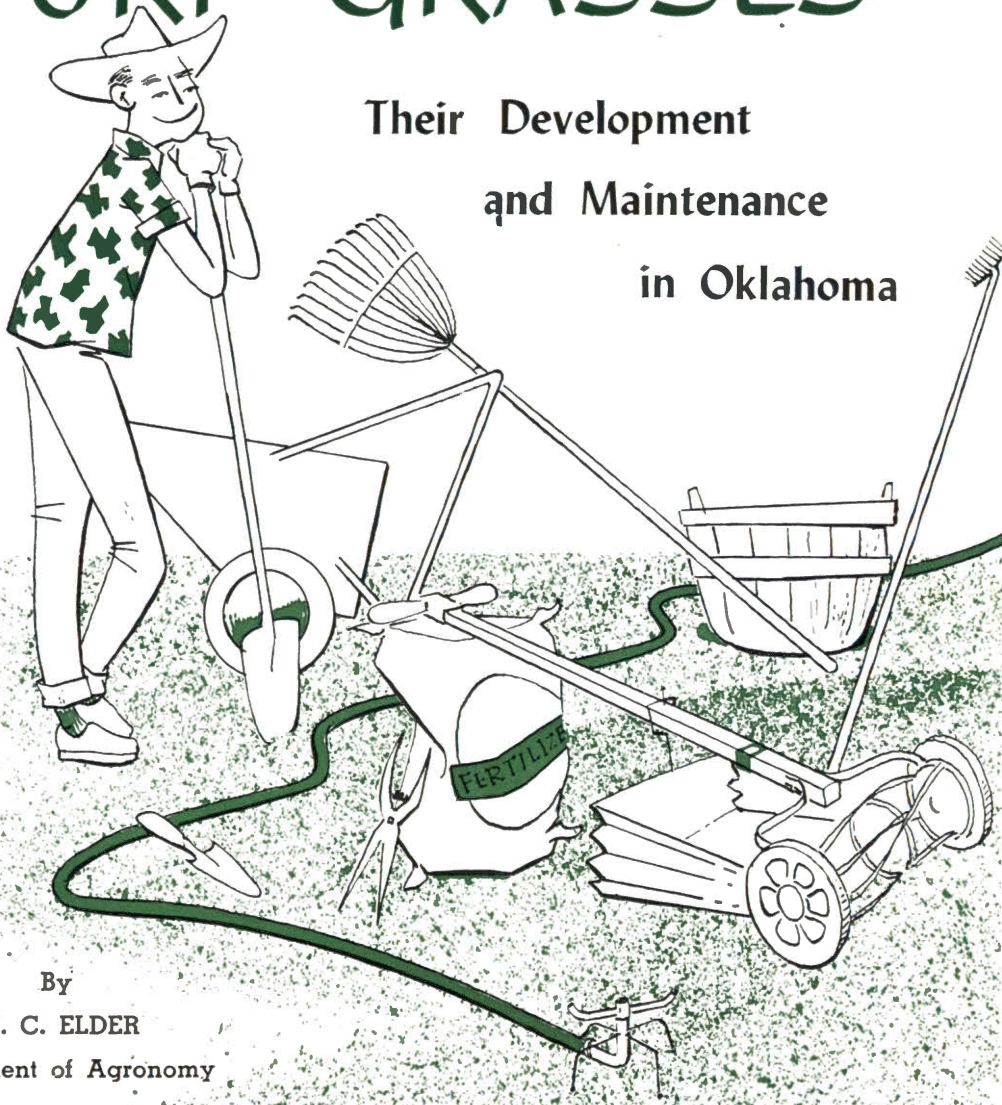
TURF GRASSES

Their Development and Maintenance in Oklahoma



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(Contents, Con't.)

STUDY of turf grasses and turf management was started at the Oklahoma Experiment Station in 1948. A portion of the money for the investigations during the first three years was furnished by the Tulsa Golfers Fund for War Wounded, Inc., through the United States Golf Association, Greens Section. The research is now supported by state funds.

Although golfers initially furnished a portion of the money for this study, the program was not confined to golf turf, but was organized to cover a wide field of turf development.

TURF GRASSES

Their Development and Maintenance In Oklahoma

By W. C. Elder

Department of Agronomy

This publication reports the results of three years study on:

(1) Grass species for turf use under different soil and climatic conditions in Oklahoma;

(2) Establishment and maintenance of some important turf grasses used in the state, and

(3) Special turf problems.

General information pertaining to the development and maintenance of turfs is contained in Oklahoma Agricultural Experiment Station Forage Crops Leaflet No. 10.

Most people think of turf in terms of a lawn for the home. A good lawn is considered the basic element in landscape designs. However, a heavy mat of grass on the surface of the soil has many other specialized uses. A good grass cover is of great importance for roadsides, highway and industrial developments, airfields, cemeteries, parks, school playgrounds, and athletic fields.

Turf in all of its specialized uses is directly related to the health and well-being of everyone. Not all of the dust, mud, and flood waters in Oklahoma come from farm lands. Also contributing to these undesirable conditions are non-agricultural lands that lack good cover crops. The most economical method of protecting such lands from wind and water erosion is the use of turf grasses—grasses that not only protect the soil, but add utility and beauty (See Fig. 1). Because of the various uses of turf grass and because of the varying soil and climatic conditions, a great deal of information is necessary in order to carry on an adequate turf program in all its phases.

Selecting the Species

The first prerequisite for establishing a good turf is the selection of a grass species that will meet the specific use requirements and still thrive under existing soil and climatic conditions. Out of the thousands of known grass species, only a few (25 to 30) have turf possibilities. Grasses must be grown under somewhat artificial conditions to form a dense uniform mat or sod. The bunch grasses do not form uniform cover and have only a few special uses for turf. To form a dense, uniform ground cover, grasses must be clipped often and very close. Leaves that are needed to produce food for root reserves are removed, and the plant is never allowed to make seed for reproduction. Only a few grasses can survive this treatment and form the desired turf.

