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ANTITRANSPIRANTS

. . . uses and effects on plant life

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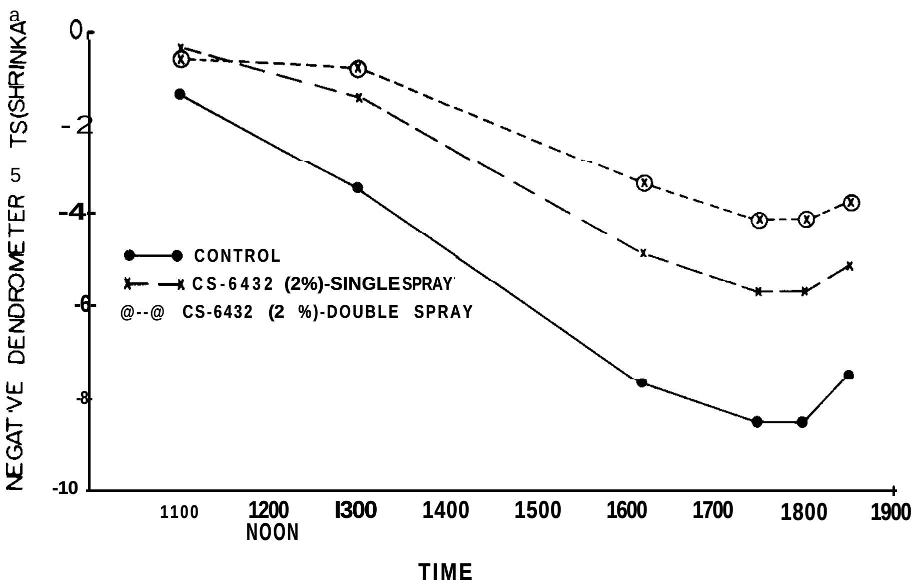
This review of recent research data on application, effects and potential uses for antitranspirants in plant growth shows particular possibilities for conserving irrigation water, aiding plant survival under dry conditions, and protecting foliage against fungus, insects, smog, and salt spray. This information is not to be considered a recommendation of the University of California. Continued research is necessary to determine which materials offer the maximum reduction in transpiration with minimum reduction in photosynthesis, as well as optimum concentrations and application methods. A list of some antitranspirant materials (naming manufacturers and addresses) is available upon request to California Agriculture, Agricultural Publications, University Hall, University of California, Berkeley, California 94720.

EFFECT OF EXPERIMENTAL FILM-FORMING ANTITRANSPIRANT (CS-64321, AS A SINGLE OR A DOUBLE FOLIAR SPRAY, ON THE DAYTIME SHRINKAGE OF ALMOND TREE TRUNKS
(One dendrometer unit = 508 x 10^{-5} mm.)



Antitranspirants are chemicals capable of reducing the transpiration rate when applied to plant foliage. Since water loss normally occurs through the stomata1 pores in the leaves, antitranspirants are usually foliar sprays, although they may sometimes be used more conveniently as dips for immersing the above-ground plant parts. The idea of coating plant foliage with waxy materials to curtail transpiration, particularly for transplanted seedlings, is not new, but research in this field is relatively recent.

Foliar sprays may reduce transpiration in three different ways: (1) reflecting materials reduce the absorption of radiant energy and thereby reduce leaf temperatures and transpiration rates; (2) emulsions of wax, latex or plastics dry on the foliage to form thin transparent films (see photo) which hinder the escape of water vapor from the leaves; and (3) certain chemical compounds can prevent stomata from opening fully (by affecting the guard cells around the stomata1 pore), thus decreasing the loss of water vapor from the leaf.

