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FUSARIUM BLIGHT, A DESTRUCTIVE DISEASE OF KENTUCKY BLUEGRASS, AND ITS CONTROL

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The occurrence of *Fusarium* blight of turfgrass was established in central and southern California in 1972. This disease has been very serious in the mid-western and eastern U.S. on Kentucky bluegrass for approximately 10 years. Couch and Bedford (2) first described the disease in 1966 and established the cause as *Fusarium roseum* (Lk.) Snyd. and Hans. f. sp. *cerealis* and F. *tricinctum* (Cdr.) Snyd. and Hans. f. sp. poae (Pk.).

In the midwest and east, the disease occurs primarily as a foliage blight which results in the bleaching and death of the affected leaves, and secondarily, as a foot rot (ie. the stem base). In California, the relationship appears to be reversed. The disease occurs primarily as a very severe foot rot (fig. 1) and secondarily, as foliage blight (fig. 2). In California, the foliage dies, but usually following death of the stem base due to infection. The disease has occurred in southern California for at least 10 years where it appears to be most damaging to bluegrass that has been over fertilized with nitrogen in the summer and to plants that are growing in areas stressed for water. During the last two years, the disease appears to be increasing in frequency of occurrence, severity and distribution. This may be related to the hot, dry summers that have occurred during this period. *Fusarium* blight now ranks as one of the most damaging diseases of Kentucky bluegrass, and consequently, has been referred to by some as the summer obliteration of bluegrass (S.O.B.) disease.

FIG. 1. Two stems of Kentucky bluegrass showing the typical dark brown to black rot of the stem base or crown. These areas are very hard and tough and difficult to cut open with a knife.

The disease can be diagnosed most readily by removing the healthy tillers, and dead leaves, and examinging the crown or basal area of the dead stems (fig. 1). In advanced stages, the affected crown, as well as some of the roots attached directly to the crown, appears dark brown or black, and the diseased crown is very hard and tough. The rotted area is very difficult to cut, even with a sharp knife. Occasionally we have been able to find the bleached white leaves that are typical of the disease elsewhere. The disease first appears as a small, roughly circular area in which all the plants within the circle usually show the foot rot stage of the disease. In the midwest and east, some plants at the center of these affected areas remain a darker green color than the plants at the periphery which are bleached. This gives a "frog-eye" appearance to the affected areas. This effect appears to be rare in California.

The disease usually first appears in late June or early July as soon as the weather turns hot. Hot, dry, windy weather is especially favorable for. the expression of the disease since the infected stem base or crown may be in an advanced stage of rot which greatly reduces the ability of the plant to take up adequate nutrients and wates. Since the disease occurs most commonly in areas that have been stressed for moisture and areas exposed for long periods to direct sunlight, Bean (1) has found that frequent irrigation helps to prevent the disease. This relationship has been verified in California. We believe that frequency of irrigation should be based upon the moisture content of the bluegrass debris or litter that occurs on the top of the soil. The litter should be kept moist but not overly wet. The frequency of irrigation necessary to maintain the litter in a moist condition will vary with the

FIG.2. A Merion Kentucky bluegrass lawn showing the typical circular areas of turf affected with "Fusarium" blight disease.

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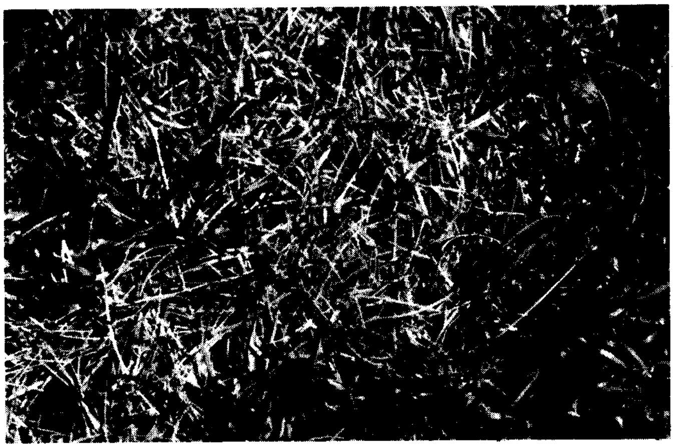

FIG.3. A close-up of a "Fusarium" blight of the Merion Kentucky bluegrass lawn shown in Fig. 2. Note that the affected leaves are completely blighted.

density of the planting and the thickness of the turf canopy. For a lawn with a dense canopy, once-a-week deep watering may be sufficient to keep both the soil and litter moist. For a lawn that is thinned-out, several short morning waterings may be necessary in addition to the weekly deep watering.