METHODS FOR DETERMINING SUPERIOR TURF GRASSES

During the 3-year study, 26 species or strains of grasses were established for observation under different management practices. (See Fig. 2 for five of these grasses.) Several plots of each grass were planted at Stillwater; and the most promising grasses were planted at various locations over Oklahoma. The following treatments were applied to each grass to determine the superior species under varying conditions:

(1) Clipped 1 inch high as found in lawns or golf fairways.

(2) Clipped 2 to 3 inches high to check suitability for golf roughs or other sites where close clipping is not required.

(3) Irrigated during hot, dry summer months.

(4) Unirrigated.

(5) Fertilized with commercial fertilizers.

(6) Unfertilized.

FACTORS TO CONSIDER IN A TURF SPECIES

On the basis of the tests, each grass was evaluated in relation to certain important qualities. The grasses and their ratings are given in Table I. Characteristics of grasses relative to establishment and maintenance are given in Table II. (See pages 33 and 34 for Tables I and II.)

It is difficult to make positive evaluations of all the qualities of a turf grass because: (A) Many factors depend on personal preference; (B) A good grass cover has so many uses that one species may have

an excellent rating under one situation but be worthless for another, and (C) A large number of qualities are involved, and accurate measurements cannot be applied for all factors.

In understanding the rating table (Table I), the following explanations of each factor will be helpful:

Density. — A thick, solid mass of leaves and stems to cover the soil is desirable in many places such as lawns, golf fairways, and athletic fields. Many injuries can be prevented with a good dense turf for protection against falls. A dense cover of grass on the school grounds in Oklahoma would improve the landscape, and prevent muddy shoes and clothing in rainy weather and dusty clothing and lung ailments in dry weather (See Fig. 3).

Texture. — Grasses have different sized leaves. As a rule, the fine, short-leaved species make a more desirable lawn; but some grasses with wide leaves make very satisfactory turfs.

Fig. 1.—Grasses can be used on steep slopes to improve appearances and also to prevent soil erosion. Good cover crops on exposed lands directly affect the health and well-being of everyone.

Fig. 2.—Five grass species currently being tested in the turf plots west of Stillwater. From left to right are Zoysia japonica **and** Zoysia matrella. Matrella **produces a thick, heavy cushion of turf. The only means of propagation is from sod.** Zoysia japonica **has wider and shorter leaves than** matrella **and is propagated by both seed and sod. It spreads more slowly than Common Bermuda. Centipede grass is subject to winter freezing, and is recommended only for southeastern Oklahoma. African Bermuda is a very fine-leaved light-green plant. Under favorable growing conditions, it makes a beautiful turf, but requires exacting attention.**

Evenness. — Most turf conditions require an even-growing grass. The bunch grasses have little use when an even sod is necessary, but can be used on highways, golf roughs, and in other situations.

Heat Resistance. — Maximum temperatures up to 110° F. are recorded some years in Oklahoma. These high temperatures kill many winter-growing grasses and eliminate the use of many good grass species used for turf in other states.

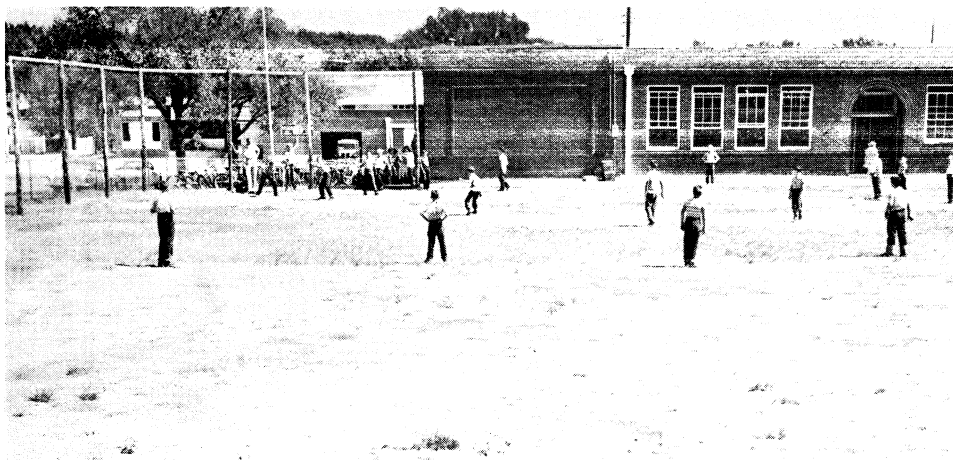
Drouth Resistance. — Where it is impossible to water grasses in Oklahoma, the species must be hardy. This is of great importance since many cities have limited water supplies and frequently restrict lawn watering.

Cold Resistance. — Cold, dry conditions in winter restrict some of the southern adapted grasses. Southeastern Oklahoma is adapted to a few southern grasses that are winter killed in other areas of the state.

Resistance to Close Clipping. — Close, frequent clipping of grasses is necessary to form a dense turf. Grasses now used for turf have a wide range of clipping requirements. Clipping heights and frequencies must be given careful consideration in a good turf maintenance program.

Wear Resistance.—Not many grasses will form a tough, wear-resistant sod. The plant must have a tremendous root system. Bermuda-grass is resistant to wear because of rootstocks just beneath the surface of the soil and the mass of leaves and interwoven stolons on the surface.

Fig. 3.—Many injuries are possible on a bare, hard-packed soil such as this playground, and children will be confined to rooms when the soil is wet. A thick, wear-resistant sod of grass would prevent injuries and make the playground usable in almost any weather condition.



Shade Tolerance. — Too often shade trees and grasses are planted together in landscape designs. Fortunately, a few grasses will tolerate some shade; but sunlight is necessary for the manufacturing of food by plants.

Resistance to Weed Invasion. — Most of the weeds in lawns are the result of poor maintenance practices. Weeds will not thrive in dense, healthy turf. A wide range of ratings can be given to turf grasses on their ability to resist weeds.

Disease Resistance. — Grasses are susceptible to many diseases, and a large group of harmful fungi is associated with turf grasses. Some grasses are more susceptible to diseases than others. Golf maintenance men must be constantly alert for diseases where Bent grasses are used on putting greens. Using fungicides in a disease prevention program is common practice on golf putting greens.

