California Turfgrass Culture

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Trees For The Golf Course

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A substantial part of the charm and attractiveness of some golf courses is in their trees, especially if they are native or have been chosen to give a definite character appropriate to the region. In recalling with pleasure the courses one has played on or visited, one visualizes the palms and palo verdes of the desert resort areas, the oak groves of some coastal areas and valleys, or the pines and incense cedars of mountain areas.

Not all superintendents are happy with the selection of trees on their courses. Few would plant again the large bark shedding species of *Eucalyptus* such as the blue gum, with their endless litter problem. The coast live oak is a beautiful tree but it is plagued in some seasons with foliage insects and diseases, not to mention also the oak root rot fungus which can be troublesome if drainage is poor or if irrigation is excessive. Trees with large leaves, especially if deciduous, may cause annoying trouble with lost balls. Nevertheless such trees as the native sycamore are particularly beautiful even when leafless because of their picturesque form and bark character and may be unobjectionable where mechanized leaf collecting or frequent mowing is used.

No tree is without certain faults from certain points of view, but this does not mean that tree selection should be careless. On the contrary, a prospective tree planting should often involve discussions with qualified persons of long experience in the particular area and the collection of full information on the trees under consideration.

Trees along fairways are used as guides for play and should provide pleasing vistas and settings for tees and greens. Care should be taken to avoid planting rapacious soil robbers close to tees and greens. Shade usually is undesirable on greens and should be kept at a minimum. Trees near a green should allow for good ventilation over the surface of the green or disease problems may be magnified, especially in hot, humid areas.

We think that one of the greatest opportunities with trees on golf courses is to develop an interesting and artistic skyline, something which can be developed in all too few locations. Probably only a clever landscape architect can take full advantage of such opportunities, but we have seen examples of planting by course superintendents which were tasteful and effective. In this discussion, we shall emphasize general principles and objectives rather than give specific recommendations or extensive plant lists. Remember that California is a state with unusually wide range of soils and climates.

A few helpful reference books for those interested in trees for the Western States will be mentioned and can be obtained through local book dealers or from the publishers. First, we shall mention a book which is unique in that it gives classified lists which aid in the selection of trees for almost every conceivable purpose and situation in the warmer areas of the U.S.A. This is Roland S. Hoyt's "Check Lists for Ornamental Plants of Subtropical Regions." (The Livingston Press, San Diego, California). Another quite different descriptive book is "Ornamental Trees" by Evelyn Maino and Frances Howard. (The University of California Press, Berkeley, or Los Angeles).

The familiar Western Garden Book published by Sunset Magazine, Menlo Park, California, is widely available and has usefulinformation on many trees. Finally those who wish to identify unknown trees by means of botanic keys will find McMinn and Maino's "Pacific Coast Trees" indispensable although unfortunately it does not include some trees which have come into recent popularity.

Reference books, although useful, cannot substitute for word of mouth information obtained from consultation with experienced superintendents in the area arboriculturists, nurserymen, landscape contractors, and other qualified persons, taking in account that their experience and observations, while valuable, may give only a part of the entire picture. Therefore information from a variety of sources is preferable.

Often the county farm advisors of the Agricultural Extension Service, especially in urban areas, have staff members who are competent in the field of ornamental plants. The street tree departments of most cities will have those who keep in touch with tree problems through participation in the National Shade Tree Conference, which publishes proceedings and newsletters.

The Department of Landscape Horticulture, College of Agriculture, Davis, California, has a research program on various arboricultural problems and should become an important source of information. On several other campuses of the University of California, investigations relating in some way to the insects, diseases, nutrition, or production of trees are in progress.

The Los Angeles State and County Arboretum at Arcadia, California, has an extensive program of introduction and testing of trees. Evaluations are also in progress in an area near the ocean and in Antelope Valley, a medium elevation desert. Their efforts will undoubtedly result in a richer, more extensive plant list. A number of other botanic gardens in the state have tree collections.

The Saratoga Horticultural Foundation, Saratoga, California, preserves and makes available superior clonal selections of many of the important ornamental trees, both evergreen and deciduous. Naturally the expense of budding or grafting these selections will add a little to the cost of the tree, but in view of the predictable and generally superior performance of the clonal selections, this added cost may be actually very trivial. Special features may include unusual forms, more vivid fall colors, resistance to disease, absence of fruits or seeds, and others.

