Physiology and Morphology of Dichondra as Related to Cultural Practices

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Introduction

The dichondra of our California lawns, *Dichondra repens,* has been reported as being introduced in many tropic and semi-tropic areas ranging from South America, through the scattered South Sea Islands, and into Australia (1) (7). Other species, some of which appear to be native in California, have not as yet received wide horticultural acceptance.

Listings of the characteristics of an ideal ground cover usually emphasize low maintenance which includes infrequent mowing, positive resistance to invasion by weeds, insects or diseases, and a high degree of permanence. The ultimate requirement is year-round green color. Dichondra has shown considerable promise in meeting these major qualifications but quite frequently fails dismally, or it may disappear from the lawn completely. The causes of these failures have not until very recently received scientific study. This may be due to the limited use of dichondra in sections of the country other than California. Dr. Victor B. Youngner and Mr. Stanley Spaulding are currently directing intensive investigations at the University of California at Los Angeles in the ecological responses of dichondra. Their studies will contribute much to fill this void in our scientific knowledge. However, little emphasis is being given to studies of the basic physiology of dichondra by scientists elsewhere.

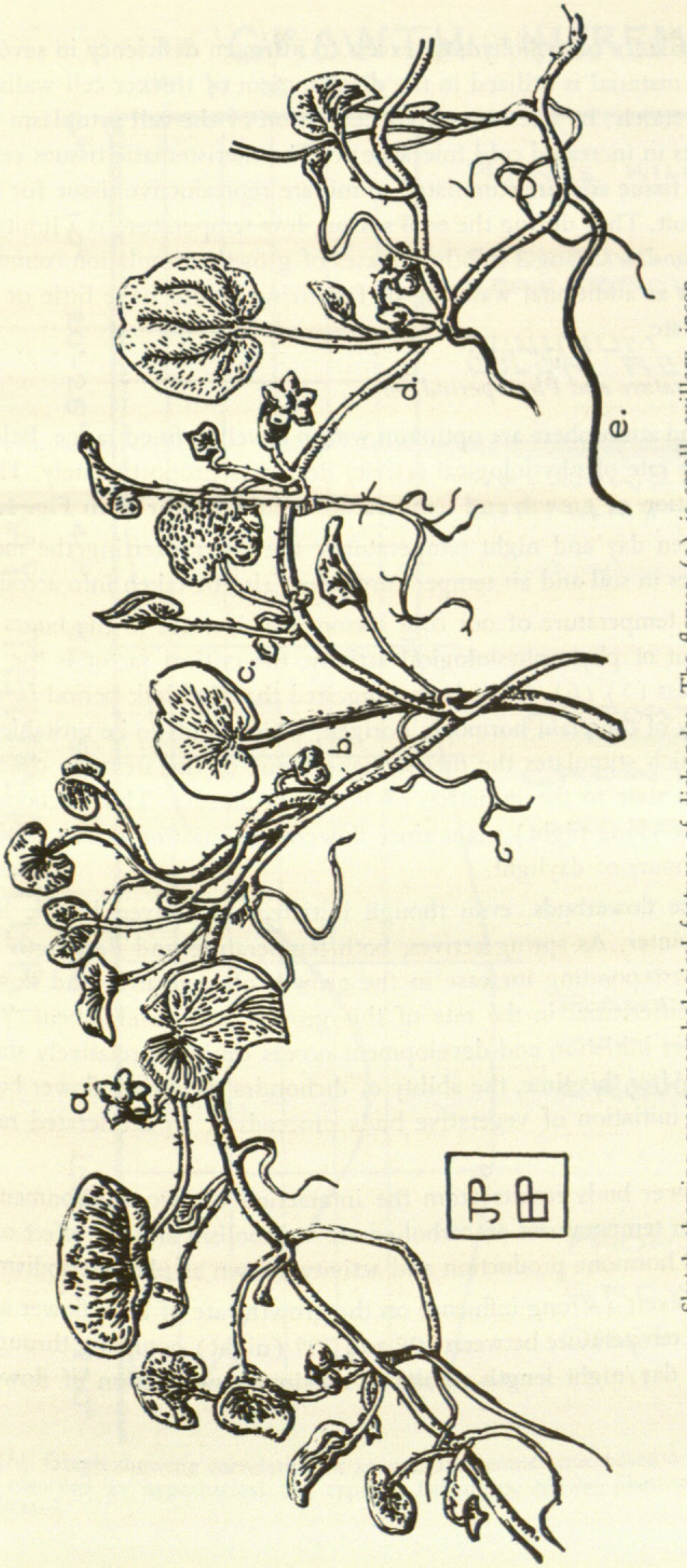
THE GROWTH CYCLE

Effect of Temperature

Dichondra is capable of little or no growth during periods of cold weather which we experience during our winter season. Color retention may vary from excellent to poor according to the variances of the weather and exposure. When management practices which favor vigor and growth are continued into the fall, a greener color usually results but somewhat at the expense of winter hardiness. Extensive yellowing or chlorosis may occur and persist in spite of the best cultural attention.

Color returns and growth resumes as the air and soil warm up in spring, but continues so for only a relatively short time. In April and May, a more or less serious deterioration occurs in appearance and vigor. This decline may vary from slight discoloration to a serious defoliation. Recovery follows naturally during June and the plants enter the summer in a lush state of growth. With adequate care, dichondra can be expected to thrive until the advent of cool weather in the late fall.

Physiologically, dichondra tends to accumulate carbohydrates when night temperatures drop below 60° in the fall. This results from several factors: a. A lowered growth rate proportional to the reduced production of sugars by photosynthesis; b. A reduction in cell activity which would translocate the carbohydrates from the leaves to the roots; c. A reduction in root growth and activity induced by the lower soil temperatures and the lack of translocated carbohydrates which results in reduced absorption of nitrogen and other soil nutrients; d. A lowered supply of nitrogen in the soil due to decreased activity of soil micro-organisms; e. A lower respiration rate throughout the system of the dichondra plant which would otherwise deplete the carbohydrates.



