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TURF BERMUDAGRASSES

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Numerous turfgrass species are used in California. The selection of the species to be established is dependent on the adaptability to environmental conditions, the use the species will receive, and the level of management that can be provided (2). Common bermudagrass *(Cynodon dactylon)* and its improved varieties are the best adapted grasses to large areas of Central and Southern California because of their dependability in these regions.

ADAPTATION AND GROW RESPONSE

Bermudagrass is a warm season or subtropical grass which grows best under extended periods of high temperatures. Generally, mild winters prevail in these regions. The subtropical zone in California includes the low elevation areas from the Mexican border to the north end of the Sacramento Valley. Bermudagrass can also be grown successfully in the transitional zone along the southern coast and in certain areas surrounding San Francisco Bay (6). Figure 1 shows these areas of adaptation (6).

These zones of adaptation are dependent on the growth response of bermudagrass to various climatic conditions, especially temperature. Edaphic factors generally have little influence on bermudagrass adaptation.

Minimum temperature for bermudagrass growth and development is approximately 50° F. and the optimum temperature is around 90° F. Significant growth has been observed at temperatures as high as 110° F. Experiments (5) have shown that bermudagrass will continue to grow with night temperatures as low as 34° F. if day temperatures above 70° F. were maintained. Thus, the effect of low temperatures can be counteracted by high day temperatures. However, it has also been demonstrated that average temperatures below 50° F. in the presence of high light intensities will result in growth stoppage and the onset of typical winter discoloration. This response is due to the degradation of chlorophyll by the interaction of low temperature and high light intensity. This response is clearly shown in Table 1 (5).

Soil temperature, as influenced by air temperature, has also been shown to be important to the growth of bermudagrass stolons, rhizomes and roots. As soil temperatures increase, stolon and rhizome growth likewise increase (5). Optimum soil temperatures for root growth is around 80° F.

Daylength has also been observed to influence the growth and development of bermudagrass. Increased daylength has resulted in an increased production of rhizomes, stolons and leaf growth. This would be expected with grasses that make optimum growth in long day, high temperature conditions. Bermudagrasses have a high

Figure 1.

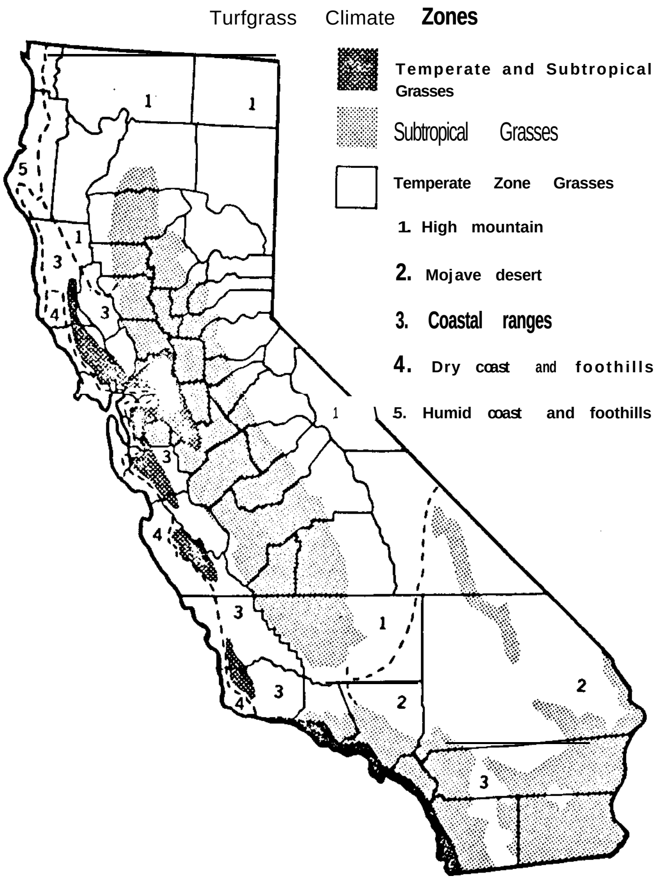

FIGURE 1. Bermudagrass is adapted to climate zones where Subtropical grasses are recommended.

TABLE 1. Effects of various temperature and light treatments on the growth of U-3 bermudanrass.