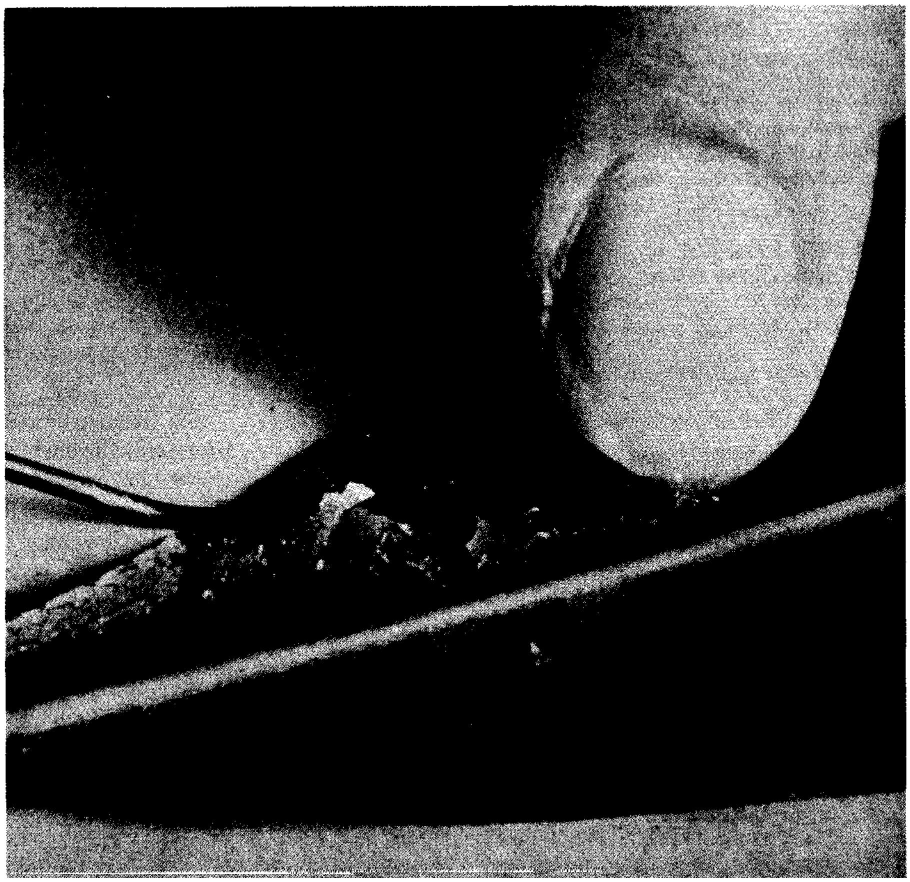
Effects

Since stomata serve as portals for both the loss of water vapor and for the intake of carbon dioxide (which is necessary for photosynthesis), an antitranspirant barrier against water loss also may reduce plant growth.

Reflecting materials do not cause blockage of stomata1 pores when they are applied to the upper surfaces of leaves with stomata exclusively on the lower surfaces. However, such coatings may curtail photosynthesis on overcast days when light is limited.

Theoretical analysis and experimental data indicate that stomata-closing antitranspirants should cause reduced transpiration ratios (less water transpired per unit of growth) provided the applied chemicals do not damage the plant's internal photosynthetic mechanism. This was illustrated by measuring transpiration and dry weight of creeping red fescue grass, *Festuca rubra* (see table). Although dry weight was slightly reduced by a moderate concentration ($10^{-3.5}$M) of the stomata-closing antitranspirant, phenylmercuric acetate (PMA), the accompanying large reduction in transpiration resulted in a transpiration ratio lower than that of the control. On the other hand, a stronger ($10^{-3.2}$M) solution of PMA increased the transpiration ratio because of the large decrease in dry weight caused by phototoxicity.

Film · forming antitranspirants can cause large reductions in transpiration rates, but since the H_2O : CO_2 permeability ratios tend to exceed unity for currently available film materials, the transpiration ratios may not be reduced. Thus, 2 hours after application of an experimental film-forming material (CS 6432, supplied by the Chevron Chemical Company) on oleander *(Nerium oleander)* leaves, the transpiration ratio was increased from 257 to 285, because of a greater reduction in photosynthesis than in transpiration (see table). Measurements on the same leaves two days later showed that the transpiration ratio had been decreased to 232 because photosynthesis was impeded less. The increased photosynthesis observed is probably the result of the decreasing continuity of the film on the leaf surface. It is difficult to maintain a continuous film over the entire leaf surface. This May actually be advantageous by preventing large reductions in photosynthesis, while still achieving a retardation of transpiration.



Film-forming antitranspirant (polyvinyl chloride complex) was applied to the entire leaf surface but only that portion of the film loosened by the needle is visible in photo.

Reducing plant growth

Reduced plant growth is not always disadvantageous. The possibility of using antitranspirants on grass to reduce both the frequency of irrigation and mowing is an attractive prospect which merits further investigation. The use of antitranspirants to decrease transpirational water losses from shrubs and trees on watersheds, where increased water yields may be more important than any harm caused by growth reductions, is a promising field for research and studies along these lines have been carried out in Connecticut and Utah.

University experiments are now being conducted with antitranspirant sprays on oleanders planted in the median strips on California's freeways to reduce the frequency of irrigation-an expensive and hazardous operation. Growth reductions from the use of antitranspirants should not be disadvantageous once the oleanders have attained a height effective for screening headlight glare.

Growth retarded

Growth is retarded by natural stomata1 closure when an untreated plant wilts, because of low soil water potentials and/or high evaporative demand. By slowing down the rate at which water is lost, antitranspirants will help to prevent or at least will delay wilting. Therefore, treatment with an antitranspirant must be made as a preventive measure before the onset of wilting.

Measurements with dendrometers have shown that the trunks of trees may shrink considerably during the day when water uptake lags behind transpiration. When the foliage of five-year-old almond trees was sprayed with an experimental film-forming antitranspirant (CS-6432) the amount of daytime shrinkage of the trunks was reduced by over 50 per cent, indicating that the water balance of the tree had been improved by the curtailing of water loss from the leaves (see graph). Radial trunk growth was reduced by 30 per cent, but no measurements have yet been made on the yield of nuts.

While antitranspirants of the reflecting type cause a reduction in leaf temperature, the film-forming and stomata-closing types tend to increase leaf temperature by curtailing transpiration rates and thus reducing evaporative cooling. However, under normal conditions the increase in leaf temperature is not very great since thermal emission, rather than evaporative cooling, is the most important means of heat dissipation.

Although it is known that the rate of mineral nutrient transfer within the plant is related to mass flow of water, the use of an antitranspirant, and the resulting reduction in transpiration (which is unlikely to exceed 30 per cent under field conditions), should not reduce the rate of mineral supply to the leaves sufficiently to retard growth. Present evidence suggests that antitranspirants will affect growth much less by altering leaf temperature and mineral nutrient supply than by retarding carbon dioxide supply to leaves.