Another group which represents considerable practical experience with trees is the Tree Seminar, a group meeting monthly in various locations in the greater Los Angeles area. Most of the heads of Park Systems or Street Trees in the area belong to this organization.

In planting of trees to mark fairways, we believe that there is often too much stiffness and formality caused by placing trees at regular intervals as in a row of telegraph poles. More natural clusterings and groupings will give a more pleasing effect. There should be some diversification of species in order to reduce the chance of disaster with the invasion of new insects or diseases. On the other hand, there should be large masses of certain species in order to obtain unity. A clutter of diverse forms and textures in a small area creates a restless, unsatisfactory effect.

Only to a limited extent is it wise to plant species of doubtful hardiness. Trees are so conspicuous in the landscape and take so long to develop to their full scale and beauty of form that foolhardy risks should not be taken. Severe freezes in California come on the average about once in 11 years. After a long period of mild years, planters become less cautious. The great popularity of *Ficus retusa* and of *Ficus nitida* in recent years has resulted in use in some areas where we personally expect severe damage, if not actual death at some unpredictable time in the future.

Some excellent trees cannot take the management practices to which they are subjected. For instance, on the fine textured soils of West Los Angeles, carob, *Pittosporum undulatum, Eucalyptus sideroxylon,* and coast live oak often make an unthrifty and unsatisfactory growth under heavy lawn watering, because of the impaired aeration.

The selection of really good street trees is distressingly small. However, golf courses can use effectively many of the larger trees which are entirely in scale with their surroundings.

Many beautiful flowering trees unfortunately do not meet the basic requirements for street trees. However, many of these could be worked into plantings for the golf course. In the warm areas, the jacaranda, the flame eucalyptus, melalucas, the erythrinas, tipuana, magnolias, *Prumus campanulata* and others can be considered. The smaller acacias, although short lived, provide seasonal color and do not take much space. Dogwoods, hawthorns, the red horsechestnut, deciduous magnolias, and redbuds are some of those which can be used in colder areas. Although Southern California is not favorable for fall leaf color, the sweet gums, ginkgo, tulip trees, Chinese pistache, and poplars contribute autumnal coloration. These lose their leaves each fall, being deciduous. Although there is a place for all kinds of trees, we suggest that the main reliance be on evergreen trees in California.

In the early years in the life of a tree, we suggest great restraint in pruning, or the development of the tree may be delayed. Many trees which tend to form weak trunks and to need staking could be developed without stakings if they were grown for a time virtually as a bush. Many troubles are created by premature pruning of lower branches. However, those not intended as permanent framework branches should be headed back.

The roots of some trees tend to be voracious and shallow, often extending far beyond the drip line of the outer branches. The blue gum eucalyptus, Monterey cypress, and the large acacias are notorious for this fault. Some trees which tend naturally to be deep rooting or tap rooted, when grown in turfgrass with frequent watering, tend to develop shallow root systems which compete for nutrients and water. For this reason, we urge care in locating large trees near greens or tees, unless the constant expense of mechanical or chemical root pruning can be financed.

Another needless expense which we would usually try to avoid would be chemical treatments for iron chlorosis which appears on certain tree species on alkaline soils or with irrigation waters of less desirable qualities. By cruising the local area and talking with well experienced persons, the choice of chlorosis susceptible trees can be avoided. Those who have to struggle with this problem which is so common in arid regions should investigate the chelates which can supply not only iron but other minor nutrient elements.

A survey of current trends would reflect the recent revival of interest in palms, especially in desert areas.

Coniferous evergreens, especially the pines, have been used, apparently with considerable satisfaction. Except in heavily massed areas, the needles do not seem to create a problem. The Monterey pine has been unreliable almost everywhere in Southern California. Some pines are declining possibly because of air pollution, but the Canary Island Pine seems to be one of the healthiest and most reliable. The Brentwood Country Club in West Los Angeles has many Canary Island pines planted between the fairways. It is tall, dense and upright and takes little space. The Aleppo pine is particularly good also, especially in hot dry places. Redwoods do well with water, but seem to be declining in Los Angeles possibly because of smog. The Italian stone pine is a beautiful skyline tree and we think that it could have been used to advantage on some courses, but it is so spreading that much space is needed. Torrey pine is always healthy but not particularly attractive in our opinion..