In the summer, localized dry spots occur that may be due to compacted soil, infrequent irrigation, uneven ground, dry litter which become-s very water repellent, wind disruption of sprinkler patterns, or too rapid a rate of water application. Since the *Fusurium* blight disease usually gets started in these localized dry spot, such areas should be detected and corrected. Water run-off due to compacted soil is the most common problem; aerification and careful water scheduling will correct this situation thereby reducing the possibility of disease incidence.

The disease has been partially controlled in the mid-western U.S. and in California with bi-monthly applications of the systemic fungicide, benomyl (Tersan 1991®) at the rate of two ounces of 50% W.P. per 10 gallons of water applied to 1000 sq. ft. or turf. The fungicide, following surface application, is "moved" into the litter and upper soil profile by drenching with additional water. Preliminary information indicates that application of the fungicide should probably begin in late April. Further trials are in progress to improve fungicide control with benomyl.

Field observations suggest that Kentucky bluegrass varieties differ in their resistance to the disease. Tentative ratings indicate the following: 1) very susceptible, the varieties Park and Campus; 2) moderately susceptible, the varieties Common, Windsor, Merion, Baron, and Newport; and 3) least susceptible, Cougar, Fylking, Nugget, Pennstar, Prato, and Victa. Further research is in progress to verify these ratings and to find additional sources of resistance.

Proper management of Kentucky bluegrass is probably best and most feasible approach to control. This includes adequate but not excessive fertilization, proper irrigation, mowing at a desirable height (1 1/2 " to 2 1/2 inches) aerifying when needed to prevent localized dry spots, and the control of excessive thatch by vertical mowing.

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CARBOHYDRATES(ENERGY), THE PIVOT POINT OF GRASS RESPONSES

V. B. Youngner*

Most people are familiar with carbohydrates as an important part of the human diet that provides the major source of energy. If the consumption of carbohydrates plus other energy foods exceeds the energy requirements at a given time the excess is stored as fats in various body tissues and organs. Continued consumption of more food than required will lead to obesity while restricting the intake of these foods to less than the energy requirement will cause the body to utilize or "bum up" the stored fat.

Somewhat similar relationships exist for turfgrasses and other plants. Green plants synthesize carbohydrates from carbon dioxide and water, using energy derived from sunlight. This process is known as photosynthesis which is a series of energy storing reactions. The simple carbohydrates resulting directly from photosynthesis may be changed to many other, usually more complex, types of carbohydrates. All carbohydrates are compounds of carbon, hydrogen and oxygen differing only in the number of atoms of each and their arrangement in the molecule.

We commonly recognize three major groups of carbohydrates as they exist in the plants: Structural, such as cellulouse and hemicellulose which form the cell walls and provide much of the rigidity of the plant body; Reserves, mainly starches and fructosans which are long chain compounds representing the stored surplus not needed at the moment; Simple sugars (glucose, fructose, sucrose) which are usually transient and used for immediate energy needs or converted to the more complex forms. Reserves and simple sugars are often referred to as the total available carbohydrates. Structural carbohydrates cannot generally be used to meet the plant's energy needs so will not be considered further here.

Respiration in plants as in animals is an energy releasing process. In a sense it is the reverse of photosynthesis. Carbohydrates are broken down into water and carbon

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dioxide, releasing energy for growth and physiological processes such as water and nutrient uptake. Respiration and photosynthesis may occur more or less simultaneously in the plant during much of its life. When the rate of photosynthesis exceeds the rate of respiration and the requirement for growth, carbohydrates accumulate as "reserves." The principal organs of accumulation are roots, stem bases, rhizomes and stolons. Conversely when the demands of respiration and growth exceed the rate of photosynthesis reserve carbohydrates are utilized. Thus, as you might expect the level of reserves fluctuate greatly from season to season and to some extent from day to day and even hour to hour.

Why are the non-structural carbohydrates considered to be important to turfgrass management? A number of studies have been conducted in recent years on carbohydrate relationships in turfgrasses because we believe the level of reserves is a useful indicator of the energy status of the plant as it is affected by various climatic factors and management practices. These studies indicate that as long as the carbohydrate reserves are maintained at a moderate level the turf is in a favorable condition for meeting most of the unusual as well as the normal energy demands.