Application

It is important to use the correct concentration of the stomata-closing materials to avoid phytotoxicity effects. Phenylmercuric acetate (PMA), in particular, must be used with care since it is a mercury containing metabolic inhibitor. Optimum concentrations may vary from 10^{-4}M (dilute) to 10^{-3}M (strong), depending on plant species. Plants differ considerably in their sensitivity to these chemicals so it is advisable to make visual observations of a few test leaves prior to any extensive use. Film-forming and reflecting materials are not likely to pose problems of phytotoxicity, although some browning may occur on leaf tips if high concentrations of emulsions flow to the leaf tip and congeal there. When seedling are dipped in a film-forming emulsion, it is important to see that the roots are not coated by the solution since water uptake may then be retarded.

EFFECTS OF ANTITRANSPIRANTS ON TRANSPIRATION RATIOS OF CREEPING RED FESCUE AND OLEANDER PLANTS-RATIO OF WATER TRANSPIRED (T) TO DRY-WEIGHT PRODUCTION (DM) OR TO PHOTOSYNTHETIC ACTIVITY (P)

CREAPING RED FISCUE (Festuca rubra)

Treatment	T (mg/ pot)	DW (mg/ pot)	T/DW
Control	93360	45.5	2052
PMA $10^{-3.5}$ M (moderate concentration)	76970	44.4	1743
PMA $10^{-3.2}$ M (high concentration)	65940	29.8	2213

OLEANDER (Nerium oleander)

Treatment	T (mg $H_2O/dm^2/h$)	P mg $CH_2O/dm^2/h$	T/P
Control	1270	4.95	257
CS-6432 (3%) (One hour after treatment)	870	3.05	285
CS-6432 (%) (Two days after treatment)	890	3.83	232

Stomata

Stomata-closing sprays are effective in extremely dilute concentration. Thus, they may be expected to be less expensive to use than other antitranspirants if their unit costs do not appreciably exceed those of other types of materials. For example, PMA at 10 cents per gram used at the rate of 15 grams per acre (diluted in 100 gallons of water) would cost only $1.50 per acre. The volume of spray to be used per acre will depend on the nature of the vegetation since the primary consideration (at least for the film-forming and stomata-closing antitranspirants) is coverage of the stomata-bearing surfaces of the leaves. On the 15-foot almond trees, about 1 gallon of spray per tree was applied with a mist blower, ensuring that the lower leaf surfaces were wetted (there are no stomata on the upper surface of an almond leaf). In one of the treatments the trees were sprayed a second time, about one hour after the first spray had dried (see graph). This resulted in less trunk shrinkage than in the control or single spray treatment because more complete coverage by the spray was obtained, and perhaps because thicker films were formed on the leaves.

The duration of antitranspirant effectiveness determines the frequency with which respraying is necessary and its economic usefulness. The duration depends on the efficiency and durability of the material, effectiveness of the spraying operation, environmental conditions, and the amount of new foliar growth produced by the plant after spraying. Thus, the effect may last from only a few days to several weeks.

Complete coverage of the stomata-bearing surfaces of leaves is impossible to achieve on a field scale, partly because of difficulties in wetting the leaves (which can be overcome by the use of surfactants) and partly because of crop geometry. It is not likely that all the lower and inner leaves of a crop will be hit by the spray. Since the highest rates of transpiration occur from leaves in the outer periphery of the plant where radiation and ventilation are greatest, these leaves should receive most of the spray.

The most obvious use of antitranspirants is to conserve soil water and thereby reduce irrigation frequency. However, applications for this purpose would be justified only if water costs are sufficiently high and if possible water savings are relatively large in comparison with application losses during irrigation. Antitranspirant treatment of watersheds or grassed areas where plant growth is not a prime factor is being investigated. Other possibilities include their use to aid survival of established and valuable plants in drought situations, to increase survival of transplanted seedinglings, to extend the range of environments in which favorable growth and yield can be obtained from plant types sensitive to water deficits, to reduce winter kill, to treat plant material for shipping, and to reduce the rate of desiccation of cut Christmas trees. There is some evidence that an antitranspirant fihn on foliage may provide a physical barrier against fungus and insect attack and that it may also reduce injury from smog and salt spray. Incorporation of an antitranspirant in a pesticide spray, assuming there is no incompatibility between the two materials, would greatly reduce application costs. Some film-forming sprays polymerize slowly on the leaf surface, thereby increasing the residual effect of the incorporated insecticide or fungicide. Numerous potential uses of antitranspirants are yet to be investigated.

This information is not to be considered a recommendation of University of California. Continued research is necessary to determine which materials offer the maximum reduction in transpiration with minimum reduction in photosynthesis, as well as optimum concentrations and application methods.