Encroaching Habits. — Some grasses have a strong tendency to invade flower beds, gardens, borders, and other areas adjacent to the turf. This is one of the weaknesses of Common Bermuda-grass. A few, such as Dallis grass and Yellow bluestem, tend to invade by seedlings.

General Observations and Recommendations For the Grasses Tested

BENT GRASS

The Bent grasses are used for putting greens on improved golf courses in Oklahoma. They can have little use as lawn grasses in this state until improved strains can be found to withstand hot, dry growing conditions.

BERMUDA-GRASS

General information pertaining to Bermuda-grass is contained in Oklahoma Agricultural Experiment Station Forage Crops Leaflet No. 14. (See Figure 4 for area of adaptation.)

Common Bermuda-grass

Common Bermuda-grass is summer-growing and takes care of 75 percent or more of the turf needs in the state. It has many good qualities required for covering the soil. It (a) withstands prolonged close clipping; (b) forms a dense, compact turf when properly clipped; (c) withstands hot, dry weather; (d) responds quickly to water and nitro-

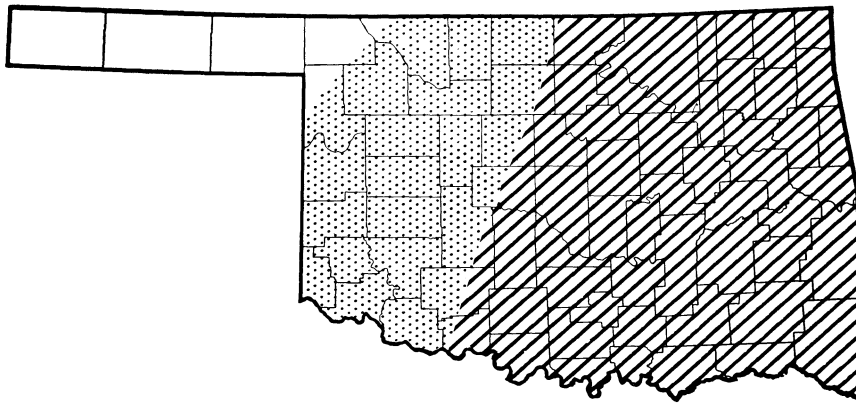


Fig. 4.—Areas of adaptation of Bermuda-grass. The heavily shaded area=major use; the dotted area=minor use. Common Bermuda-grass is summer growing and takes care of 75 percent or more of the turf needs in the state.

gen fertilizers; (e) has wide soil adaptation in the state; and (f) is persistant and wear resistant.

The greatest criticisms of Bermuda-grass for turf are its intolerance to shade and its habit of encroaching into putting greens, flower beds, gardens, and fields near highways. It is not green in winter months but does provide a good protective, wearable sod in the dormant season.

Persons planning to start new turf areas from Common Bermuda-grass should seek fine-leaf strains. Many strains have broad leaves that will not produce a close, compact turf.

U-3 Bermuda-grass

U-3 Bermuda-grass, a strain of Common Bermuda-grass, has been tested over a wide area where Bermuda-grass is adapted, and is now considered outstanding for turfs. In the Oklahoma tests, U-3 produced finer leaves, denser turf, and a more uniform pleasant color than several selections of Common Bermuda-grass that had been used for turf in the state. It seems to require the same growing conditions as Common Bermuda, and it evidently is winter hardy because plantings at Stillwater, Oklahoma, have survived six winters. The most impressive features of this strain are the blue-green color, the thick, compact turf that can be formed by fertilization and close clipping, and the fine leaves growing close together that do not show injury after mowing.

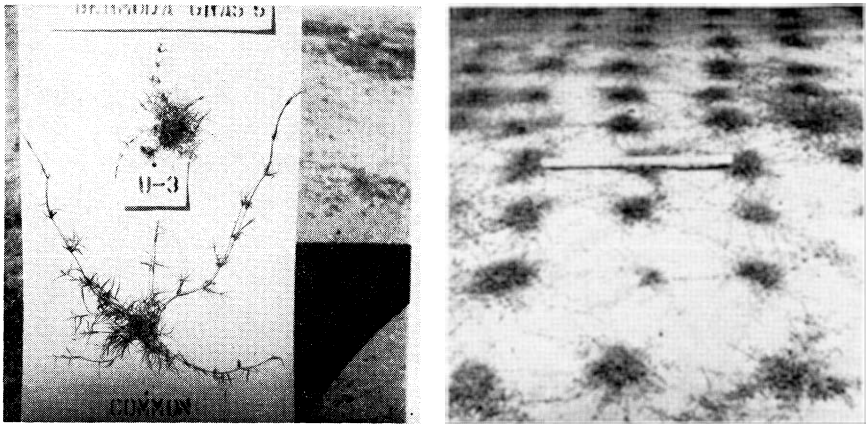


Fig. 5.—U-3 Bermuda-grass does not spread rapidly compared with Common Bermuda (right), but it provides a dense mat of fine leaves. By placing 2- to 3-inch plugs of U-3 Bermuda-grass 18 inches apart (left), a complete cover can be expected in 40 to 50 days under good growing conditions.

This strain spreads more slowly than Common Bermuda and requires more time to cover the soil after planting (See Fig. 5). In many places this slow growth may be an advantage: it will not encroach into other areas as rapidly as Common Bermuda-grass; and the slow growth, accompanied by the characteristic low-growing slender stolons and leaves, will reduce the frequency of mowing. U-3 Bermuda is recommended throughout the state where Common Bermuda-grass is now growing. It should find its greatest use on lawns, golf courses, parks, athletic fields, etc. Common Bermuda is preferred when fast cover is necessary for soil protection, as in the case on highway shoulders, right-of-ways, or other places where a dense sod is not necessary.

Several commercial nurseries in the state have U-3 Bermuda-grass for sale. Sod from the Experiment Station is being increased by Oklahoma Foundation Seed Stocks, Inc., Oklahoma A. & M. College. Sod and roots from these plantings will be sold by members of the Oklahoma Crop Improvement Association as certified U-3 Bermuda-grass stock.