Treatment (Temperature) Day	Night	Light Source	Growth rate (mm)	Color
34	34	lights	none	normal
40	40	lights	none	normal
50	34	daylight	none	discolored
50	34	lights	none	normal
50	40	daylight	none	discolored
50	40	lights	none	normal
50	50	daylight	none	sl. discolored
50	50	lights	none	normal
60	34	daylight	none	sl. discolored
60	40	daylight	3.8	normal
70	34	lights	15.5	normal
70	40	lights	27.8	normal
60	60	daylight	16.1	normal
70	70	lights	58.0	normal

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light requirement and will not grow well under low light intensity (shade) conditions (1).

Although it is considered a drought tolerant species, the continued presence of adequate levels of soil moisture is necessary for the growth of bermudagrass. In contrast, bermudagrass will also tolerate temporary flooding but will not thrive in waterlogged soils. Under flooded conditions weeds such as annual bluegrass, oxalis, spotted spurge and chickweed frequently become a problem.

An objectionable characteristic of bermudagrass is the production of flower heads in mowed turf. These are most abundant under conditions of high temperature, moisture stress or nitrogen deficiency.

Bermudagrass Species and Varieties

In areas of adaptation in California the bermudagrasses are used for all types of turf. A description follows of the species and varieties most commonly chosen.

Common bermudagrass *(Cynodon dactylon (L.) Pers.),* naturalized throughout the warmer parts of the United States, was introduced from Africa or Asia. It is a rather coarse textured, medium green grass that spreads by stolons, rhizomes and seed to form a moderately dense turf. It has a longer dormancy period than the improved varieties. In regions of California where it is adapted, it is seldom attacked by diseases or insects. It is often used where minimum managed turf is required, however, if well maintained, a turf of good quality will result.

Floridagrass or African bermudagrass *(Cynodon transvaalensis* Burtt-Davy) is one of the finest textured grasses that is used in turf. This African introduction, like common bermudagrass, spreads by rhizomes, stolons and seeds. Its bright green summer color changes to a reddish-purple hue and is followed shortly thereafter by a straw colored dormant appearance. It is somewhat more susceptible to insect and disease damage than common bermudagrass. African bermudagrass is seldom used as a straight species in California.

Breeding and selection within and between the species described has been extensive and has resulted in several improved varieties that are commonly used.

Santa Ana (7) *(C. dactylon x C. transvaalensis)* was released by the California Agricultural Experiment Station in 1966. It was developed specifically for California conditions but has found acceptance in other bermuda growing areas. It is characterized by a deep blue-green color and a medium-fine texture. Color retention in cool weather is excellent. It is resistant to smog and is highly tolerant of the Eriophyid mite and saline soils. Flower stems may appear but viable seed is not produced. Propagation is therefore from sprigs, plugs, stolons or sod. Santa Ana can be used in any turfed area but is especially recommended for tees, athletic fields and playgrounds where wear resistance and rapid recover are required.

Tifway (*C. dactylon x C. transvaalensis)* was released by the U.S.D.A. and the Georgia Agricultural Experiment Station in 1960. It is characterized by a dark green color and stiff leaves of a medium-fine texture. Fall color retention is nearly as good as Santa Ana. It was selected for good density, disease resistance and an acceptable rate of spread. It is frequently discolored by moderately high levels of air pollution which results in an orange cast over the sward. Tifway is recommended for golf course tees and athletic fields. Vegetative propagation is essential.

Tifgreen *(C. dactylon x C. transvaalensis* was released by the U.S.D.A. and the Georgia Agricultural Experiment Station in 1956. It is a dark green, fine textured, disease resistant, dense variety. It is severaly discolored by air pollution in areas where this is a problem. Fall color retention is poor. It is recommended for use on golf greens, bowling greens and home lawns where a high level of management can be anticipated. Vegetative propagation is essential.

Tifdwarf *(C. dactylon x C. trasvaalensiso* is probably a mutant of tifgreen and was selected by the U.S.D.A. and Georgia Agricultural Experiment Station. It was released in 1965. It is characterized by a dwarf growth habit and a deep green leaf color. Because of its low growth habit, it has been mistakenly believed that Tifdwarf requires no mowing. Other characteristics, ie., disease resistance, smog susceptibility, etc., resemble Tifgreen. Because of Tifdwarf's susceptibility to some herbicides, weed control is difficult. It has been suggested that this variety be used for home lawns, golf greens and bowling greens, Vegetative propagation is essential.