PROGRESS REPORT:
ELECTRICITY IN CLIMATE CONTROLFOR WINTER-GREEN BERMUDAGRASS

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Los Angeles State and County Arboretum

Bermudagrasses have a high heat and light require ment. Even when other conditions are optimum, bermuda will lose vigor and fail to grow proportionately when these factors become limiting as in shaded locations or during subtropic or temperate zone winters. Having no definite dormant period, bermuda will grow proportionately as heat and light from natural or artificial sources approach its maximum requirements. Loss of color from bermuda foliage is due to the high rate of destruction of its chlorophyl under conditions of high light intensity and low temperature and a concomitant low rate of chlorophyl synthesis. Thus the familiar straw-colored, "dormant" bermuda of our winter season reflects only the inadequacies of climate in our particular environment.

In a broad sense, home gardeners are generally aware of the response of plants to horticultural practices such as mowing, watering, fertilizing and the like. Seldom do they realize that the visible effects in plant growth may have been produced indirectly by changes such practices exert on the climatic environment.

For example, close mowing permits more light to reach the soil surface, thus increasing soil temperatures and stimulating light-sensitive seeds (often weed seeds) to germinate. The surface soil, being more exposed, loses moisture faster through evaporation which results in a lower humidity, thus inhibiting the spread of disease-producing fungi or of competing plants having a high moisture requirement.

Certain Benefits and Limitations of *Water*

Water has a wide range of influences on climate, according to its use and disposition within the terrain. In large bodies, such as lakes or oceans, it tends to alternately absorb and release large amounts of heat energy so as to modify extremes of temperature. In metered amounts and timed applications, water was used recently in an experiment at the University of California South Coast Field Station, Santa Ana, to maintain night temperatures adequate to keep bermudagrass green through the winter. Because of the large volume required to be effctive, this method does not appear to have a wide practical application except in areas such as Santa Ana where winter temperatures are modified by coastal influences.

In Europe and other places, heated water or steam has been piped under turf to maintain soil temperatures adequate for the growth of grasses during the winter. This practice, also, has not proven to be economically feasible.

The evaporation of water is promoted through the absorption of heat energy and contributes to an increase in humidity and a decrease in tempature, a condition which would reduce transpiration. This is the principle involved in the horticultural practice of syringing to alleviate insipient wilting.

Water has the capacity to absorb large quantities of heat without a comparable rise in its temperature. For this reason it is generally inadvisable to irrigate lawns in the late afternoon when higher temperatures and lower humidities are desirable into the night for improved disease control, or even for better germination of seed in a newly planted lawn. For this same reason, it has been shown to be undesirable to permit excessive amounts of water as rain or irrigation to infiltrate into the soil when attempts are being made to maintain higher than normal soil temperatures. Tarps of clear plastic have been used to protect turf areas from this unwanted precipitation.

Certain Benefits and Limitations of *Plastic Tarps*

Acting to transmit incoming solar radiation and to inhibit re-radiation of heat from the soil, a similar protective covering of clear plastic, supported a few inches above the turf, has been shown to be effective in maintaining soil temperatures adequate to sustain winter color in grasses and certain other plants in mild climates. Esthetic considerations and problems such as excessive humidity, reduced air circulation, and the difficulty of application and removal make this practice one of questionable value in many situations.

A new type of plastic is being developed that shows promise in modifying the spectrum of the light it transmits in favor of the wave lengths that are most effectively used by plants. This added value of a plastic covering could enhance its usefulness tremendously if used in combination with all the other factors previously mentioned for climate control.

Varieties and Management

Certain improved varieties of bermudagrass inherently remain greener through longer periods of the year than others. Good management practices such as thatch control and the prudent use of nitrogen fertilizers can induce vigor and contribute to an even longer period of green, even with common bermuda. However, color is lost, regardless of the excellence of care when temperatures drop sufficintly and light intensities are high. Increasing light levels over large turf areas is at present impractical, but the problem of maintaining adequate temperatures in the soil is within the ability of present day technology.

The Electrical Resistance Cable

A very practical source of heat energy is the electrical resistance cable. These cables have been used in colder parts of the country for many years, implanted in walks and driveways to keep them snow-free in winter. They have been used in plant propagation to supply bottom heat in seed and cutting beds. Studies conducted at the Arboretum and at other places across the country have demonstrated the practicality of using these cables embedded m the lawn to help maintain temperatures adequate for growth and color in grasses during the winter. Climate control by supplying supplemental heat electrically to the soil in the root zone has many practical applications in athletic fields, golf or bowling greens and other high value, high use turf areas, not excluding the home lawn.

History of Existing Installations

Perhaps the first attempt at using this electrical resistance cable in turf was made by J. R. Escrit at Bingley, England, as early as 1951. Several commercial installations were subsequently made in England, Scotland, and Sweden. The Farm Electrification Research Branch of the U.S. Agricultural Research Service, working cooperately with the Departments of Agronomy and Agricultural Engineering at Purdue University in Indiana were the first to investigate the use of the cable in America.

Later installations have been successfully operated at Lethbridge in Alberta, Canada, at Busch Stadium in St. Louis, at Falcon Stadium at the U.S. Air Force Academy in Colorado Springs, at Texas A. & M. University in College Station, and at several other locations.

The grasses used have included the full range of the varieties used for lawns, chiefly St. Augustine, beruda-grasses, bentgrasses, bluegrasses, zoysia and rye.