In the medium elevation deserts, Arizona cypress is good. Forbes cypress is disease resistant and is good in Southern California. Monterey cypress is so disease-ridden that it should never be used.

For skyline, if drainage is good and the climate is mild, the sugar gum and the lemon gum are unique. The Los Angeles Country Club has groupings of both and they are particularily notable when placed in groups where they may be viewed when approaching a green, A eucalyptus relative, the tristania, or Brisbane box has been particularly successful at this club. Flowering peaches and crab apples in well chosen varieties cover a long season of bloom and are freely used. Purple-leaved plum is also used for color. The sweet gum or liquidambar has been very successful and has fall foliage coloration. Oleander groups have been very useful on the courses of this club, which furnishes many examples of good use of trees. The Virginia Country Club of Long Beach is also notable for tree plantings.

Some of the older clubs have well developed, mature tree plantings. Some others have quite recently gone into an extensive program of tree planting. If intelligently planned, such a program can hardly fail to lend an increased dignity and beauty to the physical facilities of the club.

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Making Sand Greens Softer

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Excessively hard surface conditions sometimes develop on putting greens constructed primarily of fine sand. Turfgrass researchers at UCLA have advocated the use of special mixes of high sand content to simplify management problems of putting greens.

Usually the cause of excessive hardness is due to the failure to incorporate sufficient organic matter in the mix. A proper degree of resiliency is achieved when the organic matter content is about 15 to 20 per cent on a volume basis.

The undesirable hard condition is usually overcome by aerifying the green, removing the plugs, and topdressing with a mix unusually rich in organic matter, For this purpose, the use of a mix containing two to three parts of organic matter to one part of sand is satisfactory. Fine sawdust, peat, or a material such as digested sewage sludge may be used as the source of organic matter. The topdressing should be worked into the holes. It is usually necessary to repeat the aerification and topdressing treatment two or three times, a month to six weeks apart, to establish the desired resiliency.

An excessively dry green will also contribute to the hardness. When hardness is due to this condition irrigation frequency should be increased. If the green varies in hardness from place to place the uniformity of water application may be poor..

Aerificaion as a regular practice twice per year or more often, if conditions demand, is helpful in maintaining desirable water penetration and resiliency in greens.

MEMBERS OF THE FIRST SOUTHERN CALIFORNIA TURFGRASS RESEARCH ADVISORY COMMITTEE, 1948
Back row, left to right, F. W. Roewekamp, Vern Wickham, V. T. Stoutemyer, Gene Marzolf, William Bereford. Front row, *left to right: C. C. Simpson, W. P. Bell, William Stewart.*