Royal Cape is a selection of tmknown parentage from the Royal Cape Golf Course in South Africa. It was released by the U.S.D.A. and the California Agricultural Experiment Station in 1960 for use along the lower Colorado River Basin, but is not recommended elsewhere in California. Royal Cape is an extremely fine-textured grass with good green color and vigor. It is more tolerant to saline soils than several other varieties. Vegetative propagation is essential.

Other varieties of bermudagrass that have been grown in California include U-3, Sunturf, Ormond, Tiffine and Everglades. These varieties have been replaced by the cultivars previously described. Description of other varieties have been presented by Hanson, et. al (3).

The improved bermudagrasses have several advantages over the common type. These would include a green carpet-like appearance, a greater resistance to wear, a higher tolerance to salinity, a greater tolerance to closer mowing, and a more rapid recovery from injury. Disadvantages of the improved varieties are usually related to the necessity of a higher management level. As an example, because of a higher nitrogen requirement for an aesthetically pleasing sward, thatch accumulation and its removal is usually accentuated. This is pointed out in an economic analysis where it was shown that hybrid bermudagrass costs 2 1/2 times more to maintain than common bermudagrass (4).

BERMUDAGRASS MANAGEMENT

Fertilization

As with any grass used for turf, all bermudagrasses require the presence of nutrient elements. Usually a complete fertilizer, such as a l-l-l ratio material, is incorporated prior to establishment, however thereafter the most frequently required nutrient is nitrogen. Bermudagrass has been observed to respond by improved quality to nitrogen applied at the equivalent of one pound per 1000 square feet per month in the spring and fall. Somewhat lesser summer rates are adequate; higher summer rates can result in excessive thatch accumulation. It has been shown that frequent, light application of nitrogen in the fall will postpone the onset of winter dormancy.

With this management practice bermudagrass can be kept green in areas with mild winters.

Irrigation

Although bermudagrass is considered to be a drought tolerant species, adequate soil moisture must be maintained for the desired appearance. Water application rates are directly related to water use rates of the bermudagrass sward. The water use rate is governed by climatic factors such as temperature, wind, humidity and light reflection. Of course, water use increases in the warmer summer months and decreases during the cooler times of year. The frequency of irrigation is also influenced by the soil type, ie., sandy soils have less water holding capacity than do the heavier textured soils which results in the necessity for a more frequent irrigation schedule.

A third factor that benefits bermudagrass regarding irrigation is its extensivaroot system. Bermudagrass roots may grow to a depth of seven or more feet but the heaviest mat of roots will be in approximately the first 6 inches with the majority of roots in the first foot of soil. Adequate moisture therefore should then be maintained in the top foot of soil.

Mowing

The cutting height of bermudagrass will vary with the various species and varieties, however, they are all tolerant of relatively close mowing. The best cutting height for common bermudagrass ranges from 1/2 to 3/4 inch whereas improved variety such as Santa Ana and Tifway will perform well at 1/4 to 1/2 inch. Tifgreen and Tifdwarf may be mowed as closely as 3/16 inch. Mowing frequency will increase as temperatures increase. Generally, varieties that are mowed close will require a greater frequency of mowing than those maintained at a higher cutting height.

Thatch Control

Bermudagrasses, because of their growth habit, produce large amounts of thatch. This is especially true of most of the improved varieties. Thatch, if allowed to accumulate will restrict air, water and nutrient penetration into the soil and thereby result in a decline of the turf. Cultural practices to control the thatch therefore must be utilized.

The most common method is the mechanical removal of thatch by vertical mowing. This procedure is usually performed during mid to late spring and/or late summer. Late summer vertical mowing will assist in retaining fall color but should be performed early enough to allow time for regrowth before cold weather. If vertical mowing is performed later in the fall, *Poa annua* seed germination may be stimulated.

For best quality turf, frequent thatch removal during the bermudagrass growing season is suggested if the budget allows for this operation. Under this management, thatch will not become a problem.

Heavy thatch may be removed in a single operation without permanently injuring bermudagrass turf. This can be accomplished with a vertical mower or a sod cutter.

Aeration

If the bermudagrasses are growing in a tight or heavily compacted soil, removal of soil cores by aeration will benefit the turf by permitting the entry of air, water and nutrients into the soil. A regular aeration program will also reduce thatch accumulation. Aeration is usually performed during the growing season for bermudagrasses.

Summary

Bermudagrasses have many advantages for turf in the regions of California where thev are adapted. To obtain a desirable sward, management practices must be followed to benefit the grass; the bermudagrasses are not low maintenance turfgrasses. It must be stressed again that one of the principal advantages of the bermudagrasses is their dependability. With the resumtion of good cultural practices following long periods of neglect, they will quickly restore a high quality turf.