African Bermuda-grass

African and Common Bermuda-grass are different botanical species. African Bermuda is a very fine-leaved, light-green plant and closely resembles fine strains of Common Bermuda-grass. Under favorable growing conditions it makes a beautiful turf. Unfortunately, it requires exacting attention and management practices. It must have

ample water and good fertilization for good growth. It is subject to diseases. If African Bermuda-grass is not clipped properly, a brown color will appear. This off-color is the result of clipping the green leaves that are bunched near the end of the stem, exposing a characteristic brown sheath covering each stem. African Bermuda-grass has the same adaptation in Oklahoma as Common Bermuda-grass. Its use is recommended only for those people who possess a good knowledge of growing turf grasses and who have plenty of time for maintenance.

KENTUCKY BLUEGRASS

Kentucky bluegrass is popular in many areas of the United States but it is not well adapted to the hot, dry summers of Oklahoma. (See Figure 6 for area of adaptation.) It thrives in shade and is sometimes used in shady areas of northeastern Oklahoma. It can also be grown in the high altitude of northwestern Oklahoma if water is provided. The new lawn strain, Merion bluegrass, was superior to Common Kentucky bluegrass in all plots on the Experiment Station. It has a wider leaf and can be clipped lower than the Common Kentucky bluegrass which must be mowed at a height of not less than 2 inches.

CENTIPEDE GRASS

Centipede grass is used on a few lawns in southeast Oklahoma (See Figure 7). It is a southern grass and subject to winter freezing. A winter hardy strain now being tested by the Oklahoma Agricultural Experiment Station has a possibility of increasing the adaptation of Centipede

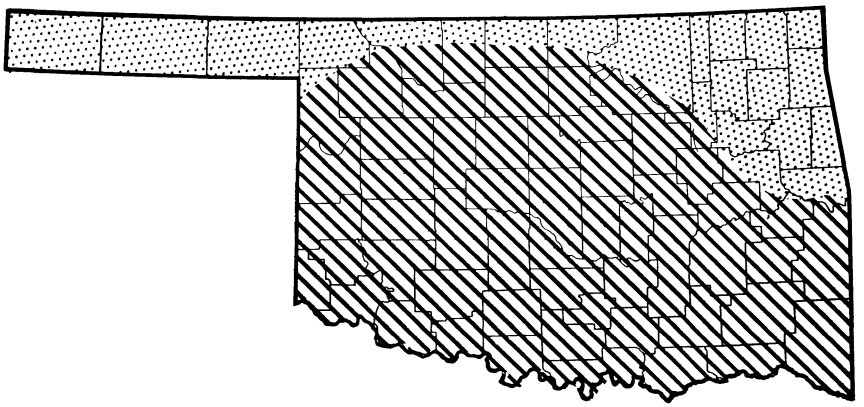


Fig. 6.—Kentucky bluegrass is not well adapted to the hot, dry summers of Oklahoma. However, it can be grown in the high altitude of northwestern Oklahoma (dotted area) if water is provided. It thrives in shade.

grass. This strain has grown well from all transplantings in the Stillwater area. The leaves are coarse but form a dense turf. The uniform light-green color is different from most other lawn grasses. Centipede grass will grow on poor soils but responds well to fertilizer. Its slow, low-growing habit reduces the task of frequent mowing. Probably the greatest use for Centipede grass in Oklahoma is in shaded areas where a grass cover is desired. It will not grow as well in shaded areas as Kentucky blugrass but is superior to Bermuda-grass in this respect.

FESCUE GRASSES

In the Oklahoma tests, the short growing fescues (Chewings, Illahee and Sheep) made good growth during the cool season but could not survive the summer months. Alta and Kentucky 31 fescue show promise for some turf use in Oklahoma. In the tests, no difference could be distinguished between the two strains, and they are treated as one grass (tall fescue) in this publication. Since most popular winter grasses are not adapted to Oklahoma, tall fescue may have widespread use in the future. It has a longer growing season than other grass in Oklahoma. It turns brown during dry weather but responds quickly to watering and makes new growth within two or three days, even at 100° F. It thrived under the 2- to 3- inch clipping height. The leaves are somewhat coarse, and the turf is not as dense and even-growing as Bermuda-grass turf. The vigorous, hardy root system of this species should produce a sod that will stand heavy use. It also looks promising under shaded conditions.

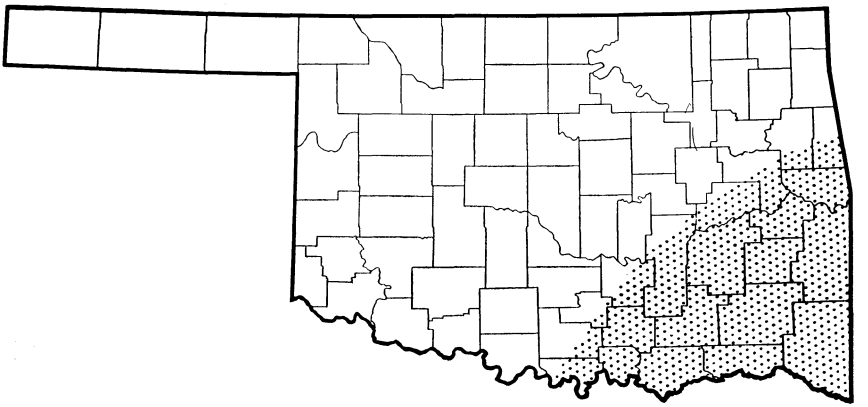


Fig. 7.—Centipede grass is used on a few lawns in southeast Oklahoma (dotted area). Its slow, low-growing habit reduces mowing. Probably the greatest use for Centipede grass in Oklahoma is in shaded areas where a grass cover is desired.