Studies at the Arboretum

Investigations at the Arboretum were inintiated during the late summer of 1966. Ten reels of heating cable were supplied by the Easy-Heat Division of the Singer Company of Lakeville, Indiana, along with accompanying thermostate controls. The cost of installing electrical service to the research site and connecting the cables to the control panels was underwritten through a grant by the Southern California Edison Company. Specialized equipment used in inserting cable into the sod was sup plied by The Ryan Equipment Company of St. Paul, Minnesota, and the Pacific Toro Company, including its affiliate Moist-0-Matic Division, of Los Angeles and Riverside. Recording Thermographs were loaned by California Turfgrass Nurseries of Camarillo. Installation and inspection of electrical service and connections were performed by the Mechanical Division of Los Angeles

Ten plots were laid out in a well-established stand of Tifgreen bermudagrass, each 3 feet x 20 feet, and separated by a 3 foot x 20 foot control plot. These were arranged in two rows of five plots each, spaced 6 feet apart. An additional control plot was added along one length of each of these rows at the east and west end.

These plots were randomized but, due to the limitation of equipment, were not replicated. Based on information then available, a spacing and burial depth of 6 inches was selected. Plots were designated as follows:

Plot No.	K Key	Wattage of Cable* per lineal foot	Watt Density of Plot per Square Foot	Temperature Operating (Degrees F.)
1	D		2.5	
2	A	5.0 1.25	10.0	560
3	A	2.5	5.0	50
4	C	2.5	5.0	60
5	A	5.0	10.0	55
6	B	3.75	7.5	50
7	B	3.75	7.5	60
8	C	2.5	5.0	55
9	A	5.0	10.0	60
10	B	3.75	7.5	55

*Physical Description of Cable: Solid core resistance wire (Nichrome and copper alloy) with P. V. C. primary insulation 3/64 inch and nylon jacket, with copper overbraid grounding provision. Hot to cold lead junction of waterproof, encapsulated, pressure type sleeve connectors joining heating section to 10 feet U. F. type cold leads of stranded #IO AWG copper conductors. — Courtesy Easy Heat Division, Singer Co.

During the first year the minimum operating temperature that would produce satisfactory results was to be determined, as well as the minimum watt density capable of sustaining that temperature. It was projected that during the second year, all plots would then be operated at this minimum temperature, with an overview on the performance at the various watt levels.

Installing the Cable

The cable at Texas A. & M. University and at Falcon and Busch Stadiums was installed in bare soil, using a modified sub-soil plow to open the trenches. Turf was grown later. At Lambeau Field (Green Bay Packers), cable was installed in existing turf, using a rolling coulter to slit the bluegrass sod, followed by a cable-laying device. The Texas A. & M. University installation consisted of cable spaced variously from 3 to 12 inches and attached to 1/2 inch mesh hardware cloth which was then placed in their plots at depths of 2, 4, and 6 inches.

The Arboretum installation required a completely different approach due to the nature of the investigation. First, the well-established Tifgreen bermudagrass sod had a tough and extensive rhizome and root system that required heavy and powerful equipment to slit. With such equipment it would have been extremely awkward to make the numerous 3 inch radius turns required by the 6 inch spacing of the cable. Also, slits in this well-knit sod could not be closed accurately enough to insure good soil-to-cable contact necessary for reliable heat exchange.

The method that finally proved satisfactory involved excavating the trenches 1/2 inch wide, using a modified arrangement of tynes on the Toro Mole Trencher. These carbide-tipped tynes have staggered angular blades towards the end, enabling an operator to open a trench up to 3 inches wide by selecting the proper set for mounting into a hb-disk. The depth of cut can be regulated to about 8 inches. Soil is removed by the whirling tynes and deposited at the surface, parallel with the trenches, by a chute.

Accurate spacing was obtained between the trenches by using a 1 inch x 6 inch straight-edge, anchored in place, as a guide for the wheels of the Toro Mole.

In the absence of a laying device, the resistance cable was then inserted into the trenches of the test plots by hand from individual reels, and immediately secured at the 6 inch depth with soil. This backfilling process was rather tedious since the trench was only 1/2 inch wide and the soil had a tendency to bridge over rather than fall in. This necessitated much packing in of small quantities of soil at a time, using a contrived tamp of 1/2 inch plywood.

The magnitude of this task is better appreciated when one realize-s that the total length of the trenches amounted to over 1/3 of a mile. However, due to the extreme importance of eliminating all air spaces around the cables, every precaution was taken to firm the soil back into place.

The ten-foot cold leads from the cables were installed to the individual thermostat control, entering from underground through conduit. Similarly, the leads to temperature sensors left the thermostat through conduit to underground and the sensors installed in the center of each plot at a depth of 3 inches, positioned halfway between two cable-bearing trenches.

Duplicate trenches were excavated and backfilled in the two east and west control plots, although no cable was installed. Any possible effect of this vertical cutting could then be observed by comparison with the remaining checks.

Installation was completed too late in the 196667 winter to gain much information. However, preliminary tests were made that yielded very promising results. The system was again energized on December 1, 1967. Outside temperatures were sufficiently low to engender ob servable results by December 27. Numerous records of temperatures and ratings of the plots were taken before the termination date of the 14th of February, 1968. These were considered too inconclusive to be included here.