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SPRINKLER DISTRIBUTION RELATED TO CHEMICAL INJECTION

Ralph A. Strohman and Albert W. Marsh [1]

In recent years, due to the increased use of sprinkler systems for the distribution of irrigation water, more and more emphasis has been placed on the use of such systems for the distribution of chemical material. The success of applying chemical material to crops by any system is dependent upon the uniformity of distribution attained. The higher the degree of uniformity, the better control of the quantity applied over the [any given] area covered.

Little information is available on uniformity of chemical distribution by sprinklers and its relation to the distribution of irrigation water applied. Most publications dealing with chemical application through sprinklers (Chemagation) contain recommendation which are based on theory and limited observations in the field. Several publications discuss the characteristics of many common chemicals with respect to chemagation and various methods of introducing the chemical materials into the sprinkler svstem.

Two important statements that appeared in most of the publications (3) were:

1. "The uniformity of chemical application can be no greater than that of the water application."

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2. "For any significant improvement in chemical application through sprinklers, an increase in the uniformity of the water application is necessary."

During the summer of 1969, we ran several catchment tests on a sprinkler system containing two lines with 21 sprinklers per line. The sprinklers were Rainbird 14V with 5/64 inch nozzles. The spacing was 40 ft. between lines and 30 ft. between sprinklers along the line. The chemical material used as an indicator was 95% potassium chloride (KCl) .

From these initial tests, we were able to establish the following conditions for the 1970 trials:

1. Two lines do not give a true picture of sprinkler water distribution in a solid set system. Therefore, in the 1970 trials, the catchment plots will be located between the center two lines of a four-line system.
2. Five to ten pounds of 95% KC1 in 30 gallons of water will be injected into the system with the injection period ranging between 30 and 120 minutes.
3. The operating pressure of the sprinkler system will be between 50 and 60 nsi. Injection will be started after the sprinkler system is running at operating pressure.
4. The total irrigation time for each test will be no less than 180 minutes with at least 30 minutes of untreated irrgaton water applied after chemical injection.
5. The sprinkler system will be operated only when the wind is less than 5 mph.

Experimental Method Set-up, 1970 Chemagation Trials

The four irrigation lines oriented east and west were connected in common to the mainline with the chemical injection point upstream from the common connection.

Three plots each containing 48 catchment cans arranged in a 5-ft. grid pattern were located within the 1200 sq. ft. rectangle enclosed by sprinklers 3 and 4, 9 and 10, 18 and 19 (plots 1, 2, and 3 respectively) of the center two irrigation lines. Before the start of each chemagation treatment, 8 similar cans, each filled with a known volume of irrigation water and covered, were placed, 4 to west and 4 to the east of each plot, between the center lines to assess evaporation during readout.

Data Collection

After each chemagation trial the following raw data per plot were obtained:

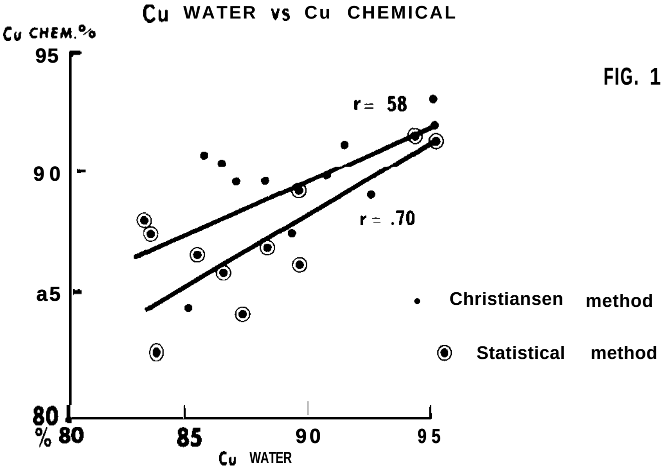
1. Water volume (mls) from each of the 48 catchment cans per plot.
2. Subsamples for laboratory determination of K concentration from the same cans.
3. The 4 evaporation cans to the west of each plot were measured and sampled immediately before those in the plot, those to the east immediately after.