Sketch showing gross morphological features of dichondra. The flower (a) is small, axillary, inconspicuous, borne on a long pedicel, but remains hidden beneath the leaves. The calyx consists of five narrow sepals united at the base. The corolla is made up of five united petals, greenish-white in color. There are five stamens with small anthers and two styles with rough surfaced stigma. The ovary has two lobes, each of which develops into a one-seeded utricle at maturity (b). The pedicel curves downward sharply as the seed develops. The leaves (c) are kidney-shaped with entire margins, varying in width from ½ to ¾ inch and occasionally up to 1½ inches. The petioles vary in length from ½ inch to 2 inches or more, often according to growing conditions and exposure. The creeping stems (d), more technically called stolons or rhizomes, develop into a dense mat and produce many taplike roots (e). Courtesy of Gerry V. Patton and Edward Pugh, Arboretum Staff Artists.

Plants respond to this imbalance of carbohydrate excess to nitrogen deficiency in several ways: a. Some carbohydrate material is utilized in the development of thicker cell walls as cellulose or dehydrated into starch; b. The osmotic concentration of the cell cytoplasm increases, a factor which results in increased cold tolerance; c. The meristematic tissues cease the production of vegetative tissue and are stimulated to initiate reproductive tissue for the production of flowers and fruit. Thus during the cool season, low temperature is a limiting factor in the growth of dichondra. Changes in other phases of growth stimulation common in horticultural practice such as additional watering or fertilizing would have little or no effect during this dormant state.

The Inter-relation of Temperature and Photoperiodism

Temperature in the soil and atmosphere are optimum within a well defined range. Below and above this optimum, the rate of physiological activity decreases proportionately. Thus a graph showing the correlation of growth and temperature would appear as in Fig. 1.

There is a relation between day and night temperatures, the latter exerting the more critical influences. Differences in soil and air temperatures must also be taken into account.

Concurrent with this low temperature of our cool season is a decrease in the hours of daylight. From the viewpoint of phyto-physiological activity, the critical factor is the increase in the hours of darkness (5) (6). It has been suggested that the dark period favors the accumulation and activity of the plant hormone, florigen, which tends to be unstable in light. It is this hormone which stimulates the meristematic tissue of the stems to change drastically from a vegetative state to the initiation of flower primordia. Thus dichondra may be classed as a short day (long night) plant since flowerbud initiation occurs during periods of less than twelve hours of daylight.