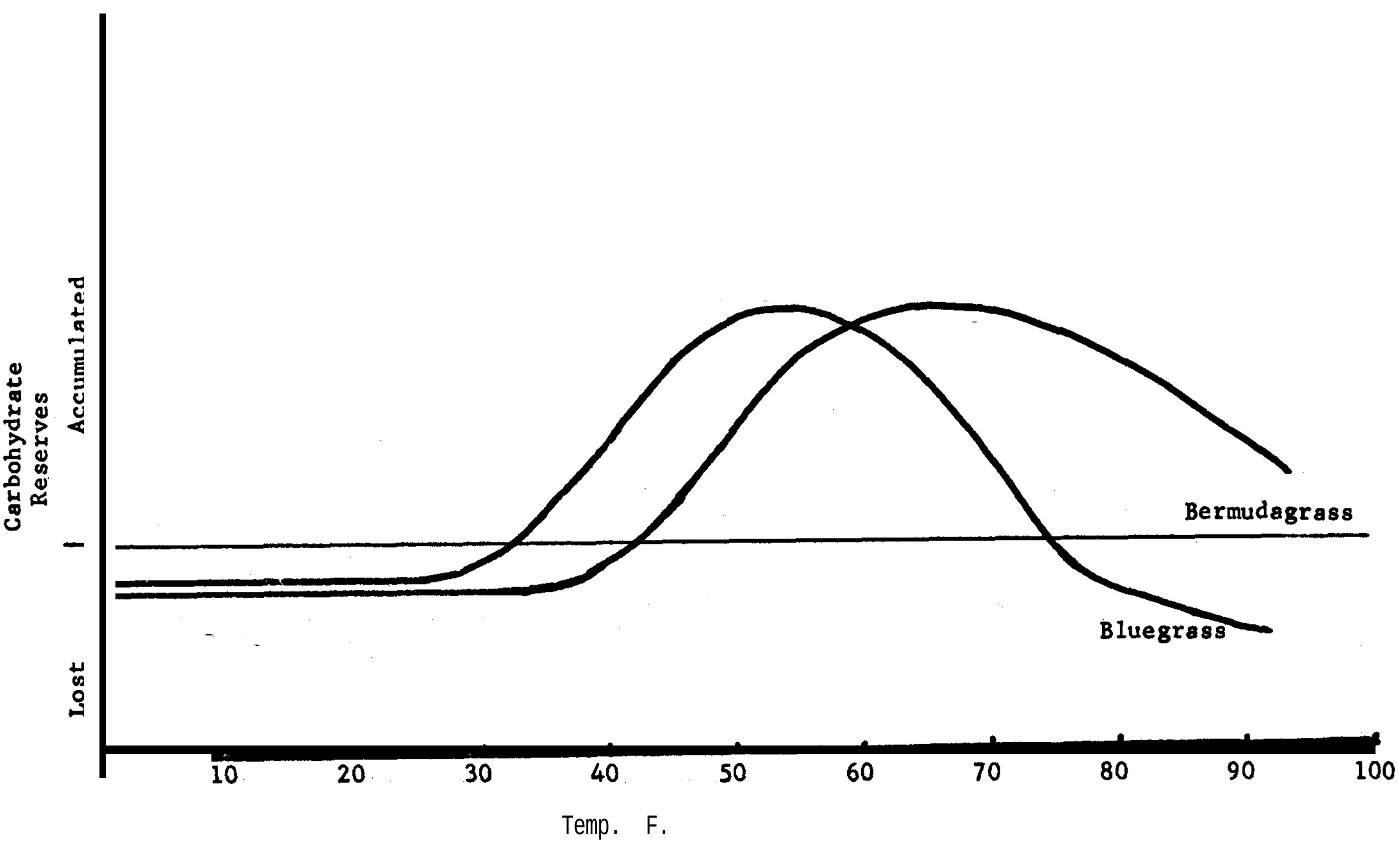
One of the more important uses of reserves by the grass plant is the initiation and growth of new roots. In many grasses, both cool and warm season, considerable root growth occurs when air temperature may be too low for a high photosynthesis rate. The plant then must draw upon carbohydrates stored in older roots or in stem bases. Reserves may also be used for root growth at other times as well but the extent of the dependency upon reserves has not been established.

Early development of new tillers, rhizomes and stolons may also utilize reserves. Translocation of carbohydrates from old tillers to developing new ones has been demonstrated. However, this translocation may be of carbohydrates just synthesized as well as of stored material. Whether reserves or currently produced carbohydrates are used at a given time, active root and shoot development does require that an ample supply be available.