Chemical Control Of Plant Growth And Development

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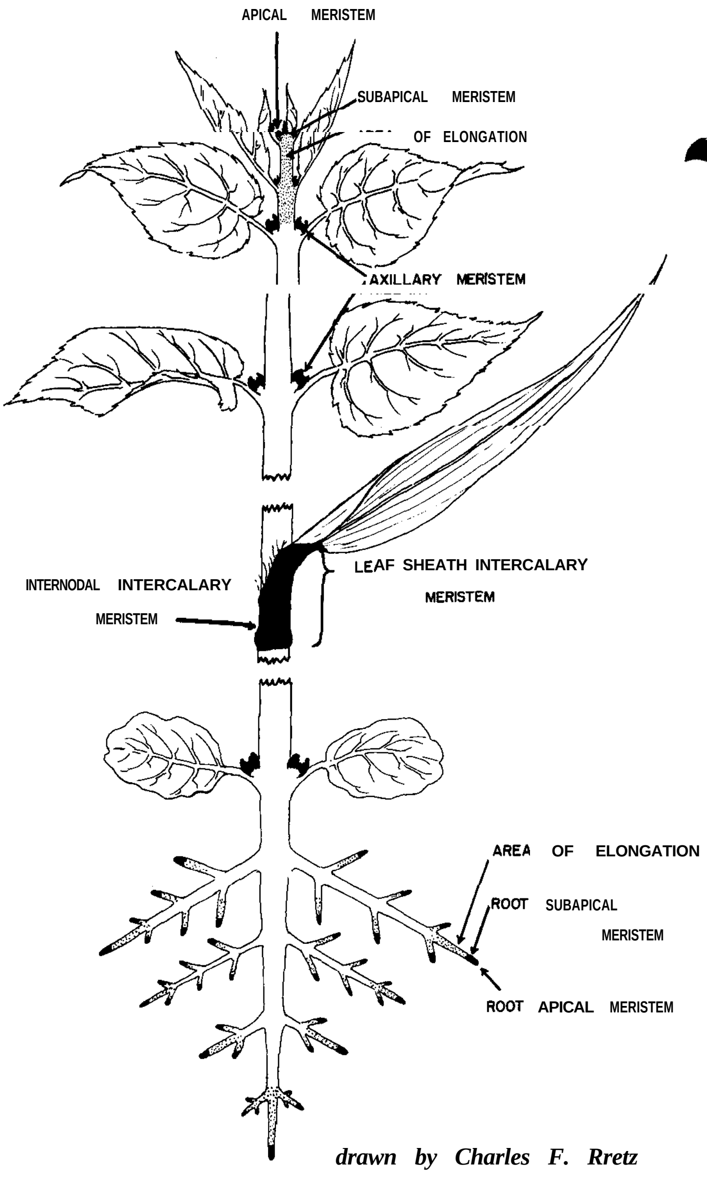
NEW DEVELOPMENTS

In the 30 years that have passed since the discovery of the first plant growth substance, auxin, our knowledge of plant growth has increased enormously. It is safe to say that auxin (identical or closely related to indole acetic acid) has been the basis for an entirely new approach to the study of plants and as a result has led to a revolution in agricultural practices. Herbicides, defoliants, fruit-drop inhibitors, and parthenocarpic agents were all byproducts of research with auxin. Today several new substances, the gibberellins,, quarternary ammonium carbamates and kinins promise to expand our basic knowledge of plant growth and development and, as with the auxins, improve and modify our approach to agricultural and horticultural problems. Strict chemical control of plant stature, growth habit, and perhaps longevity may be byproducts of current research with these growth substances.

These new aspects of growth control can best be understood after some basic principles of plant growth are set forth. It should be kept in mind that cells are the fundamental structural and functional units of all living things; hence, the growth (increase in volume) of plants must always be the result of an increase in cell size and/or cell number. The direction of expansion and pattern of formation of new cells determines the form of plants. Ordinarily both cell expansion and cell division (the process by which cells increase in number) operate simultaneously in plants, although cell division activity is localized to a considerable degree in regions called meristems. There are several kinds of meristems differing in their location and function. For example in the highly schematized plant depicted in figure 1, no fewer than 6 meristems are indicated: 1) the root apical meristem is responsible for the organization of the tissue pattern of the root; 2) the root subapical mecistem is responsible for the great increase in cell number of the various root tissues; 3) the shoot apical meristem determines the number and position of leaves and flowers and plays an important role in organizing the underlying tissues, its diameter may be correlated with the diameter of annual shoots; 4) the shoot subapical meristem is the major site of cell production for the cells of the elongate stem; 5) the axillary bud meristems are similar in organization and function with the apical mecistem yet for some reason their development is generally retarded and very much dependent upon the activity of the apical meristem; 6) the cambium is a circumferential tissue in which cell divisions add to the vascular tissues causing an increase in diameter of the shoot; the annular rings of perennial, woody shoots are the result of seasonal cambial activity; 7) the intercalary meristems are generally found at the leaf bases and nodal constrictions of grasses; activity in these regions is responsible for the major portion of the cells found in the leaves and is one of the reasons why grass blades must be continually clipped.

Although this may be an over-simplified version of the major growth centers in plants, it is essential to keep the concept of specific, localized meristems in mind in discussing chemical control of plant size and shape. If we add the regions in which cell expansion is most rapid, our picture of plant growth is nearly complete.