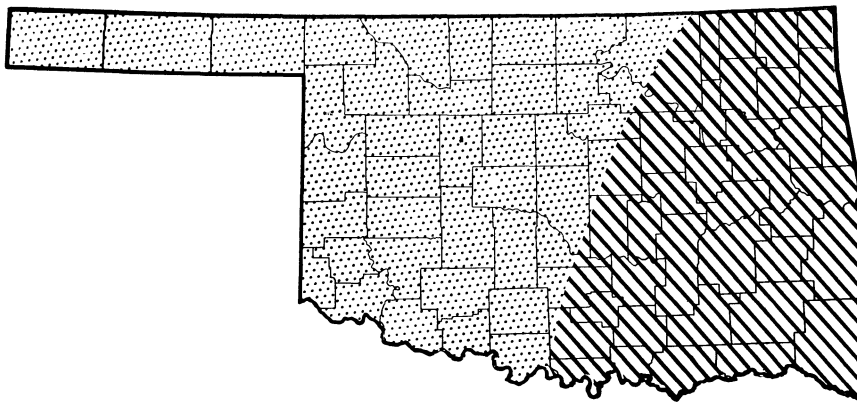


Fig. 8.—Tall fescue appears to be the best winter turf grass for Oklahoma. Its major use is in eastern Oklahoma (heavily shaded area), though it can be used in special cases in central and western Oklahoma.

Tall fescue appears to be the best winter turf grass for Oklahoma. Also, there are possibilities of combining fescue with summer grasses to produce a green sod the year-round. Fescue grown alone should find a place where a turf is desired for large areas. It is easy to establish from seed and the maintenance cost is low. Figure 8 shows the area of adaptation.

NATIVE GRASSES

Most of the native grasses of Oklahoma are of the bunch type and have little use where close clipping is necessary. However, the tall native grasses cover thousands of acres on highway shoulders, railroad right-of-ways, and the property of public utility lines. Sand lovegrass is very good for protecting non-agricultural sandy soils of western Oklahoma, and Western wheatgrass makes a cover for the heavier soils.

Buffalo Grass

Buffalo grass is a sod-forming, summer-growing grass with fine leaves. It survives close clippings and hot, dry summers. This grass is popular in western Oklahoma and ranks second to Bermuda-grass as a lawn grass in Oklahoma. Buffalo grass has spread from western Oklahoma into pastures in the central part of the state where the tall-growing grasses have been overgrazed or otherwise destroyed. This grass should fulfill all the needs for a good turf on the heavy soils in the western one-third of Oklahoma. It is not adapted to sandy soils. See Figure 9 for area of adaptation.

Blue Grama

Tests showed that Blue grama has turf possibilities in Oklahoma. It is a short grass which is usually associated with Buffalo grass. Although it is taller growing than most good turf grasses, close clipping does not reduce stands. Blue grama is highly resistant to heat and dry weather and should become a popular turf grass in western Oklahoma.

Ryegrass

The results obtained with Perennial and New Zealand Victoria ryegrasses were similar to those obtained with Kentucky bluegrass. They looked promising in cool weather but were thinned out by summer heat and drouth. New Zealand Victoria ryegrass produced a beautiful sod but was almost destroyed in all plots by diseases.

Annual ryegrass can be used under trees for winter turf or in combination with summer grasses. More information is given on this subject under "Combining Summer and Winter Grasses," page 24.

Zoysia Grass

Zoysia matrella. — This summer growing grass produced the thickest, heaviest, and densest sod of all the grasses in the tests. The *matrella* plots could always be identified by simply walking on the turf. This sod presented a heavy cushion far superior to all other species under trial. It has a good rating in all factors except speed of establishment (See Table II.) The grass must be propagated from sod. Dur-

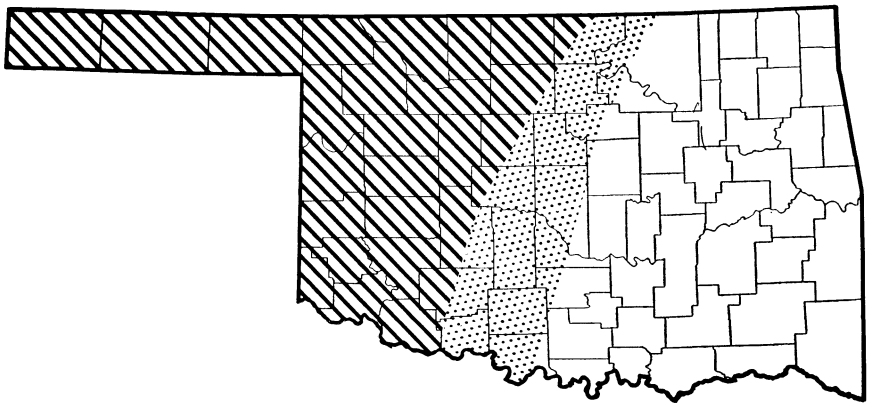


Fig. 9.—Major use for Buffalo grass is in the western half of the state (heavily shaded area.) Minor use can be found for it in central Oklahoma (dotted area), but Buffalo grass is not recommended for eastern Oklahoma (white area). It is not adapted to sandy soils.

ing tests it took two to three years for growth from 2-inch plugs spaced 6 inches apart to completely cover the soil. This slow growth reduces mowing to a minimum, but few persons are willing to wait the time required for a complete sod to form or have the patience to keep the weeds and weedy grasses out of the area until a grass cover is complete.

Zoysia japonica. — The *japonica* species has wider and shorter leaves than *matrella.* It can be established from both seed and sod. Strains used in the test plots did not look promising; however, some recently improved strains may have possibilities.

Management of Bermuda- and Buffalo Grasses For Turfs

Some general information on turf management was gained from the study of evaluating strains and species of grasses. However, to secure specific information on Bermuda- and Buffalo grasses (the two leading turf grasses in Oklahoma), additional plots were set up on established sod of each grass. Clipping heights were 5/8-inch, 1-inch, and 2 inches. Ammonium nitrate was applied in April each year at rates of 0, 50, 100, and 150 pounds of nitrogen per acre.

CLIPPING HEIGHTS

Many controversies arise over height of cutting grasses. Mowing height requirements for turf grass differ greatly (See Table II). For example, Kentucky bluegrass must be mowed 2 or 3 inches high, while Bent grasses are moved less than ½-inch on putting greens. Fortunately Bermuda-grass and Buffalo grass can be clipped very close if managed properly. All plots clipped 2 inches high produced an inferior turf with an unkempt appearance. Where higher rates of fertilizer were used the 5/8-inch mowing formed a dense, compact, fine-leafed turf. One-inch clipping appeared best where little fertilizer was used, especially on the fast-growing Bermuda-grass. Unfertilized, closely-mowed Bermuda-grass had more weed invasion, while the 2-inch clipped Buffalo grass allowed many annual grasses to grow and produce seed.