New leaves require carbohydrates from older leaves during the first few days of growth, until they have emerged to the sunlight and become self sufficient. Some evidence indicates that during this time they may draw heavily upon carbohydrates stored in the bases of older leaves on the same shoot. Grass recovery from mowing is also dependent upon reserves in leaf bases. Studies have shown that the concentration of soluable carbohydrates in the bases of expanding leaves is the factor controlling leaf regrowth after clipping. Old fully expanded leaves make little carbohydrate contribution to regrowth. Soluble carbohydrates in the leaf bases are important only in the first 2 to 4 days following mowing. After that time the leaf appears to be capable of meeting its carbohydrate requirements through current photosynthesis.

Rapid recovery from injury from traffic, insects and

Fig. 1



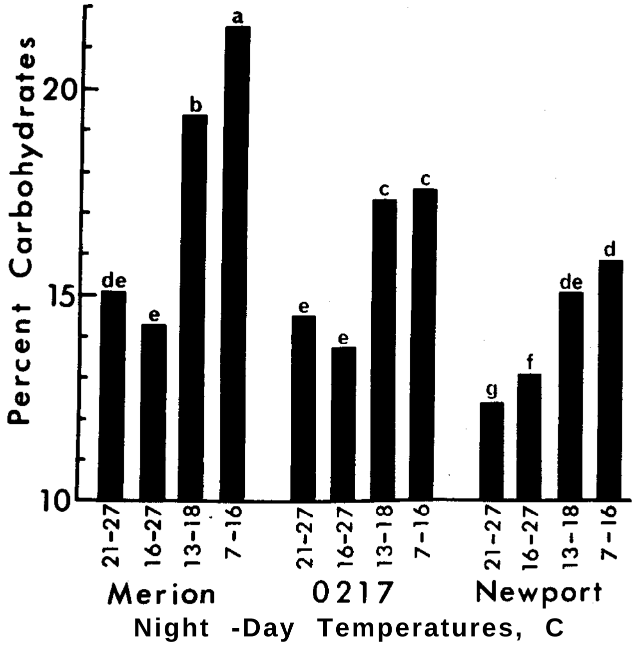


Fig. 2. Total available carbohydrate in stem bases of three Kentucky bluegrass strains at four temeprature regimes, expressed as percent of total dry mater.

other causes may in a similar way be partially dependent upon sufficient reserves in uninjured plant parts. An ability to resist attacks from some disease organisms may be related to the level of reserves. Workers in eastern United States have shown that *Helminthosporium* melting out of 'Kentucky bluegrass is a "low carbohydrate" disease, i.e., the incidence of this disease appears to be more severe when carbohydrate levels are low.

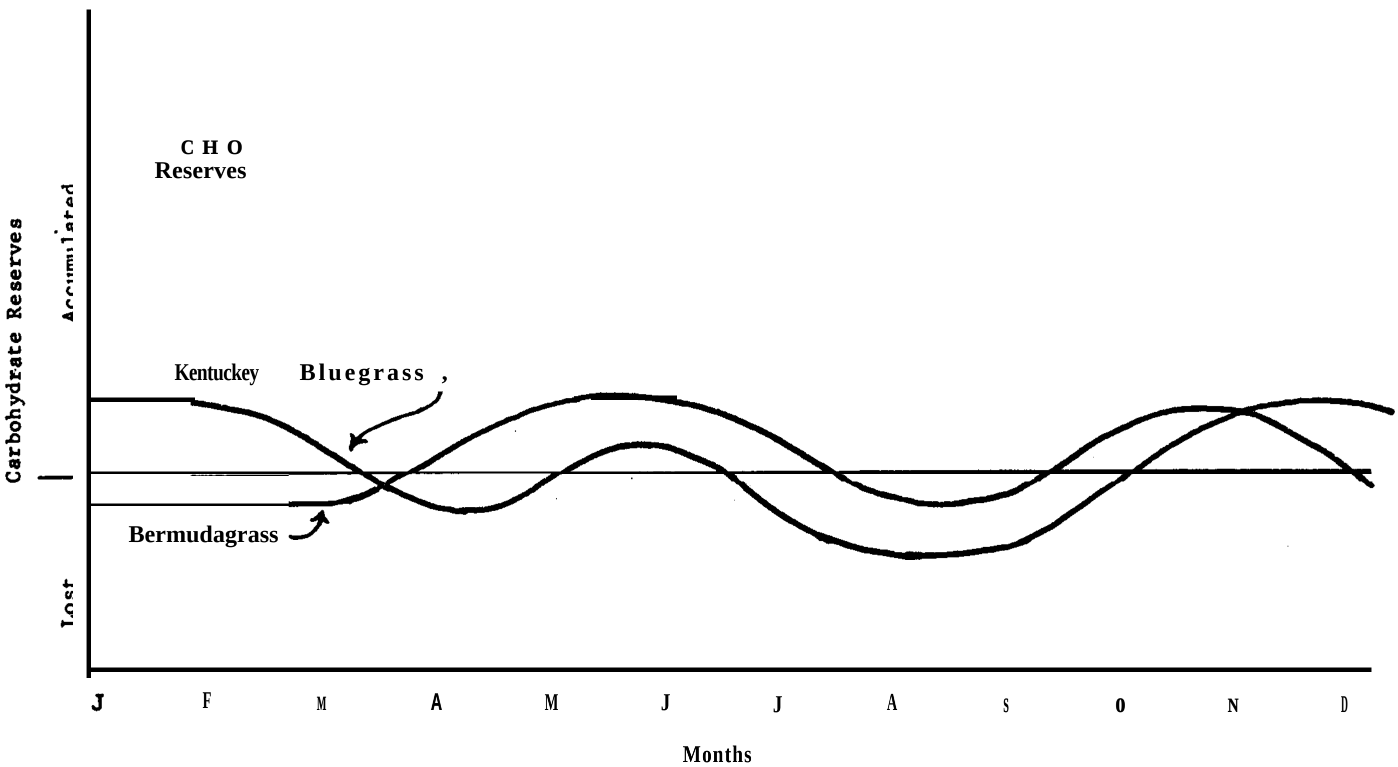
Survival of turfgrasses during winter dormancy is directly related to an adequate reserve of soluble carbohydrates. Even though the shoots may be fully dormant respiration of roots, rhizomes and crowns continues. As there is little or no photosynthesis the energy needs for respiration at this time can be met only by the soluble carbohydrates accumulated in the storage tissues. Spring recovery also calls heavily upon the reserves during the initial phase until photosynthesis is again adequate to meet all carbohydrate demands. Survival and recovery from other stress periods such as drought and high temperature may be similarly related to the presence of sufficient reserves.