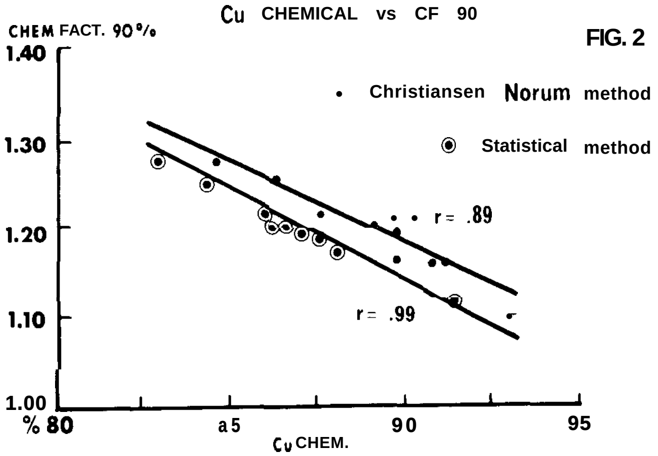
Adjustments

The measured volumes from each can were adjusted for can wetting and evaporation losses. The K concentrations in the subsamples were corrected for background K and multiplied by the adjusted volumes to find amount of K caught per can.

Uniformity Calculations

With the adjusted data, the coefficient of uniformity





(Cu) for both the water and chemical catchment for each treatment were calculated. The Cu was calculated using two different methods:

1. Christiansen method (1)
   Cu=l00 (1-Ey/Ex)
   Ey=summation of the departure of each can from the mean
   Ex=summation of the adjusted values for all cans.
2. Statistical method (2)
   Cu=l00(l-o/x) where:
   o==the standard deviation of the can values
   x=the mean of all can values per treatment

Another calculation that can be used to describe the uniformity of chemagation distribution is the chemical factor (CF_{90}) . The CF_{90} is the average chemical application needed so that chemical equal to or greater than a unit minimum will be received over 90 percent of the area covered by the sprinklers. E. M. Norum (4) calculated the CF_{90} as follows:

$$CF90\% = \frac{x}{(n/10)th\ can} \text{ where:}$$

x=mean of chemical catchment per treatment in mg.
n==number of catchment cans per treatment
(n/10) th can=mg. of chemical catchment in (n/10) th can if the can values are ranked in ascending order.

The CF or CF_{90} as given in the previous example by the Norum method depends entirely on the contents of one or, at the most, two cans and, in most cases, these cans have a very small amount of chemical in them. A small error, therefore, can drastically affect the calculation of the CF_{90}. A statistical method for calculating CF_{90} was worked out by T. M. Little which takes into consideration the variation among all of the cans in a given treatment. The equation for the statistical method is:

$$CF90\% = \frac{1}{1-(t_{.20}\ \sigma/\bar{x})}$$ where:

$t_{.20}$=the probability value from a statistical table (Handbook of Chemistry and Physics) for the number of can values per treatment and the area of coverage desired (90% of the area).

Results

The relations between water and chemical uniformity are contained in figure 1. For our system operated under good field conditions, the water Cu was 85% or greater calculated by the Christiansen method shown as the upper line. The lower line, calculated by the statistical method, has slightly lower Cu values. With both methods of calculation the chemical Cu is greater than the water Cu at values less than 90% but reverses above 90%. The statistical method has a higher correlation coefficient and provides a truer picture for relating water distribution to chemical distribution. Since data were not obtained for Cu values less than about 83%, we are unable to project what the relationship would be at water Cu values between 65% and 80%. Many commercial irrigation systems fall in the latter range. Further tests within this range will be needed.

Relations between the CF90% and the chemical Cu are shown in figure 2. Again the values calculated by the statistical method fall slightly below those calculated by the Christiansen method but have a higher correlation coefficient.

Though the lines in these tables cannot safely be extrapolated beyond the limits of data points obtained, it is obvious that greater amounts of chemical will have to be applied to meet minimum requirements for most of the area when the water Cu is low than when it is high. At the same time, some areas will receive much more than needed. Both plants and the environment may suffer from the excess. A high water Cu is essential if chemicals are to be applied through the sprinklers.

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A PROGRESS REPORT

Control of Annual Bluegrass in Turf

C. L. Elmore, L. Frey, K. Gowans, and J. Van Dam [1]

Annual bluegrass *(Poa annua)* is found as a weed in turfgrass throughout California. It germinates in the fall and winter months, grows during the cool season, matures and normally dies during the summer. If the turfgrass areas are irrigated frequently, this grass can be found throughout the year.