Similar tests were run between December 1, 1968 and March 1, 1969, except all plots were operated by thermostat control at 60°F. During this period the weather was characterized by some of the coldest periods ever recorded at the Arboretum, as well as the wettest. The abnormal amount of precipitation nullified any meaningful performance by the cable, especially so, since no provision had been made for employing plastic tarping. However, all the heated plots were satisfactorily green except 1-D with only 21/2 watts per foot heat density. Results were further obscured by a heavy invasion of *Poa annua,* Annual Bluegrass, which grew well even in the check plots.

Extensive studies are now underway at the Arboretum to determine effective measures for pre-emergence control of P. annua. The more promising of these results will be employed next winter when further trials with the heating cables will be conducted.

A review and analysis of the data taken so far during this investigation has revealed several interesting trends, some deficiencies in the equipment used and a glaring shortage of recording instrumentation.

A very high quality of turf was produced on the plots designated to be maintained at 55°F. and 60°F minimum, by thermostat control. Theoretically, this imbalance in soil and air temperature, especially at night, would encourage the development of a greater root system, retard top growth, increase nutrient intake, stimulate chlorophyl formation, increase carbohydrate levels, and produce a dense, fibrous leaf and stem tissue. To date, no laboratory tests or measurements have been made to ascertain the degree to which any of these may have occurred. However, visual results observed suggested that all or most of these physiological processes were taking place.

The growth of the turf was very slow and did not necessitate mowing during the test run of over two months. This would suggest that the lower air temperature was elevated above that of unheated plots but may have lost heat by radiation and convection air currents. The resultant leaf temperature was probably adequate for chlorphyl formation and for photosynthesis to proceed at productive rates, which would have resulted in the excellent leaf color and texture observed.

There was a differential between the growth of turf proportionate to the temperature maintained in the soil. Physical limitations precluded more extensive tests that might have disclosed a maximum growth rate under the environmental limitations of the season. In situations where a higher growth rate would be required, such as in areas of high traffic and use, adequate temperatures might be provided but light might become limiting in both quantity and quality for the satisfactory growth of bermudagrass.

Preliminary tests involving three nitrogen level were not adequate to show any significant results. However, it is almost certain that nitrogen could become an important factor under more controlled conditions.

The low maintenance of the plots and the high quality turf resulting could suggest that the cost of supplying electricity for the heat energy might be equally offset by a lower maintenance cost than that of other methods used to sustain winter color in bermuda, such as overseeding. This would make this type of installation one of great interest to the home gardener.

Unfortunately, no meters were available to determine the actual power consumption. Also, various management programs would need to be investigated that might minimize heat loss such as the use of plastic tarps permissible thicknesses of thatch in the turf as a natural insulation, regulation of the amount of water applied, mowing height, etc.

Data on temperatures were taken during the late afternoon and proved to be of limited validity in this study. Only a one-week period of night temperatures was recorded and this indicated a range of 18°F. in the soil while air temperatures for the same period ranged through 48°F. Several factors might be involved: Inaccurate thermostat, unfavorable location of sensor, maladjustment of recording thermograph, or inadequate watt density of cable. Further study is need to make a determination.

It appears that the cable could have been spaced to a more economical 12 inches apart since check plots adjacent to the heated ones showed considerable response.

Conclusions

The resistance cable energized by low-cost electricity available in most parts of Southern California proved to be an excellent method of maintaining adequate temperatures in the soil for the production of a beautiful, green bermudagrass turf throughout the winter. There appears to be a practical application of this method in all types of lawns, but especially in high value turf such as athletic fields, golf and bowling greens.

Installation costs could be expected to be lowered by the use of improved implements to implant the cable into established turf. Electrical service at many sites is already adequate, especially at athletic fields where facilities for night lighting exist. Cables may be operated during off-peak hours and at even more favorable rates where night lighting is used. Accessories such as plastic tarp for control of moisture and prevention of heat loss could further reduce operating costs.

Thus it is projected that sustaining winter color in bermuda and other lawn grasses can be accomplished successfully through the used of the electric resistance cable and at a cost competitive with other methods now being used.

THE STORY OF COHANSEY

BY E. R. STEZNIGER, Superintendent, Pine Valley Golf Club, Clementon, N. J.

In 1933 an outstanding patch of creeping bentgrass was first observed on our fourth green of Pine Vallev. which is an old South German mixed bentgrass green. In 1935, after close watching and recording the behavior of this strain, one square foot of it was planted in our nursery along with other selected strains. Later in the year the first sizable plot (3,500 square feet) was established in our turf garden. Its fine texture and upright growth made it a fine putting green turf, and its light green color was pleasing to see.

In 1939 Dr. lohn Monteith. Jr., and Fred V. Grau introduced this strain into the turfgrass gardens at Arlington, Va., and designated it as C-7. The "C" designation was the code for creeping bentgrass selections tested by the Green Section. C-7 did very well at Arlington, and later at Beltsville, Md., except for a little dollar spot; in fact it did so well that prior to World War II, when the 'pie greens" were laid out all over the country by the Green Section, C-7 was included. The performance of the nationwide tests was reported in the June, 1944, issue of the Green Section's publication "Timely Turf Topics" as follows:

Four-Year Summary of Ratings of Creeping Bents in Experimental Greens

"Data from the experimental greens established in 1939 and 1940 by the Green Section in many parts of the country have been summarized during the past winter. Since the summaries reveal much of interest to those responsible for putting greens now and in the postwar period, it seems advisable at this time to publish some of the inescapable conclusions.