The development of these flowerbuds, even though initiated, is delayed by the low temperature of California winter. As spring arrives, both temperature and daylength increase, accompanied by a corresponding increase in the growth of vegetative and flower buds. However, there is a differential in the rate of this growth and development. The optimum daylength for flower initiation and development occurs during a relatively short period during early spring. After this time, the ability of dichondra to initiate flower buds drops off rapidly while the initiation of vegetative buds proceeds at an accelerated rate. See Fig. 2.

Thus the initiation of flower buds results from the interaction of two environmental factors, the influence of lower temperatures on carbohydrate metabolism and the effect of a day/night length upon plant hormone production and activity known as photoperiodism.

Temperature continues to exert a strong influence on the growth rate of both flower and vegetative buds. A favorable temperature between 60° and 70° (night) occurring throughout the period of favorable day/night length results in maximum production of flowers and fruit (seed).

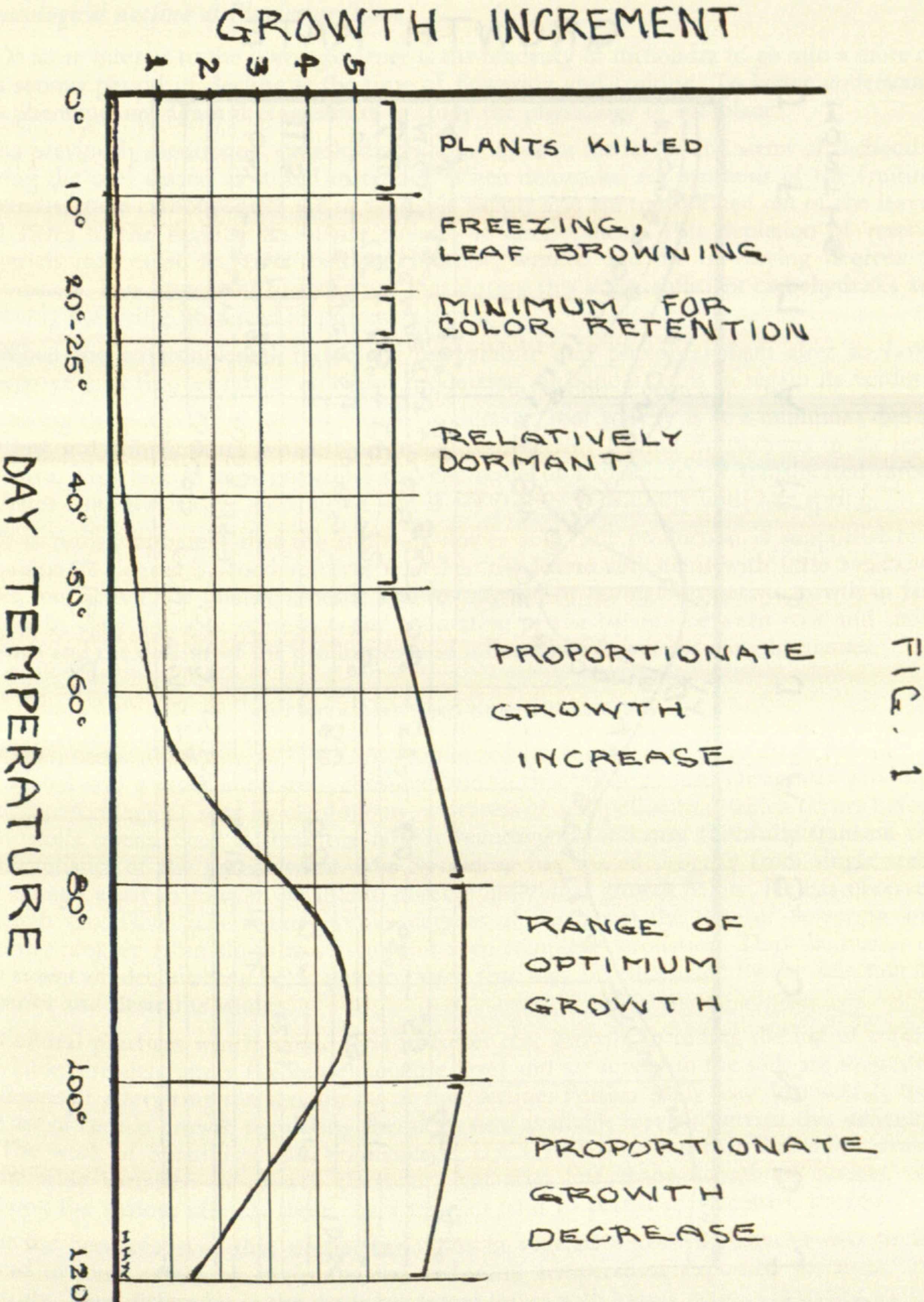


Fig. 1. Graph showing correlation of growth and temperature based on available data. The curve must be regarded as hypothetical but typical. Responses of the plant to temperature ranges are also indicated.