As the first, and perhaps most straightforward illustration, we can give some fairly precise examples of the control of shoot elongation, or plant height. We ace now certain that the gibberellins play a major role in the normal functioning of the shoot subapical meristem as well as in the elongation of cells. Most rosette plants having (highly compressed stems) that have been studied can be induced to form a stem by treatment with one or more of the gibberellins; in these cases the first events following gibberellin-application is the rapid increase in subapical meristematic activity, the new cells adding to



drawn by Charles F. Rretz

the length of the stem. Likewise the difference in stature of so-called dwarf (or bush) and normal (or vine) varieties appear to be related to a deficiency in gibberellin production in the dwarf members; as to be expected, gibberellin-treatment of the dwarfs in amplifying their shoot growth causes an increase in cell numbers and size. As we are beginning to learn the gibberellins are involved in the normal development of stems of most if not all plants, and hence any control over gibberellin production or activities is an invaluable tool for regulating plant height. Recently a new class of compounds, having a quarternary ammonium portion in their structure, have been shown to reduce stem growth without seriously interfering with other aspects of plant development. They are referred to as growth retardants. Amo-1618 is the best known and still the most readily available of these substances, although CCC (2-chloroethyl, trimethyl ammonium chloride) and AMAB (ally1 trimethylammonium bromide) are now being tested in several laboratories throughout the U.S. Our experience with Amo-1618 suggests that these compounds restrict plant height primarily through their inhibitory effect upon cell division in the shoot subapical meristem and upon expansion in the cells below. Two additional facts stand out: 1) Am-1618 does not inhibit shoot apical meristematic activity, and thus, flower and leaf initiation are nearly normal; 2) Gibberellic acid completely prevents or reverses the inhibition of stem elongation. It can readily be seen that by using substances such as Amo-1618 and gibberellic acid, in proper proportion and sequence, plant height can be altered in a very specific manner – this information has already been put to use in regulating the height of pot-grown chrysanthemums and poinsettias. Still, one of the most serious problems facing research with growth retardants is their limited range, i.e., many plants do not respond to Amo-1618 or related substances, and several laboratories are presently involved in a search for other physiologically similar compounds.

Maleic hydrazide and several phosphonium derivatives (in particular, Phosfon D, tributyl, 2, 4-dichlorobenzyl phosphonium chloride) have in some instances been used as growth retardants with striking success. They differ from the quarternary ammonium derivatives, however, in that they are generally quite toxic to plants and their use must be carefully regulated; also their inhibitory effect upon stem growth is not reversed by gibberellic acid, eliminating this avenue for more precise growth control. It is well known that maleic hydrazide inhibits meristematic activity in all regions of the plant, and, hence interferes with every aspect of plant development including flower and leaf initiation – another reason for the judicious use of this material.

Although the auxins have been available for three decades and their most important role was thought to be in the regulation of cell length, they have never proved valuable in controlling plant stature. However, several investigations indicate that the auxins may yet find use in controlling stem length in certain plants. For example, in the development of flower scapes, the shoot subapical meristem appears to be a major site of auxin action; however, full use of auxin in this case depends upon the presence of other unknown growth factors. These developments in the control of shoot growth may become extremely important in the field of turf-grass management. It requires very little stretch of the imagination to see that the discovery of non-toxic, selective, shoot growth-retardants for grasses would find immediate application. Generally speaking any substance which inhibits intercalary, but not apical, meristematic activity will probably be useful, since it would meet the requirements of preventing shoot and blade enlargement without interfering with axillary bud or tiller, stolon, and rhizome development. Amo-1618 is without effect on most grasses, however, the choline derivates (CCC and AMAB) may be useful in this respect,

If we shift our attention to chemical control of flower and leaf initiation, we find that we are on much shakier ground. The main reason for our uncertainty is that we are dealing with the most compact, delicate, and complicated region of the plant – the shoot apical meristem. The number of activities crammed into this region, sometimes no larger than a small pinhead, which in concert organize the future course of plant development, must be staggering. We know with fair certainty that it is within the apical meristem that the number, position, shape, size, and even rate of growth of the leaves are determined; it is here that the transition to the reproductive state, with all its involved floral structures, must take place. As if all this were not enough, the apical meristern also determines the shape of the vascular tissues (responsible for the transport of nutrients throughout the plant) and indirectly the size of the stem. Considering these complexities, it seems surprising that we have achieved chemical control of flower initiation in several plants; in the cases where such control is possible, we do not clearly understand the relationship between the treatment and the growth events occuring within the apical meristem. In fact most investigators now agree that the successes achieved with the auxins and gibberellins are probably the results of indirect effects of these substances upon some other parts of the plant. The search for flower-inducing or promoting substances is still extremely active, and, because our knowledge of the environmental control of flower initiation in many plants is rather good the chance of finding specific substances also appears good. In fact the main value of the gibberellins in the control of flowering is that they seem to be primarily if not solely effective within a certain group of plants – the longday, rosette plants (such as carrots, celery, lettuce) – which without gibberellic acid treat-- ment, ordinarily require a low temperature and/or long day treatment for flower initiation, Hence, finding the chemical relationship between gibberellin metabolism and the environmental control of flowering may lead us to the discovery of more specific substances useful in controlling reproductive development.