Cultural control may be effective by controlled irrigation. The concept behind this control method is to allow the soil surface to drv in the fall of the year when annual bluegrass is germinating or in early summer to eliminate existing populations. The roots of desired turfgrass species generally are much deeper and can tolerate this drought stress whereas annual bluegrass cannot. Increased mowing height will greatly reduce annual bluegrass invasion. Also, aeration in late August and September when annual bluegrass is germinating should be avoided.

Using the proper cultural practices can reduce or often eliminate annual bluegrass from a turf. However, often the best cultural practices for control do not coincide with present management; thus, annual bluegrass becomes a pest.

Preemergence control of annual bluegrass has been effectively worked out for many turf situations and is widely used; however, there are times when a postemergence chemical control method is needed. The series of experiments described in this article were conducted to evaluate various herbicides for annual bluegrass control under various management regimes.

Two studies were conducted to evaluate postemergence herbicides for annual bluegrass control in Kentucky bluegrass sod. Two studies were also conducted on bermudagrass turf using preemergence herbicides alone or with postemergence herbicides.

Study One

Three experimental herbicides, as given in Table 1, were evaluated and compared to two commonly used materials, bensulide and benefin, for control of annual bluegrass and crabgrass in Tifgreen bermudagrass turf at the Los Angeles State and County Arboretum. Treatments were hand sprayed on February 25, 1970, to 10 ft. x 10 ft. plots. All treatments were replicated four times and arranged in a completely randomized block design. The initial evaluations were made on annual bluegrass control and subsequent evaluations on crabgrass control. Phytotoxicity evaluations were made two and five months after application.

Results

EL-119 and Pronamide gave early control of annual bluegrass while the EL-119 treatments gave good residual crabgrass control. BASF 2903 did not injure the Tifgreen bermudagrass turf, however, it did not give effective weed control. Early injury was evident on bermudagrass treated with all rates of EL119. Pronamide and benefin also showed early stunting of the turf. At five months after

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TABLE 1. Control of annual bluegrass and crabgrass and phytotoxicity to Jifgreen bermudagrass turf.

Treatment	Rate lbs. ai/A	Weed Control[1] Months after application 2(a)	3(a)	3(c)	6(c)	9(c)	Phytotoxicity[2] Months after application 2	5
EL-119	2	7.3	5.6	10.0	6.6	7.2	3.0	0
EL-119	3	8.5	7.6	9.9	8.4	6.5	5.0	0
EL-119	6	9.5	9.0	10.0	9.8	9.4	7.5	0
Pronamide (KERB®, RH-315)	2	8.8	7.3	7.8	5.5	4.1	3.2	0
"	4	9.8	9.6	8.8	7.4	4.4	3.5	0
BASF 2903	4	3.0	4.0	5.3	4.4	1.9	0.7	0
BASF 9203	8	3.3	4.0	5.4	5.0	2.6	1.0	0
Bensulide (BETASAN®)	15	4.0	4.0	9.0	8.6	7.1	0.7	0
Benefin (BALAN®)	3	5.3	5.4	8.8	7.7	5.7	2.5	0
Control		3.3	4.0	6.0	5.0	2.1	0.5	0

[1]Weed control: O=no effect; IO=complete control. (a) annual bluegrass evaluations. (c) crabgrass evaluations

[2]Phototoxicity: O=no injury; 10=dead turf.

TABLE 2. Postemergence control of annual bluegrass and phytotoxicity of several herbicides in a Merion-Newport Kentucky bluegrass sod.

Herbicide	Form.	lbs. ai/A	Weed Control[1] 12/10	12/23	2/8	4/l	Phytotoxicity[2] 12/10	12/23	2/8	4/1
Endothal	Potas. salt	0.75	5.5	6.8	3.5	5.2	2.2	1.8	1.3	1.2
Endothal		1.5	8.2	8.5	7.5	8.0	4.5	4.5	3.8	2.8
Endothal		3:0	9.5	9.8	9.5	9.4	7.5	8.2		
MSMA	Ansar 529 4#/gal.	3.0	1.0	1.8	0.5	2.2	0.8	0.8	7.5. 1.0	4.8. 0.5
MSMA			2.2	1.0	0.25	2.8	0			
Terbutol	80% 1.5 lb/gal WP	6.0 3.0	1.0 1.8	3.0 2.5	0	3.0	0.2.0	0.8	0.. 0.8	0.2 0.8
Benefin+Endothal		3.0+15.	8.0	9.3	0.25	1.5	6.8	7.0	5.5	3.8
Control	—	—	0	0.2	8.5	8.9	0.2	0.5	0	0

[1]Weed control: 0=no effect; IO==complete control

[2]Phytotoxicity: O=no effect; IO=dead turf

TABLE 3. Annual bluegrass control and phytotoxicity.