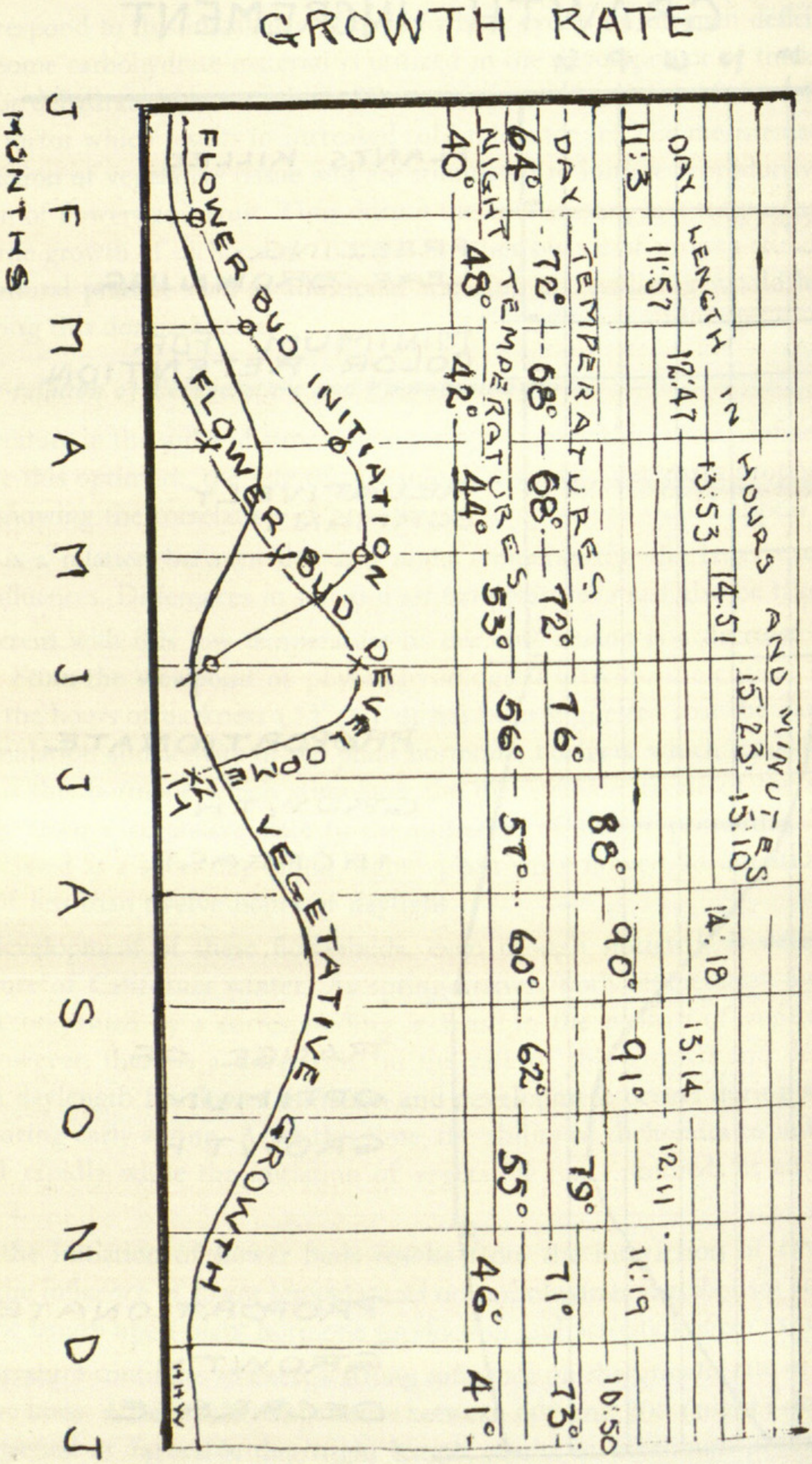


FIG. 2

Fig. 2. Graph showing inter-action of photoperiodism and temperature in influencing flower-bud initiation, flower-bud development and fruiting, and vegetative growth. Based on weather data supplied by Dan Martel of Arboretum Weather Station and Victor B. Younger of U.C.L.A.