A good program of mowing at 1-inch is desirable for playgrounds and athletic fields. Higher clippings reduce the density and wearing qualities of the turf and provide poorer footing for cleated shoes. On golf courses or lawns, the cutting height can be under 1-inch providing the grass is fertilized and mowed often.

Frequency of clipping is important for best turf development. If grass is allowed to grow tall and then cut back close, severe damage

is possible. Grass has a tendency to balance the root system with the leaf growth. Frequent mowing allows more leaves to produce food for the root system and at the same time improves the utility and appearance of Bermuda- and Buffalo grasses. When tall grass is clipped only stems are left, and it will not form a dense, compact, tight turf. It may be desirable on lawns to raise the mower for the last cutting in the fall to produce a heavy cover for protection and provide more wear for winter.

FERTILIZATION

Nitrogen is the most important fertilizer element in promoting leaf growth in grasses. Lime, phosphorus, and potassium are necessary for turf growth and should not be overlooked in the fertilizing program. Too often, grasses are planted on subsoil removed from foundations and basements of buildings. If there is any doubt concerning fertility, a soil sample should be analyzed and the proper amount of fertilizer elements applied.

Soils where these clipping tests were carried on had a sufficient supply of lime, phosphorus, and potassium for good grass growth. Nitrogen was applied in the form of ammonium nitrate. Since this material contains approximately 33 percent nitrogen, it requires 300 pounds of the commercial fertilizer to equal 100 pounds of nitrogen.

Bermuda-grass has a higher nitrogen requirement than Buffalo grass. Nitrogen fertilizers created a darker color in Buffalo grass and increased growth to some extent.

Fertilization of Buffalo grass is a minor problem since it is grown in western Oklahoma where fertility levels of the soil are high.

Some Buffalo grass turfs may respond to light applications of nitrogen in the spring of the year, or when water is applied.

Bermuda-grass has a high nitrogen requirement. Weight from all the clippings showed that vegetative growth of Bermuda was in direct proportion to the amount of nitrogen used. One hundred fifty pounds of nitrogen was the highest rate used in this experiment, but similar tests using higher rates indicate that Bermuda-grass has the capacity to use more nitrogen. Increased growth and dark color showed a short time after nitrogen was applied.

The length of time that commercial nitrogen will remain available in the soil was the most important thing learned from this test.

After six to eight weeks, the weights of clippings from treated and non-treated plots were practically the same. One year, nitrogen was partially leached from the soil when rain came immediately after application. The tests indicated that at least two applications of inorganic nitrogen are necessary for best Bermuda-grass growth throughout the season. One hundred pounds of nitrogen[1] per acre applied the first of April, and 50 pounds per acre applied on the first of July appeared to give the most satisfactory results during tests.

Commercial nitrogen can be applied on small areas by hand, or on large areas with any kind of machine that will distribute the material uniformly over the grass.

WATERING

Buffalo grass becomes dormant during dry weather and can withstand prolonged periods of drouth. Compared to Bermuda-grass, it is slow to start new growth after rains. For good turf appearance, both grasses require some watering during the summer months in Oklahoma. Properly managed Bermuda-grass turf on good soil does not require water except in extremely dry periods. One simple rule for watering grasses is to make sure that sufficient water is applied at one time to soak down into the soil far enough to meet subsoil moisture. Bermuda-grass roots penetrate the soil several feet if it is moist. If light, frequent watering is practiced, the root system will develop on the surface of the soil, thereby reducing drouth resistance and increasing injury from winter freezes.

Watering is a problem on many turf areas that have heavy wear. Soils of athletic fields, school playgrounds, golf courses, etc., become compressed and are slow to absorb water from rains and irrigations. Sometimes complete renovation is advisable to break this heavy layer of soil to allow air, water, and fertilizer to enter and facilitate good root development.

The soil is heavy on the Oklahoma A. & M. College football practice field. With heavy wear, it becomes compressed near the surface, causing great loss of moisture by surface run-off. It is difficult to grow a good turf under these conditions; and without a good cover, injury to players is increased. To alleviate this situation 2 tons per acre of gypsum is worked into the soil occasionally to improve soil structure. Also, the field is cultivated often with an aerifier, a machine with a series

[1] For an area of 1000 square feet, 12 pounds of 20-percent or 7½ pounds of 33-percent commercial nitrogen fertilizer is equivalent to 100 pounds per acre.

of spoons that enter and remove 3- to 4-inch cores of soil and deposit them on the surface (See Fig. 10). By running this machine over the field several times during the season, the compressed layer is broken, and water, air, and fertilizers penetrate the soil for deep root formation. The addition of several forms of organic matter has produced a protective cushion for players and added greatly to the water-holding capacity of the soil.

Special Turf Problems

CONTROL OF BERMUDA-GRASS ON GOLF FAIRWAYS

Bermuda-grass is used on a large number of golf fairways in central and eastern Oklahoma. It is well suited to close mowing, responds well to fertilizers, and is acceptable to the golfer both summer and winter. It is not acceptable to the golfer when it encroaches and sends coarse runners on the surface of fine Bent grass putting greens. Where Bermuda-grass is used on the aprons, its control is a problem for the greenskeeper throughout the growing season. Before 1949, chemicals gave little promise for controlling it. Bermuda-grass runners had to be removed by hand, and when infestation was severe all the sod and soil had to be removed and replaced with Bent grass sod. Labor costs were tremendous, being almost prohibitive on some courses.

The grass must be killed without disturbing golf play. One chemical method considered was TCA (trichloracetic acid). This chemical kills Bermuda-grass sod, but 90 days must elapse before Bent grass can be replanted. If it is used in the spring, all aprons around putting greens are bare until fall. If applied in the fall months, the Bent grasses cannot be established from spring plantings.