An understanding of the factors that affect the level of soluble carbohydrates in turfgrasses will assist the turf manager to manipulate his management program so as to maintain a favorable carbohydrate status in his turf.

Photosynthesis and respiration both increase with increasing temperature, however, respiration rates generally continue to increase well beyond the optimum temperature for photosynthesis. Under these conditions reserves are rapidly depleted. 'Under cool temperatures respiration rates may be low while photosynthesis remains high. If top growth is also moderate, carbohydrates accumulate. In Fig. 1 fluctuations of reserves with temperature are shown for bermudagrass and Kentucky bluegrass. At temperatures too low for photosynthesis reserves are used for respiration of roots, crowns and rhisomes and to some extent for new root growth. When temperatures become somewhat warmer the grass becomes photosynthetically active but growth and respiration are still low so reserves accumulate. At still higher temperatures reserves are lost because of high rates of growth and respiration.

Varieties of a grass species may differ in their ability to accumulate carbohydrates under identical conditions

Fig. 3



as shown for Kentucky bluegrass in Fig 2. A variety such as Merion that accumulates large amounts of carbohydrates may be better able to survive periods of stress. Merion is a selection from an area where summers are hot and humid and winters are cold. Newport was selected along the Oregon Coast where summers are cool and winters are moderate.

Seasonal carbohydrate fluctuations in Southern California, largely caused by temperature, are shown in Fig. 3. In Kentucky bluegrass reserves accumulate in the late fall. winter and early spring but are depleted with the early flush of spring growth and during the hottest summer months. Bermudagrass loses reserves during its dormant winter period but accumulates carbohydrates during early spring and summer and in early, fall. Even in bermudagrass, reserves are depleted durmg the hottest summer weather.

Controlled environment studies have shown that Kentucky bluegrass seedlings grown under moderately warm temperatures (85°F days and 65°-75°F nights) accumulate no reserve carbohydrates. This may be an important factor in the difficulty in establishing bluegrasses during the summer.

Since photosynthesis uses the sun's energy for carbohydrate synthesis it logically follows that shaded turf would have a less favorable carbohydrate status than the same turf in full sun. Reserves are generally low in heavily shaded turf. To assist turf growing in shade it should be mowed at a greater height to give it more light absorbing leaf surface.

Mowing turf reduces its ability to synthesize carbohydrates under all conditions of culture. Carbohydrate reserves are reduced directly with the severity (closeness) and frequency of mowing. Removal of large amount of topgrowth in a single clipping causes a rapid decrease in stored carbohydrates. Whenever grass leaves are removed the plant must utilize reserves for the initial stage of regrowth at the same time as its ability to produce new carbohydrates has been severely restricted. Repeated severe defoliation, as most normal mowing practices must be considered, prevents the grass plant from attaining its full potential to synthesize carbohydrates to be used for growth and storage. The results are a smaller root system, a general reduction in vigor, and usually a slower rate of tillering. To ameliorate these adverse effects of mowing, proper cutting heights and mowing frequencies should be maintained. Mowing frequency should be based on growth rate so that no more than one-third to one-half of the top growth is removed at any mowing.