No development would be of greater interest than that of a substance which enhanced the leaf producing activity of the apical meristem. The number and disposition of leaves upon stems are two primary factors influencing the appearance of a plant. More importantly, leaf number is often correlated with the transition of plants from their juvenile to adult stage of development, which oftimes determines whether a plant will initiate flowers, whether cuttings can be rooted, the nature of the foliage, and the habit of growth. As yet no substance is available that specifically affects apical meristematic activity, although, as with the case for flower initiation, there is evidence that chemical control or modification should be possible. Light plays a significant role in activating apical meristems, and our knowledge of light effects upon metabolism has recently advanced enormously. A complex chemical system has been isolated from plants which behaves in every respect like the primary light receptor causing activation of the apical meristem. Whatever discoveries result from these investigations, they will undoubtedly advance our understanding of the effect of light upon plant growth and development in general for the light-receptor which activates the apical meristem apparently also controls or modifies stem growth, chlorophyll development, seed germination, and the response of leaves to daylengths effective for floral initiation.

One of the most novel substances discovered in the last decade is kinetin, 6-furfuryl amino purine, a substance which in conjunction with auxin has been shown to determine the development of plant tissues grown in test tubes (on nutrient media), both with regard to the rate of cell division and the course of differentiation into plant organs. For example, in some cases it has been possible to promote the formation of root apical meristems, in others shoot apical meristems, and in others both root and shoot development by choosing the proper auxin/kinetin balance supplied in the nutrient media. Almost without exception it has been shown that both kinetin (or some related substances) and auxin are required for cell division, a fundamental requirement for plant growth and organ development. As a result of these studies, we have come to believe that plants control their own development by adjusting the balance of two or more growth substances – not only auxin and kinetin but gibberellins and anti-gibberellins may be involved. Several new as yet unidentified kinins the general term given to substances promoting cell division in tissue cultures, have been isolated, and one or more of these substances may prove extremely valuable in the treatment of intact plants particularly in combination with auxin or gibberellin. For example, we now recognize that the proper rooting of cuttings is a problem that cannot be solved by the use of auxin alone; judging from the manner in which root apical meristems are formed on plants and the effect of kinetin upon root initiation in plant tissue cultures, it seems likely that future "rooting-compounds" may include kinetin-like substances combined in certain proportions with an auxin or mixture of auxins.

Generally speaking, the form of plants is largely controlled by pruning (or mowing) procedures. It is well known that the topping or pinching of plants forces development of lateral branches. The belief has long been held that auxin from the apical bud inhibits development of axillary meristems and, hence, lateral shoots. In tobacco, however, kinetin can force the rapid outgrowth of axillary buds even in intact, unpinched plants; in peas, it has been shown that by adjusting the kinetin/auxin balance axillary buds may be stimulated or completely repressed regardless of the presence or absence of the apical bud. Not all plants respond to kinetin and auxin in this fashion, but there is fairly convincing evidence that the apical portions of plants do produce substances that control the activity of axillary meristems and their subsequent outgrowth into lateral branches. From the viewpoint of one interested in the practical application of growth substances, these developments are most promising, particularly as they bear upon the establishment of turfgrasses. Any substance which promotes the outgrowth and development of tillers, rhizomes, and stolons will be of considerable value during the early stages of turf development (particularly since most grasses of commercial importance depend upon lateral outgrowths for their rapid establishment and subsequent competitive advantages).