Methyl Bromide

Intensive tests using methyl bromide were initiated on Bermuda-grass at the Oklahoma Experiment Station in April, May, and June, 1949. The kill was so positive from the start that demonstration areas were shown visitors during Turf Field Day on the Experiment Station in June 1949. Several greenskeepers in Tulsa, Oklahoma, used this method of Bermuda-grass control on golf greens in the fall of 1949. From the start it was a success and soon had widespread use.

Using Methyl Bromide

The soil to be treated should have sufficient moisture for good grass growth.

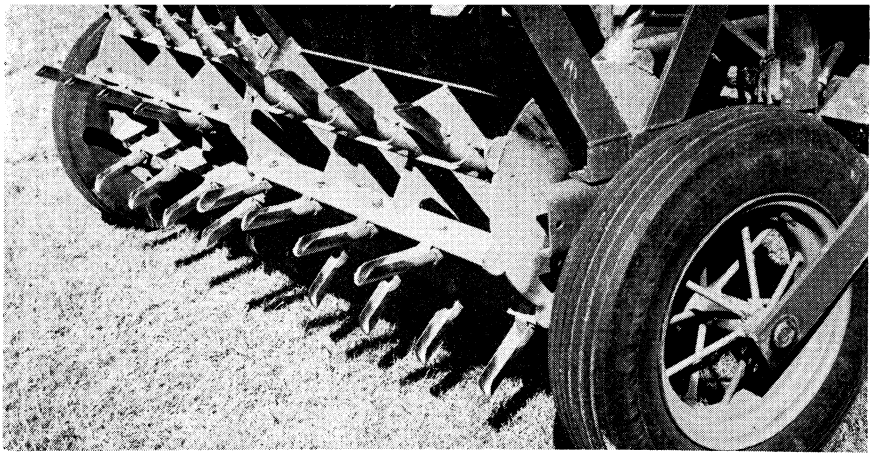


Fig. 10.—A turf aerifier: a good method of cultivating hard, compact soils without injury to the grass. Plugs of soil removed by the spikes will permit entry of water and fertilizer to the soil to produce a deep root system for good turf development.

A methyl bromide solution can be obtained in handy 1-pound cans. The liquid is dispensed at the rate of one pound per 100 square feet by an applicator designed especially for this purpose. The applicator consists of a 10- to 15-foot saran tube with an outlet at one end and a sharpened steel tube and clamp at the other. When the clamp is closed, the steel tube penetrates the can, permitting the liquid to escape through the saran tube. The chemical is released into a shallow pan under an air-tight cover where it quickly forms a gas and penetrates the soil and the grass root system.

The gas is held in close contact with the turf by an asphalt laminated paper blanket, or other gas impervious cover (See Fig. 11). This cover is raised above the grass 2 to 4 inches to allow uniform spread of the gas over the entire area. Brick, lumber, tile, etc., can be used for supporting the air-tight cover. The cover may be folded inside around the edges to fit circular greens, making it possible to treat long strips at one time. Edges of the cover are weighted down with soil or top dressing to prevent escape of the gas.

Covers may be removed after 24 hours exposure to the gas. After one day elapses, Bent grass can be planted safely in the treated area. For conditions in Oklahoma, the fumigation should be made sometime in September since that is the best time to plant Bent grasses. The Bermuda-grass stubble should not be completely removed. It serves as a stable seedbed that can be played over immediately after seeding, and acts as an anchorage for new plants. It is more difficult to re-establish Bent grass in areas where Bent grass has been killed, than