Nitrogen fertilization beyond the minimum needed to maintain growth usually reduces the level of carbohydrate reserves. Nitrogen stimulates growth, hence as more and more nitrogen is applied to the turf the plant uses more and more of its carbohydrates to provide the energy for the increasing production of foliage. The result is a declining surplus of carbohydrates.

Management and climatic factors often interact to affect the status of available carbohydrates. An appreciation of these interactions may assist the turf manager in designing a good program. To cite one example, as both close mowing and high temperature reduce the level of total available carbohydrates, higher mowing during hot weather can appreciably improve the turfs quality and even ability to survive. Limiting nitrogen fertilization at the same time will be of further help by avoiding stimulation of excessive top growth to be removed in mowing. Similar relationships are apparent for timing of vertical mowing and aerification which have a temporary injurious effect on the grass.

In summary, a basic objective of a well planned turf management program should be to maintain a favorable carbohydrate (energy) status in the grass plant at all times if possible. If this is accomplished the turf will be better able to withstand many unavoidable stress periods such as heat, cold and drought. It will be able to recover more rapidly when it is injured and may even be able to better resist certain diseases.

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WEED CONTROL PROGRESS REPORT POSTEMERGENCE BROADLEAF WEED CONTROL IN TURFGRASS

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Two trials using six postemergence herbicides and herbicide combinations were applied April 21, 1972, in two locations on an established Kentucky bluegrass/bentgrass turf. Both tests were designed to give phytotoxicity information as well as control for the two principal weeds *Soliva sesselis* (Soliva) and *Ranunculus muricatus* (field buttercup). Additional weeds, *Trifolium repens* (white clover) and *Pkmtago major* (broadleaf plantain) were found in sufficient quantity to evaluate control.

All treatments were applied in 100 gpa with a CO_2 pressure spayer to 5 ft. x 10 ft. plots that were replicated four times. The temperature was approximately 70-73°F. in the shade at the time of application. No water was applied to the turf for 48 hours following treatment. The *S. sesselis* was in bloom stage and the *R. muricatus* was bloom to early seed stage at application time. Phytotoxicity and weed control evaluations were made April 30, May 9 and 21, and June 9, 1972.

Control of four broadleaf weed in turfgrass with six postemergence herbicides and herbicide combinations at various dates following treatment.

Herbicide	Rate lb a.i./A	Soliva control 4/30	5/9	5/21	6/9	White clover 5/21	6/9	Broadl. plantain 6/9	Ranunculus muricatus 5/9	6/9	Phytotoxicity (IO=IOO%) 4/30	5/9	5/21	6/9
bromoxyni l	0.5	6.5*	9.5	9.2	9.6	2.5	0.8	0.8	3.2	6.2	0.0	0.4	0.5	0.1
bromoxynil	1.0	7.8	9.8	9.8	10.0	2.5	1.3	0.8	6.0	7.5	0.0	0.6	0.2	0.0
bromoxynil	2.0	8.3	10.0	9.8	10.0	2.0	1.4	4.8	8.5	8.8	0.0	0.8	0.5	0.1
2,4-D O.S. amine	0.5	0.2	0.2	2.0	1.0	0.2	1.8	7.0	4.0	9.2	0.0	0.0	0.0	0.1
2,4-D O.S. amine	1.0	1.0	1.2	4.2	2.8	2.8	2.3	9.7	4.2	10.0	0.0	1.1	0.2	0.1
dicamba	0.125	1.0	4.0	8.2	10.0	9.2	9.7	2.8	2.8	5.8	0.0	1.4	0.8	0.5
dicamba	025	2.0	4.0	9.5	9.8	10.0	9.9	1.0	2.8	5.8	0.0	1.2	0.2	0.4
2,4-D + silvex	0.5 + 0.25	3.2	4.2	8.2	7.0	9.2	8.5	9.8'	5.0	9.2	0.0	1.4	3.5	1.0
2,4-D + silvex	1.0 + 0.5	4.5	8.0	9.8	10.0	10.0	9.4	9.5	4.0	10.0	0.0	2.2	4.5	2.0
2,4-D • t. silvex	2.0 + 1.0	4.2	8.5	10.0	10.0	10.0	10.0	9.9	5.8	10.0	0.5	3.1	5.8	2.3
MCPP + Maintain@	1.0 + 0.33	1.2	1.2	3.2	1.2	6.8	4.0	2.2	2.0	3.2	0.0	0.2	0.5	0.5
MCPP + Maintain@	2.0 + 0.67	1.2	1.5	4.5	5.0	8.0	4.6	7.2	2.0	8.5	0.0	0.0	1.0	0.6
Control		0.0	0.5	0.5	2.2	0.0	0.5	0.5	0.2	0.5	0.0	0.0	0.5	0.4

