamentals.

Dichondra is a popular ground cover in California and may even increase in popularity. Improved strains with greater uniformity, more vigor and disease tolerance surely would increase its appeal and usefulness. A breeding program with these objectives is in progress at the University of California. Better methods of culture and pest control too are on the way.

Santa Ana, A New Turf Bermudagrass for California

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A new variety of bermudagrass, recently named Santa AM has been released by the University of California Agricultural Experiment Station this spring. This new vegetatively propagated strain is recommended for athletic fields, playgrounds, golf course tees and other heavy use areas. Extensive testing has shown it to be an excellent variety for Southern and Central California. Santa Ana may be adapted to other areas of similar climate, but it was developed specifically for California conditions.

The new turfgrass was named after the well known city of Santa Ana so that it would be immediately recognized as an introduction from and for California. Much of the early testing of this strain was done at the University of

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California South Coast Field Station near Santa Ana.

Santa Ana bermuda is a seedling selection of Plant Introduction No. 213387 obtained from the Union of South Africa through the plant introduction service of the United Smtes Department of Agriculture. The initial selection was made at UCLA in 1956 and then planted into turf plots at the South Coast Field Station with many other selections in 1958. Testing followed at locations throughout California and in several other states as RC-145.

This new variety is characterized by a deep blue-green color and a medium-fine texture. Color retention in cool weather is excellent; the turf remaining green later into the fall and greening up earlier in the spring than turfs of our other varieties. With good maintenance it has held excellent color throughout the winter in mild frost free areas of California.

Santa Ana bermuda establishes itself quickly in a new planting and heals divots or other mechanical injury rapidly. It produces a smooth even surface quite free of grain, clumps or swirls. Resistance to wear from foot traffic is high.

It shows a high degree of tolerance to some of the difficulties common to many parts of the Southwest. Smog, which frequently discolors the Tifway and Tifgreen varieties, has little effect on Santa Ana. The bermudagrass Eriophyid mite, which causes severe injury to common bermuda and many varieties, seldom if ever causes trouble. Though bermudagrass in general is tolerant of soil salinity, Santa Ana ranks as one of the most salt tolerant of the turf varieties.

Flower stems may appear at times but viable seed is not normally produced. Thus, there should be no problems of contamination of plantings by seedlings or seedling invasion of other areas.

As with any turfgrass, good cultural practices must be followed if the full potential of this new strain is to be realized. A vigorous bermudagrass will produce thatch in time under most management practices. Although Santa Ana bermuda develops thatch more slowly than most comparable strains such as Tifway, thatch control measures are required. Best winter color is obtained only if accumulated thatch is removed in early autumn about six weeks before cool weather is expected. The new growth will remain green all or most of the winter depending upon the severity of cold. Frequent close mowing and regular vertical mowing throughout the summer may relieve the necessity of fall thatch removal and at the same time provide a better summer turf.

Nitrogen fertilizer must be supplied through fall, winter and spring except when the grass is actually dormant. If this is done, it may be necessary to fertilize very little during the warmest part of summer. High nitrogen levels during the cool season assist greatly in maintaining satisfactory turf color.

Propagating'material of Santa Ana has been distributed to commercial stolon and sod producers. It should be available for sale to the public in 1967. Turf nurseries wishing to grow this new strain may obtain small amounts of propagating material from the Department of Agronomy, University of California, Riverside. The University cannot provide material to the general public.

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