"For those who are not acquainted with these experimental greens it may be stated that the typical green is composed of 12 or more wdege-shaped sections, each planted with a single strain of creeping bent. So far as possible the greens were used throughout the test period as regular or practice greens so as to expose each of the grasses to the customary wear and tear of play. For comparison purposes each green contained wedges of one or more of the three commercially available vegetative strains - Washington bent (C SO), Metropolitan bent (C 51), and Old Orchard bent (C 52).

"In addition, sectors were planted with one or more of the following commercially available seed: Seaside creeping bent (C 60), Astoria Colonial bent (C 61), and Highland Colonial bent (C 65). The remaining sectors were planted vegetatively with strains of creeping bent which had been assembled by the Green Section from various parts of the country and had proven most promising in the tests over a period of years in plots maintained under putting green conditions in the trying climatic conditions on the turf garden at Arlington, Va. Usually only six or seven of these strains were included on anv one green. In all. 19 strains were tried on one or more of these experimental greens.

'They are as follows:

Strain	Club Where Found Originally	City	State	Date
C l	Country Club of Atlantic City	Atlantic City	N.J.	1928
c 4	Arlington Turf Garden	Arlington	Va.	1934
c5	Arlington Turf Garden	Arlington	Va.	1934
c7	Pine Valley Golf Club	Clementon	N.J.	1935
C8	Baltimore Country Club	Baltimore	Md.	1935
C9	Washington Golf & Country Club	Arlington	Va.	1936
c 11	Washington Golf & Country Club	Arlington	Va.	1936
c 12	Los Angeles Country Club	Beverly Hills	Calif.	1936
c 14	Toronto Golf Club	Long Branch	Ontario	1936
C 15	Toronto Golf Club	Long Branch	Pa.	1936 1936
C 16	Rolling Green Golf Club	Springfield		
c 17	Manor Country Club	Norbeck	Md.	1936
c 19	Congressional Country Club	Bethesda	Md.	1936
C27	Washington Golf & Country Club	Arlington	Va.	1937
c 28	Washington Golf & Country Club	Arlington	Va.	1937
C 32	Congressional Country Club	Bethesda	Md.	1936
c35	Manor Country Club	Norbeck	Md.	1937
C 36	Manor Country Club	Norbeck	Md.	1937
C38	Arlington Turf Garden	Arlington	Va.'	1937

Commercial Strains

C 50 — Washingtpn bent	C 60 — Seaside bent
C 51 — Metropohtan bent	C 61 — Astoria bent
C 52 — Old Orchard bent	C 65 — Highland Colonial bent

"It will be recalled that, at the request of the Green Section, the grasses were rated in order of preference, all characteristics, both favorable and unfavorable, being considered. The most desirable grass was rated as 1, and the least desirable as 12 (when, as was usually the case, 12 grasses were under test on the green). It was hoped that the ratings would be made at intervals throughout the growing season so that progressive seasonal changes in the relative ratings of the grasses might be followed over a period of years.

"In order to summarize the results, all of the ratings for each climatic season during which the grasses were actually growing (spring, summer and fall) were averaged for each green. Consequently a green which was established in the spring of 1939 had a possibility of 14 seasonal averages through the fall of 1943.

"It is noteworthy that of the 23 greens established in that year, only one experimental green enjoys the distinction of having that number of seasonal ratings to its credit. Also, only one of the remaining greens which were established either in the fall of 1939 or spring of 1940 has a perfect record since it was established. However, in spite of these facts, for some of the strains such as C 52 and C 19, which were established on 36 and 35 of the experimental greens, respectively, we have as many as 173 seasonal averages from which to draw conclusions.

"Of the total number of 19 strains included on the experimental greens, five of them were tested along with the commercially available vegetatively propagated strains (Washington, Metropolitan, and Old Orchard) on 32 or more of the greens. Therefore between 150 and 175 seasonal averages have been obtained for these grasses. Comparable number of seasonal averages were also obtained for the seed-propagated bents — Seaside creeping bent and Astoria and Highland Colonial bents. For two other Green Section strains there werre as many as 73 seasonal averages, whereas for most of the others not more than 20 are available. Since the results from so few ratings could scarcely be considered significant, only those strains for which 70 or more seasonal averages are available are included in the accompanying summary.

"In order to arrive at a satisfactory basis for comparing the relative merits of these strains, summaries were made for each season for each of the experimental greens. From these summaries it was easy to determine how many seasons on each green each strain took first, second, third, or fourth place, respectively. It was believed that it might be unfair to the strains to limit the summaries to the number of times the grasses fell in first place since so much of personal prejudice is inevitable in the selection of the best of the superior strains. For this reason in the accompanying summary the grasses are arranged in order of the percentage of seasons in which they fell in any of the first four places. Figures also are included, however, which indicate the frequency with which each strain was given first, second, third, or fourth choice, respectively.