***Scale: O=No. control: IO=IOO% control**

Results

Bromoxynil at 0.5 to 2 lb. a.i./A effectively controlled both *S. sesselis* and *R. muricatus* in these trials. A single application of bromoxynil at 2 lb. a.i./A did not satisfactorily control *T. repens* OT *P. major.*

Good control of *R muricatus* and *P. major* was achieved with 2,4-D oil soluble (o.s.) amine at 0.5 to 1 lb./A. T. repens and *S. sesselis* were not controlled.

Dicamba controlled most weed species well except *P. major* and *R. muricatus* which has been consistentlv tolerant of this herbicide in other tests. The combination of 2,4-D O.S. amine plus silvex gave excellent control of all weeds at a rate of 1.0 + 0.5; however at this rate bentgrass injury was unsatisfactory.

Acceptable control was not achieved on any weed with a single application of the MCPP + Maintain combination, however, some control of *R. muricatus* and *T. repens* was noted at the high rates.

COLONIAL BENTGRASS IN CALIFORNIA

Dean Donaldson"

Colonial bentgrass ***(Agrostis tenuis*** Sibth) is a cool season species native to Europe which has become naturalized in the cool humid regions of the United States. Naturalized strains of colonial bentgrass have been propagated keeping the name of the region where the seed was produced. Nationally, colonial bentgrass is also known as Astoria, Browntop Rhode Island, New Zealand, Northwest and Prince Edward Island bentgrass (1, 5). In California, colonial bentgrass is used in parks, fairways and home lawns in areas where it is adapted.

Description:

Colonial bentgrass is a cool-season, fine-textured perennial (Figure 1.). Leaves are rolled in the bud shoot; sheaths are round, smooth, split with overlapping margins; auricles are absent; collar conspicuous, narrow, smooth; ligule is membranous, truncate, short (0.3-1.2mm long), entire or finely toothed, blade is flat, short tapered to a sharp point, ridged on upper surface, upper surface and margins moderately scabrous; stems are erect, slender, tufted; rhizomes and stolons are determinate, weak, short or absent, rhizomes leaves appearing as brown scales; inflorescence is an open, delicate, loose panicle. The seeds are small, 7 to 8 million per pound.

Adaptation and Growth Responses:

Colonial bentgrass is best adapted to the coastal region of California north of Santa Barbara County and to the cool mountainous regions of California shown in Figure 2 (6). These areas are characterized by moderate to cool temperatures with high humidity. Colonial bentgrass is adapted to a wide range of soil types but grows best on fertile fine textured soils with a pH of 5.5 to 6.5 (1). It has a low tolerance to heat, salinity, and water stress, with

1. SALINITY TOLERANCE

High Improved bermudas
Common bermuda
Creeping bentgrass
Zoysia
St. Augustine
Tall fescue
Perennial ryegrass
Meadow fescue
Red fescue
Kentucky bluegrass
Colonial bentgrass
Low Dichondra

II. HIGH TEMPERATURE TOLERANCE

High Zoysia
Improved bermudas
Common bermuda
St. Augustine
Tal l fescue
Dichondra
Meadow fescue
Kentucky bluegrass
Colonial bentgrass
Red fescue
Ryegrass
Low Creeping bentgrass

III. DROUGHT TOLERANCE

High Improved bermudas
Zoysia
Common bermuda
Tail fescue
Red fescue
Kentucky bluegrass
Perennial ryegrass
Meadow fescue
Colonial bentgrass
St. Augustine
Dichondra
Low Creeping bentgrass

IV. SHADE TOLERANCE

Shade Red fescue
Zoysia
St. Augustine
Dichondra
Colonial bentgrass
Tall fescue
Creeping bentgrass
Meadow fescue
Kentucky bluegrass
Perennial ryegrass
Improved bermudas
Sun Common bermuda

'County Director and Farm Advisor-Napa.