Physiological decline at Flowering Time

Of more interest to the home gardener is the tendency of dichondra to go into a more or less serious period of decline at the time of flowering and fruiting. To better understand this phenomenon, again it is necessary to study the physiology of the plant.

As previously mentioned, carbohydrates accumulate in the leaves and stems of dichondra during the cool season as stored materials. When demanded for synthesis of the fruiting materials, these carbohydrates are in available supply and are translocated out of the leaves and stems to the regions of intense embryonic development. This depletion of reserve materials may cause leaves to become chlorotic, weaken and die in varying degrees of seriousness. It is important to recognize that during this stage, sufficient carbohydrates are probably not being produced to prevent a deficit.

When the environmental factors of temperature and photoperiodism alter to favor vegetative growth over flower and fruit production, dichondra tends to regain its verdure.

During the period of flower and fruit production, root activity is at a minimum due to the low soil temperatures which tend to lag considerably behind fluctuations in air temperature. This lack of root growth is also the result of a deficiency of translocated carbohydrates from the leaves, a condition that is not corrected naturally until late spring.

It is readily apparent that the strain of flower and fruit production is supported to a considerable degree by food reserves stored in the leaves and stems with little assistance from root activity or photosynthesis. The resumption of normal vegetative growth in late spring or early summer represents the restoration of the balance between root and shoot growth and the decline of the production and influence of flower inducing hormones.

CLEISTOGOMY AND GENETIC STRAINS

Experiments underway at U.C.L.A., conducted by Mr. Stanley Spaulding, provide an additional and a most interesting consideration to this phenomenon. Dichondra produces a high percentage of seed by cleistogomy, a process of self-pollination which occurs before the corolla opens. Seed is therefore largely homozygous and may faithfully transmit the characteristics of the parent plant. Mr. Spaulding has spaced progeny from single seeds far enough apart in rows to be able to observe individual growth habits. He has observed through successive generations various degrees of decline at the time of flowering and fruiting ranging from slight to serious and even complete defoliation. Thus the matter of the extent of decline may be a genetic factor that may be eliminated by the selection of superior and desirable strains.

Cultural practices which would tend to foster root growth, including the use of readily available nitrogen, and a favorable moisture level and air supply in the soil, are suggested as means of alleviating the seriousness of this decline. Further study may demonstrate that the use of certain growth regulating chemicals now available may circumvent this difficulty.

The work of Spaulding and Youngner at U.C.L.A. has shown that dichondra strains show wide variation in growth character, leaf size, leaf shape, length of petiole, etc. Among the various strains, these characteristics tend to persist in successive progeny.

It has been observed that similar variations in vegetative growth character may be induced to some extent by environmental factors of temperature, exposure, moisture, and fertility. Thus dichondra in the shade has larger leaves with longer petioles than that grown in full sun. The same condition would be exhibited to some degree with individual plants before they become crowded as in a lawn. However, this observation of growth habit as a genetic factor introduces another important consideration in horticultural practice.

A lawn planted from seed represents a collection of individual plants of different strains which have gradually become selected by dominance. An unmowed dichondra lawn is generally quite uneven due to the variation in height of growth and leaf size of the individual plant clumps. The practice of mowing may favor the survival and expansion of the smaller-leaved, shorter plants and eventually give rise to a more uniform stand. A new approach to this situation could well be the planting of seed from a uniformly selected strain and so eliminate the necessity for mowing altogether.

A lawn of mixed grasses including Kentucky Blue and Bermuda and some weeds has been invaded by Dichondra. The grasses at this stage are dominant in the stand. (Photo taken September, 1963).