Herbicide	lbs. ai/A	Annual Bluegrass Control[1] 4/1	5/6	Phytotoxicity[2] 2/8	4/1	5/6
Endothal (K salt)	0.15	4.5	4.8	3.0	1.5	1.8
Endothaf + bensulide	0.75+10	7.0	6.2	3.3	1.2	2.0
Endothal + benen	0.75+3	.	4.8	3.3	1.2	2.2
Pronamide	0.25	5::	2.2	0.5	6.5	8.5
Pronamide	0.5	6.5	4.0	0.2	7.0	70.0
Nitrofen (Tok®)	5	0.5	0.2	0.0	0.2	0.2
Nitrofen	10	1.5	1.2	0.5	1.2	2.2
Nitrofen + bensulide	5+10	0.8	0.8	0.5	1.2	2.2
Bensulide	10	0.8	0.2	0.2	0.2	1.5
Benefin	3	0.0	0.2	0.0	0.0	0.0
Control	—	0.0	0.2	0.2	0.5	0.5

[1]Weed control: O=no effect; 10=complete control

[2]Phytotoxicity: O=no effect; 10=dead turf

TABLE 4. Postemergence control of annual bluegrass (Poa annua) in bermudagrass turf.

Herbicide	Rate lbs ai/A	Annual Bluegrass Control* 3/23/71	4/8/71	6/25/71	11/4/71
A Pronamide	½	0.8	0	4.5	8.2
B Pronamide	¾	1.0	1.2	5.0	7.2
C Pronamide	1	1.8	5.0	6.8	8.0
D Pronamide + Bensulide	½+7.5	0.5	1.2	3.0	6.5
E Pronamide + Bensulide	½+10	0.2	0.5	3.5	7.2
F Pronamide + Bensulide	¾+5	0.5	2.2	4.2	7.8
G Pronamide + Bensulide	%-l-7.5	1.0	3.2	5.8	8.5
H Pronamide + Bensulide	¾+10	1.2	1.7	5.0	8.1
J Pronamide -l- Bensulide	1.5	1.2	4.7	6.2	8.0
K Pronamide + Bensulide	1+7.5	2.5	7.5	7.8	8.2
L Bensulide	10	0	0	1.2	4.2
M Pronamide + Bensulide	1+10	1.8	6.0	6.8	8.3
N Pronamide + Bensulide	1.5+15	3.0	8.2	7.2	8.2
P CC 1418**	¾+7.5	+2	4.1	5.2	8.1
Q CC 1418	1.5+15	+2.8	5.5	8.2	9.1
X Control	—	0	0	1.8	3.8

*Weed control: O=no effect, IO=complete control

**CC-1418 is a Chevron Chemical Company mix of pronamide + bensulide on 22-4-4 fertilizer carrier.

application, no visual effects could be observed with any treatment. Bensulide did not control annual bluegrass because it was already established.

Study Two

Several herbicides were evaluated on a Merion-Newport Kentucky bluegrass sod which had been planted in early June, 1970. The herbicide applications were applied as a broadcast spray on November 13, 1970, on a wet, poorly drained area. Terbutol (AZAK®) and benefin were applied to dry turf and the treatments were followed by a five minute irrigation. The remaining treatments, as given in Table 2, were applied to wet turf following the irrigation. Air temperature was approximately 70° F. at application time. Control of annual bluegrass and phytotoxicity to the bluegrass sod were evaluated December 10 and 23, 1970, and February 8 and April 1, 1971.

Results

Endothal gave good to excellent control of annual bluegrass at 1.5 to 3.0 lb per acre on bluegrass sod, however, at 0.75 lb per acre, less than adequate control was achieved. At 1.5 lb per acre, early injury was very evident and at the 3.0 lb per acre rate, injury was severe.

When endothal at 1.5 lb was added to benefin as a preemergence material, more injury was noted without an appreciable increase in annual bluegrass control. Terbutol, benefin, and MSMA (monosodium methanearsonate) did not control annual bluegrass in this test. Injury was observed from the terbutol treatment at the 15 lb per acre rate.