V. WEAR RESISTANCE

High Zoysia
Improved bermudas
Tall fescue
Common bermuda
Perennial ryegrass
Meadow fescue
Kentucky bluegrass
Red Fescue
St. Augustine
Colonial bentgrass
Creeping bentgrass
Low Dichondra

a medium tolerance to shade and low tolerance to wear, as is shown in the comparative species ranking.

Rhizome and stolon growth of colonial bentgrass is weak or lacking and the root growth is relatively shallow. When seeded in mixtures with erect cool season turfgrasses, colonial bentgrass often becomes dominant by colonizing into roughly circular patches which are differentiated from the other species by color, texture and a

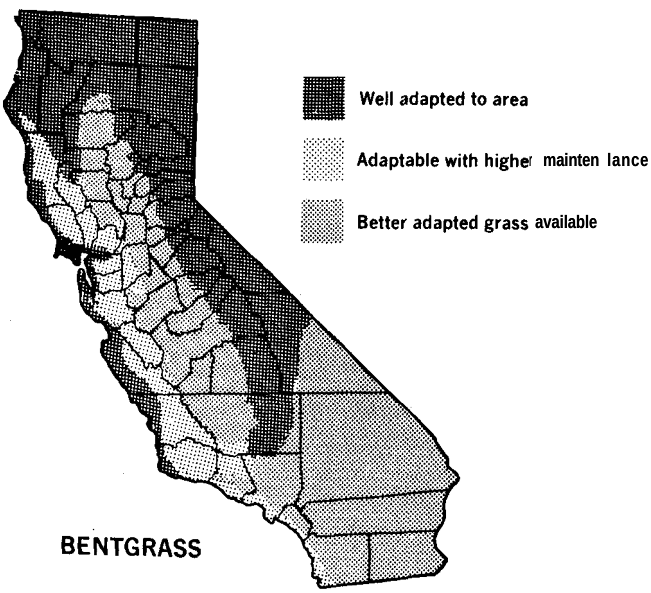

FIG. 2-California adaptation map for colonial bentgrass.

comparatively dense growth. Dominance is encouraged by high rates of fertility, frequent irrigations and a mowing height less than one inch. False crowns, which are clusters of tillers arising from fine aerial stolons, are common to the Highland cultivar.

Colonial bentgrass is susceptible to a large number of common turf diseases. Couch (2) lists 22 of which red thread, Fusarium patch, brown patch and dollar spot are commonly observed in California. In addition, at least five nematode species are known to attack colonial bentgrass (2). The species is also sensitive to chemical applications, with certain herbicides causing injury to the roots (1). Preemergence materials such as DCPA and translocated foliar materials such as 2,4-D and 2,4,5-T should be used with caution.

Colonial bentgrass is favored by cool weather. Where mean July temperatures are about 65°F. it thrives, but root growth stops when the soil temperature exceeds 80°F. (4). Thus, it will survive in California transitional zones only under intensive care. These zones are indicated as "adaptable with higher maintenance" in Figure 2.

Management:

Sow seed at l-2 lb. per 1000 sq. ft. for home lawns, 40-80 lb./acre for fairways. Colonial bentgrass requires a relatively high degree of management to produce a high quality turf. Frequent irrigations are often necessary because of the shallow rooting habit of colonial bentgrass. Cutting heights most favorable to colonial bent range from 0.5 to 0.8 inches (1) .

It responds best to nitrogen levels of 0.5 to 1.0 lbs. per 1000 sq. ft. applied each month of active growth. The lower rate should be used during the warmest summer months. Thatching is frequently a problem and is best prevented through a program of topdressing, vertical mowing and aeration. False crowning can be controlled by raking before mowing or by occasional mowing at lower cutting heights.

Varieties:

The following varieties of colonial bentgrass are currently available for turfgrass use (1,3,5).

Astoria: From seed collected in northwestern Oregon, released by Oregon AES, Corvallis in 1936. Astoria has a medium green color with noted susceptibility to brown patch.

Exeter: From comparative testing of seed collected along the Atlantic Coast in Rhode Island, Connecticut and Massachusetts, released by Rhode Island, AES, Kingston, in 1963. Similar in color and growth to Astoria but better able to withstand winter cold and greens-up earlier in the spring. Resist dollar spot.

Highland: From seed collected in Willamette Valley, Oregon, released by Oregon AES, Corvallis in 1934. Distinctive blue green color and habit of forming false crowns. Good draught resistance, susceptible to brown patch. More heat tolerant than other strains.

Holfior: From seed collected in Southern Holland, released by D. J. van de Have, Netherlands in 1940. Holifior is similar in growth habit to Astoria and Exeter, but has a darker green color with somewhat less tendency to form thatch.

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