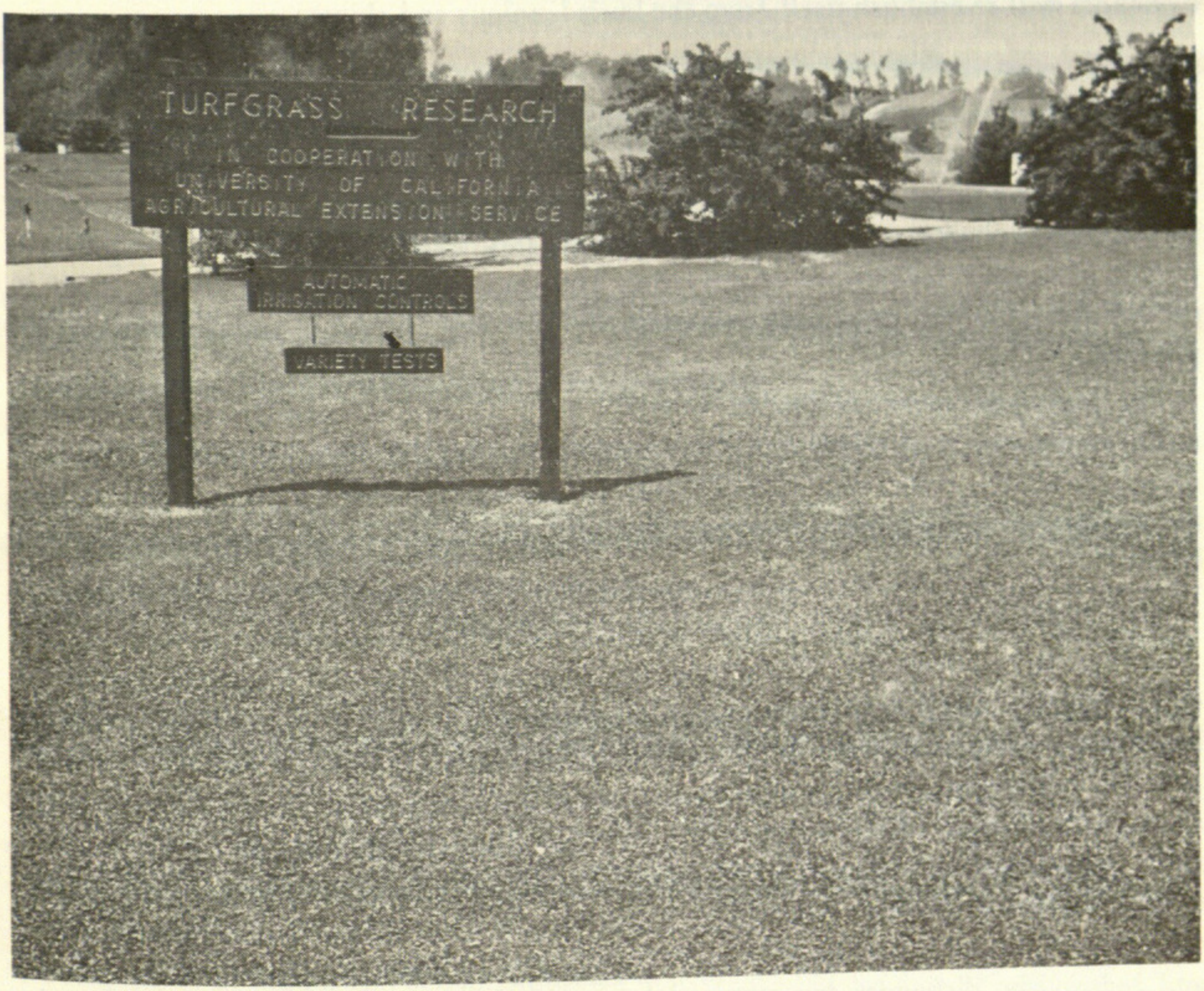
Photo by Bobby M. Vargas

ROOT MORPHOLOGY AND SELECTIVE HERBICIDES

The emergence of the primary root at the time of seed germination proceeds as a determinate tap root to a considerable depth before branching and giving rise to a fibrous root system. The use of recently developed selective herbicides, including monuron and diphenamid, may be possible due to this characteristic aside from any consideration of physiological tolerance. These herbicides tend to become fixed in the top layers of soil where they would be lethal for shallow rooted plants and the roots of germinating weed seed.

David Mitts of Bandini Fertilizer Co. has observed that dichondra is sensitive to monuron under shade conditions while highly tolerant to concentrations sufficient to eliminate oxalis, a shallow rooted weed, when growing in full sun. This might indicate that the more shallow roots of dichondra in shade and other physiological differences induced by low light reduce the tolerance to the herbicide.