Study Three

A new trial was established on January 25, 1971, on a Kentucky bluegrass sod in the same area as Study Two to observe phytotoxicity and annual bluegrass control with five herbicides applied singly or in combination. All treatments were applied as a broadcast spray to wet turf with a CO, pressure sprayer operated at 30 psi with a 100 gpa water carrier. Air temperature was approximately 65° F. at time of application. Annual bluegrass control ratings were made April 1 and May 6, 1971; phytotoxicity to the bluegrass sod was recorded on February 8, April 1, and May 6, 1971.

Results

Annual bluegrass control was less than adequate from all treatments with the exception of a combination of endothal at 0.75 lb plus bensulide at 10 lb per acre. Even this combination was marginal when application was made to fully established annual bluegrass plants as were present in this trial. An earlier application may have been more effective with endothal or a combination of endothal-benefin or endothal-bensulide.

There was some initial phytotoxicity to Kentucky bluegrass from 0.75 lb per acre of endothal, however, this injury was temporary. Severe injury was evident on plots treated with pronamide at 0.25 or 0.5 lb per acre. This injury was apparently from root uptake of the herbicide as indicated by the increased injury during the evaluation period. This was in contrast to a foliar injury on plots treated with endothal.

Study Four

On February 11, 1971, broadcast treatments of the herbicides pronamide and bensulide, and combinations of the two materials, were applied to a Tifway bermudagrass sod in San Jose, California. The herbicides were applied with a knapsack sprayer operated at 30 psi and carried in the equivalent of 50 gpa of water. Each plot was replicated 4 times. The trial area was sprinkler irrigated February 13, 1971. The temperature was 71° F. at time of application with a wind of 10-15mph. Both herbicides were applied on a fertilizer base (Table 4) and as liquid sprays. Control of annual bluegrass was evaluated on March 23, April 8, June 25, and November 4, 1971. The treatments gave no apparent injury to the bermudagrass so phytotoxicity evaluations were not made.

Results

Postemergence control of annual bluegrass was not observed on plots treated with bensulide, a preemergence herbicide. Also, pronamide did not give adequate control at 0.5, 0.75, or 1.0 lb. per acre. When pronamide was used at 1 lb. per acre in combination with bensulide at 7.5 lb. per acre, commercial control was achieved (Table 3). A combination of 1.5 lb. per acre pronamide and bensulide at 15 lb. per acre, or the fertilizer with this herbicide combination, also gave better than 70% control of annual bluegrass. With this combination, apparently pronamide is controlling the established annual bluegrass plants and bensulide is controlling the germinating seed. As indicated in Table 4, control of established annual bluegrass plants is a slow procedure with pronamide.

From the results obtained in this trial, it would be worthwhile to further investigate combinations of pronamide at the 1 lb per acre rate and bensulide at the 7:5 or 10 lb per acre rate at various times of the season.

Summary

Results presented indicate there are two potential treatments for further testing. In warm season grasses (bermudagrass, zoysiagrass) a combination of pronamide and bensulide could be quite satisfactory at 1 lb. plus 7:5 to 10 lb per acre, respectively, for postemergence control plus residual preemergence control. In bluegrass turf, endothal should be further tested alone but particularly in combination with bensulide. Rates of 0.75 to 1.5 lb per acre of endothal appear to be adequate for control of young annual bluegrass. These rates probably should be maintained to avoid injury to the desired species.

PUBLICATIONS OFINTEREST

The University of California Agricultural Extension Service currently has publications available on various aspects of turfgrass selection and management. These references are listed below for your convenience. They can be obtained by writing or calling your county U.C. Home and Farm Advisor's office or by writing to:

Public Service, 90 University Hall,
University of California, Berkeley, Ca 94720

For charge publications, kindly make checks or money orders payable to THE REGENTS OF THE UNIVERSITY OF CALIFORNIA.

Publication	Identification No.	Charge
Know Your Turfgrasses	AXT-9	Free
A Guide to Evaluating Sands and Amendments Used for High Trafficked Turgrass	AXT-nl13	$2.00
Turfgrass Disease Control	AXT-116	Free
Which is the Best Turfgrass?	AXT-227	Free
Dichondra	AXT-303	Free
Protect Your Investment in a Landscape Sprinkler System	AXT-313	Free
Mowing your Lawn	AXT-352	Free
Turfgrass Pests	Manuel 41	$2.00
Guide to Turfgrass Pest Control	Leaflet 209	Free
Crabgrass Control in Turf	OSA n-12	Free
Maintaining Your Lawn on Heavy Soils	OSA -92	Free
Zoysiagrass for Lawns	OSA -106	Free
Trisect Control on Lawns	OSA -154	Free

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