Our fascination with kinetin-like substances would be justified if we considered only its effects upon bud development and cell proliferation, yet the most far-reaching kinetin-induced phenomenon has not been discussed. And this is its effect of prolonging the life and even further development of excised leaves. Recent studies have shown that kinetin-treated leaves retain their ability to synthesize proteins and carry on other vital activities for a much longer period than untreated ones, and in this way kinetin has extended the life of leaves of several different plants. Obviously such an effect is the result of a deep-seated involvement with some basic metabolic property of plant cells. This development is of potential commercial value and cheaper, more easily synthesized kinetin-analogs have been made available and are being rapidly tested for their effect upon leaf longevity. One such substance, N6 - benzyladenine, has been shown to greatly improve the keeping quality of lettuce; obviously an extension of this type of research can be exceedingly important for all aspects of agriculture and horticulture inasmuch as senescence is being approached for the first time from a chemical point of view. One can imagine the importance of substances prolonging the life of leaves of ornamental shrubs, cut flowers, and grasses.

The last problem of chemical control to be discussed is that of climatic adaptation. The goal of research in this field is to extend the geographical (climatic) range over which valuable plants may be grown. There is only one piece of evidence suggesting that such a goal is feasible, and this is with pea plants. Generally, peas must be grown in fairly cool climates, and in fact most varieties are damaged at 80°; yet one heat-sensitive variety has been grown at an average temperature 20° above normal after treatment with adenine (a substance related to kinetin). No other plants respond to adenine in this fashion, yet there is hope, particularly following the discovery of kinetin-effects upon leaves, that a series of substances will be discovered which will help protect a plant from excessively high or low temperatures. Here again, turfgrass management is directly concerned. Considering the deleterious effects of low temperatures upon Bermuda Grasses (and this is now the really main drawback to Bermuda lawns), any protective chemical would be extremely valuable.

In summary, I hope certain aspects of chemical control of plants have been made clear to the uninitiated but interested reader. He should now understand that plant growth is the result of cell division and enlargement, that the control of these activities depends upon the coordinated action of many substances acting at different sites, and that ultimately many more growth substances must be discovered before we can solve some of our present problems. Above all he should recognize that the chemical control of plant growth and development is in its infancy, that the development of growth-regulating substances is one of the direct or indirect goals in many fields of biological research, and that the realization of this goal is ever more dependent upon our knowledge of the most basic aspects of life itself.

GROWTH SUBSTANCES

SUBSTANCE	USES	MODE OF APPLICATION	AVAILABILITY
1. GIBBERELLIN o. gibberellic acid (gibberellin A_3) b. other gibberellins now being tested although not yet commercially available.	o. increase plant height b. induce flowering in biennials and in rosette, long day plants c. promote parthenocarpy d. increase fruit size e. improve and hasten seed germination; hasten melting of barley	spray; rarely toxic, readily soluble in water, active at low doses (l-50 ppm)	. Eli Lilly & Co., Indianapolis, Ind. Abbott Lab., Chicago, III. Merck & Co., Rahway, New Jersey . as free acid or as potassium salt; as ingredient in wettable powder
2. QUARTERNARY AMMONIUM CARBAMATES a. Amo-1618 b. others not yet in use	reduce plant height	spray, dip cuttings for short term; not toxic, soluble in water; doses for chrysanthemums, 50 - 100 ppm, using "dip-wetting" technique, 24 hour immersion	Rainbow Color and Chemical Co., Northridge, California
3. CHOLINE-DERIVATIVES a. CCC b. AMAB c. other compounds tested not readily available	reduce plant height	added to soil in solution or combined with potting mix; may cause foliar damage if applied as spray; doses depend upon pot size	American Cyanamid Co., Stamford, Conn.
4. PHOSFON D	decrease plant height	added to potting mixture or short term dip of rooted cuttings; damages foliage if sprayed; injures roots and/or retards their development; dose depends upon pot size	Virginia-Carolina Chem. Corp., Richmond, Va.
5. KININS a. Kinetin b. N6 · benzyladenine	a. improve keeping quality of leaves b. force axillary bud development c. vegetative propagation of plants	foliage spray, aqueous soln; may inhibit root growth; active in some cases at 2 ppm	Numerous biochemical supply houses Shell Development Co., Modesto, Californio

Soil Amendments - What Can They Really Do?