Information on the physiological tolerance of dichondra to diphenamid indicate that the use of the material may exceed the currently recommended application rate. Whereas the ten pounds per acre which is effective for shallow rooted grasses and some weeds is the recommended treatment, monthly application at this rate up to the total of fifty pounds has produced no apparent damage to dichondra. However, the deeper rooted perennial bermuda grass has suffered greatly at half this amount in tests at the Arboretum.



Stand of Dichondra practically complete, the grasses and weeds either eliminated or under control except Oxalis. This conversion was accomplished through two applications of commercially available formulations of diphenamid at recommended rates applied in late December and during April, respectively. In other tests, Oxalis in Dichondra was controlled through the use of Monuron. (Photo taken July, 1964).

Photo by Bobby M. Vargas

THE VALUE OF THE RHIZOME/STOLON SYSTEM

The development of an extensive system of rhizomes and stolons in mature stands of dichondra may be regarded as a morphological asset in horticultural practices. This system serves as a reservoir of regenerative tissue and as a hedge against drought and other adverse conditions, including freezing. Often where the entire top growth has been killed by dessication or freezing, the restoration of favorable conditions engenders regrowth from this reserve. Thus this recovery from drought and freezing is more a matter of morphology than of actual physiological tolerance, its effectiveness being proportional to the volume of the rhizome/stolon system which survives. Where shallow-rooted weeds and dodder have invaded an established planting of dichondra, defoliants and contact herbicides may be used to completely eradicate the surface growth in the affected area. This practice will generally eliminate the pests where they have not been allowed to produce seed while the dichondra will re-establish itself from the buried stolons and rhizomes.

THE IMPERVIOUS SEEDCOAT

Dichondra seed has an impervious coat that becomes a major factor causing delayed germination. Commercial seed is scarified to circumvent this problem and so permit a rapid sprouting of the seed when planted under favorable conditions. Allied with another valuable physiological asset, prolonged viability, this feature also enables dichondra to regrow after extended periods of adversity. Thus un-scarified seed will remain intact in the soil for long periods of time and retain the potential for the re-establishment of the planting.

The fleshy seed cover is palatable to certain birds which inadvertently are instrumental in the dissemination of dichondra. After passage through the digestive tract of the birds, dichondra seed is sufficiently etched to permit germination readily. This might explain the appearance of dichondra in widely separated and isolated areas where none existed before.

LOW SALINITY TOLERANCE

During the warm season, dichondra enters a period of vigorous vegetative growth accompanied by a high respiration rate. Carbohydrates are utilized rapidly with little remaining for storage. This results in a relatively low sugar content and osmotic concentration within the plant. A corresponding sensitivity to saline concentration in the soil water must be recognized. This situation may account for the disappearance of dichondra from many lawns due to buildup of excess soluble salts. This would be especially true in the hot, interior valleys where large amounts of water are required and where the water normally contains a high percentage of salt. Where water and fertilizer have been used advisedly and judiciously, dichondra has survived long periods at 100°. Enough water must be applied to percolate to below the root zone and flush out accumulated salts. Frequent, shallow watering commonly thought advisable may lead to serious difficulties. Close mowing should be avoided to favor more foliage which would lend more shade to roots, prevent more water loss directly from the soil by lowered temperature, and encourage and support a deeper root system.

SUMMARY

1. The debilitating effects of flowering and fruiting on dichondra in late spring may be somewhat altered by supplying adequate nitrogen and other elements to the soil, by aerifying to increase the oxygen in the soil atmosphere and judicious watering to maintain a favorable aeration/moisture ratio in the root zone. Water in the morning to allow the soil to warm during the remainder of the day and so enter the night at higher temperature.
2. A build-up of rhizomes and stolons may be desirable as a reservoir of regenerative tissue where top growth may be lost through dessication, freezing or in scalping or defoliation for the control of certain weeds or dodder.
3. Salinity may be a major factor in the poor growth or disappearance of dichondra in many lawns, especially in hot regions. Avoid frequent, light waterings and fertilizer practices which result in the accumulation of excessive soluble salts.
4. The use of newly developed selective herbicides such as monuron and diphenamid greatly reduces the problem of weed control in dichondra.
5. The use of growth regulating chemicals shows promise in the control of dichondra during periods of stress such as are normal at the time of fruiting.
6. Selected strains of dichondra show promise of avoiding many of the undesirable features ordinarily experienced by the home gardener and may give rise to an even stand within a lawn which will require no mowing whatever.

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