Strain	No. of Seasonal Averages	Percentage of Seasonal Averages In Which Each Strain Falls: Ist4 Places	1st Place	2nd Place	3rd Place	4th Palce
		61.9				
C-7 Cohansey	155	60.7	20.2 12.9	16.1	14.2	18.7
C-19 Congressional	173	[illegible]			15.0	8.7
C-36 Norbeck	73	58.9	12.3	26.3	11.0	9.6
C-15 Toronto	162	58.0	27.2	10.5	11.1	9.2
Old Orchard (C-52)	173	45.1	15.0	6.9	15.0	8.1
c-17	155	38.7	4.5	9.0	9.0	16.1
C-28	73	37.0	5.5	9.6	11.0	11.0
Washin gton C-50)	165	36.4	2.4	11.5	13.3	9.1
C-1 Arlington	162	[illegible]	8.0	12.4	6.2	4.3
Metropolitan K-51)	167	30.9	3.0	4.8	4.8	6.6
Seaside (C-60)	153	17.0	0.7	2.6	3.3	10.5
Astoria K-61)	153		1.3	1.3	5.9	2.0
Highland K-65)	147	10.5	0.7	2.7	3.4	2.7

"A study of the table will show that the first five grasses are the superior strains, regardless of whether one considers their occurrence in 1st place only or in the first four places. However, the relative standing of these five superior strains is significantly different, depending upon the basis of comparison. C 15 and C 7 exchange places when first place only is considered, instead of the present arrangement. C 19 remains in the same relative position by either method of comparison, whereas Old Orchard would move up to 3rd place instead of 5th place if compared with the other strains on the basis of 1st choice only. C 1, although 9th in order under the present arrangement would fall in 6th place if only first choices were considered.

"It is obvious that in general the Washington and Metropolitan strains have been the least desirable of the vegetatively propagated creeping bent strains under test in this series of experimental greens. The seeded bents conspicuously are in a class by themselves at the foot of the list, although they did show possibilities in Pittsburgh, Tulsa, and Portland.

"It should be remembered that the figures given here represent the average behavior of the grasses in greens distributed over all parts of the country and under many types of maintenance programs. Therefore although a strain may rate at the bottom of the list it is not surprising to find that in specific limited situations it may be a superior grass.

"It appears significant that these five superior strains have excelled in diverse parts of the United States. To indicate the widely distributed geographical areas in which these grasses produce superior turf, C 7 may be cited as being one of the first four choices for the entire test period on experimental greens in the following districts: two out of four in the District of Columbia; one in Virginia; one in Massachusetts; one in Ontario; two in upper New York State; one out of three in the Metropolitan area; two in Pennsylvania; three in Ohio; one in Indiana; two out of three in Missouri; one in Detroit; four out of five in Chicago; one in Omaha; one in Tulsa; and two out of three in California.

"These figures illustrate the fact that although these grasses are generally superior in many parts of the country they do not necessarily lead in ratings on all of the greens in any one area. It would therefore seem advisable before deciding to use any single or several strains which have been superior on one or more experimental greens in your vicinity to try the grasses under your specific conditions and maintenance program."

The C-7 strain was distributed to interested commercial growers in 1946, and so a name for it had to be found. Overzealous-people concerned began to assign their own names, and one commercial firm erroneously assigned the name "Clementon," after the town where Pine Valley's post office is located. This was hurriedly retracted. Soon after, at my instigation, a contest was held among Pine Valley members and many names were suggested. Among them was "Crup;p" after the founder of Pine Valley, "Pine Valley," "The Valley," and numerous other names. After many discussions with John Arthur Brown, Pine Valley's President, the name "Cohansey" was selected and this announcement was made:

C-7 is to be named

"In trying to decide a given name of designation C-7 we came to the conclusion that the selection should be identified with a little considered element in the place where this hopeful strain was developed and not with the place itself. So excuse please if we seem to digress.

"The average golfer playing on the greens and fairways of Pine Valley takes for granted the many acres of beautiful grass which he finds at that Paradise. However he is apt to give particular attention to the fast sandy traps and bunkers which he probably thinks have been created by a power something beyond that of an artistic golf amateur. But there is no warrant for taking for granted the 40 acres of greens, tees and fairways with their various types of bent and other grasses. These all grew, believe it or not, on sand. The turf has taken years of study, of topdressing and nourishment with careful watering, to withstand the heavy use and violent treatment which seems to be the daily burden.

"Grass grown on sand needs more than a normal rainfall to retain its sparkling vigor under severe conditions and close croppings. WATER is The essential element. Nature in ages by and gone laid down the water courses in strata through which today comes this essential element in abundance, serving the many lakes, as well as the black water for the grasses and the white water for the players.

"That water course we call "The Cohansey." How else should be called our young hopeful C-7 but . . . Cohansey!"

The thought about naming this grass Cohansey came to us while we were drilling some new wells for our drinking water supply. Pine Valley is blessed with good water supply and most of this water comes out of the Cohansey strata.

The Cohansey strain of bent is fine-bladed, has an apple green color, is a rapid spreader, heals itself quickly after injury, grows upright, and produces a very fine-textured putting green.

It has been found suitable for putting greens in all regions where bent can be grown. It is liked from Virginia to St. Louis to Oklahoma and everywhere north.

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