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Will a soil amendment improve your soil? Perhaps, but just as with other materials applied to soils, the use of amendments should be based on evidence of actual need of the material by the soil. Avoid putting amendments that you know little about on your soil in the hope that they may do some good. Instead, find out if your soil really needs an amendment, and if it does select the correct one to do the job.

To help you find out if an amendment will improve your soil, let's consider what amendments are and what they can do. By definition, a soil amendment is a material which improves a soil, not by adding plant nutrients as a fertilizer does, but by changing the physical or chemical properties of that soil. What do we mean by changing the physical or chemical properties of a soil?

To keep things straight, the two will be considered separately.

Changing The Physical Properties of a Soil

Ordinarily, the main purpose in changing the physical properties of a soil is to enlarge the pore spaces to make the soil more permeable to water and air. Soils that are most likely to be improved in this manner are fine-textured soils with poor structure (little aggregation), or compacted soils.

Those amendments which alter only the physical properties of a soil are correctly termed "soil conditioners." More and more, however. the term "soil conditioner" is losing its original meaning by being used synonomously with "soil amendment," the all-inclusive term.

Enlarging the pore spaces of a soil may be accomplished in either of two entirely different ways:

(1) By binding the fine particles of the soil into aggregates.

When organic matter decomposes, gums are produced, and these bind fine soil particles into aggregates. Even these gums, however, are decomposable in time by soil micro-organisms; therefore, if aggregates thus formed are to persist, organic matter additions must be repeated.

Since World War II a number of synthetic soil conditioners have appeared on the market. These compounds are comparable to the gums produced in the decomposition of organic matter. These synthetic compounds generally have long chemical names, such as vinyl acetate maleic acid polymer. Commonly these names are shortened by abbreviation, giving us VAMA, HPAN, and IBMA, the most common types of synthetic soil conditioners.

(2) By separating the soil particles further, thereby increasing the soil volume.

Materials that are resistant to decomposition must be used if this method of enlarging the soil pore space is to have a long-term effect. In addition, large amounts of such materials must be incorporated. Some of the commonly used amendments of this type include: peat moss, redwood shavings or sawdust, rice hulls, vermiculite, sand, etc.

Changing the Chemical Properties of a Soil

Exaggerated claims made for some products marketed as soil amendments have beclouded the issue of what soil amendments can really do to improve a soil by changing its chemical properties. An important point to remember is that chemical amendments are useful for correction of specific problems. Amendments are not panaceas or cure-alls for all soil conditions that are not what you would like them to be. If, however, your soil has one of the following two adverse chemical conditions, an appropriate chemical amendment may be highly beneficial:

(1) Very acid soil conditions.

A soil pH level between 6 and 7 is considered to be desirable for a broad range of plant species. A few acid-loving species do better at lower pH levels.

When the pH of a soil drops to around 5 or below, this is indicative of an extremely acid soil condition. In such cases, addition of a liming material to increase the pH of the soil may be beneficial and should be considered. Some amendments used for this purpose include ground limestone, quicklime, hydrated lime, marl, oyster shells, sugar-mill and paper-mill waste lime.

(2) Excess sodium in the soil.

Excess sodium is a problem in some areas of California. Generally such soils occur where there has been a high water table (within a few feet of the soil surface), and the sodium content of the groundwater has been high in proportion to calcium and magnesium. The main symptom of an excess sodium condition in the soil is extreme impermeability. After an irrigation or a rain, water may stand on the soil surface for weeks or more.

If you suspect an excess sodium condition, your soil can be analyzed to determine its exchangeable sodium percentage (ESP). If the ESP is 15 or above, this is indicative of an excess sodium condition. The problem can be corrected by applying a suitable amendment to replace the excess sodium, and then leaching to wash the replaced sodium out of the soil. Adequate drainage is essential if the latter is to be accomplished.

Some suitable amendments for replacing excess sodium are: gypsum, sulfur, sulfuric acid, iron sulfate, calcium chloride, and lime-sulfur. Your local University of California farm advisor can advise you on the use of these amendments.

If you do not have one of the above two adverse soil chemical conditions, i.e. a very acid soil or one with an excess of sodium, no chemical amendment is likely to improve your soil.

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