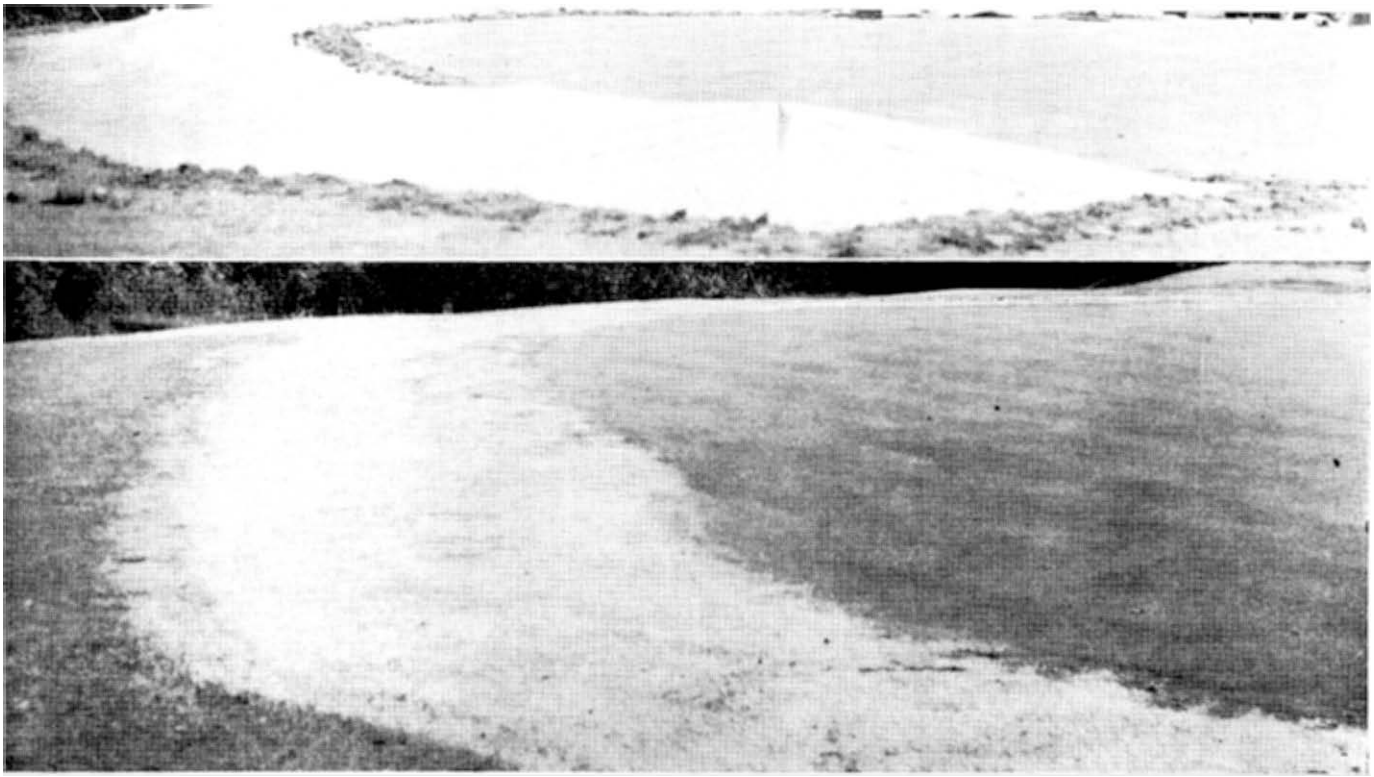


Fig. 11.—Bermuda-grass eradication on Bent grass putting greens with methyl bromide. The cover over the area to be treated (top) allows uniform spread of the gas over the entire area. The same area after treatment (bottom). This makes an ideal place to plant Bent grass in September, and the treatment does not interfere with golf playing.

in Bermuda stubble. In the dead Bent grass area, it usually requires light raking and several disc spikings before and after seeding, followed by light top dressing.

Methyl Bromide Has Other Turf Uses

Methyl bromide can be used to kill Bermuda-grass which invades flower beds, gardens, etc. Soil used as top dressing on golf putting greens, lawns, or athletic fields can be treated with this chemical to destroy all weed seeds. Too often, soil added to turf areas is contaminated with weed seed, thus increasing maintenance costs. By using methyl bromide, it is possible to kill an undesirable grass one day and plant a desirable one the next. Methyl bromide treatment is the only chemical method recommended by the Oklahoma Experiment Station for eradication of Nut grass.

GRASSES FOR SHADY AREAS

Growing grasses in shaded areas in Oklahoma is a difficult problem. Some of the grasses best adapted for shade in other areas of the United States will not grow well in Oklahoma. The two leading turf grasses in Oklahoma (Buffalo and Bermuda-grasses) must have plenty of sunlight for good development. Tall fescue and Centipede grasses appear to have good possibilities for shaded areas in the state, and Kentucky bluegrass is an excellent shade-tolerant plant in sections of the state where it can be grown.

Growing a good turf under shade trees requires more than a good choice of grasses. Trees will take up more moisture and plant food from the soil than grasses. If grasses are expected to grow under trees, extra water and plant food must be provided.

The following practices are helpful in establishing and maintaining grass under trees:

(1) Furnish abundance of water and fertilizer during the growing season.

(2) Prune the shade trees high to allow sunlight and air to reach the grass.

(3) Place fertilizer deep in the soil to encourage deep root growth of the trees.

(4) Deep-spade soil under trees occasionally.

(5) Replace soil under trees.

(6) Plant deep-rooted trees instead of trees that have a shallow, spreading root growth habit.

COMBINING SUMMER AND WINTER GRASSES

Bermuda- and Buffalo grasses are often criticized because they are dormant five months of the year in Oklahoma. A frequent question is: "Why not use a winter grass with these summer growing grasses and have a green turf the entire year?"

Combining a winter grass with Buffalo grass has been discouraged because the common winter turf grasses are not adapted in western Oklahoma. Tests indicate that two winter grasses have possibilities with Bermuda-grass in eastern Oklahoma. Tall fescue will grow with Bermuda-grass, providing there is good moisture during the summer months. When the two grasses grow together they do not produce as desirable a turf in the summer as Bermuda-grass alone. This combination has not been tested sufficiently to be recommended in the state.

By good management, annual ryegrass planted in Bermuda-grass in September or October will provide a green turf in the winter months. This combination is used on many of the best lawns in Oklahoma, but it has been disappointing to many who have tried it. Too often a poor stand of ryegrass is secured, resulting in large bunch growth in the spring months. The large tufts of grass are coarse and form seed stalks that are difficult to mow, presenting a ragged, uneven appearance. These clumps of ryegrass will leave bare spots in the Bermuda sod for the summer months. A thick stand of ryegrass will induce each plant to grow upright and prevent undesirable spreading of individual plants.

Results from the turf study show the best methods for growing ryegrass and Bermuda-grass together successfully are:

(1) Plant a large quantity of seed (5 to 6 pounds per 1000 square feet) between September 15 and October 15.

(2) Distribute seed uniformly on Bermuda-grass which has been clipped 1 to 2 inches high.

(3) Use water sprinkler on plantings each day to prevent seed from drying out until ryegrass is up and growing. If plants are more than ½-inch apart, reseeding is necessary.

(4) After ryegrass is three weeks old, add nitrogen fertilizer while the grass is dry (5 pounds 33-percent nitrogen, or 8 pounds 25-percent nitrogen per 1000 square feet).

(5) When Bermuda-grass starts growth in spring, keep ryegrass clipped very close and repeat the fertilizer application.

(6) Continue close clipping until ryegrass disappears from the turf (usually in July).

The above system must be repeated each year.

NOTE: Care should be exercised when purchasing annual ryegrass seed. It is frequently mixed with perennial ryegrass which is undesirable in Bermuda-grass mixtures.

CLOVERS IN GRASS MIXTURES

Many of the old turf seed mixtures had White Dutch clover added. A large percent of lawns now have clovers either through plantings or from encroachment. White clover will furnish some nitrogen for the grass, but addition of commercial nitrogen is better.

Some individuals want clover in turf grasses, but it is not desirable in most situations. Honey bees working on clover blossoms are always a menace to children and pets, and the leaves are soft, staining clothing easily. White clover is a pest on golf courses, and much time and expense is necessary for control measures.

CONTROL OF WEEDS IN TURF

Weeds have difficulty invading a dense healthy sod of grass that is kept thrifty by proper watering, fertilizing, and regular mowing. Any encouragement for the growth of grass will discourage weed growth. The first step in the weed control program is to find the cause of invasion because killing weeds in turf grasses without correcting the basic cause will give only temporary relief.

The following methods are helpful in preventing growth of weeds in turf:

(1) Plant only well-adapted grass species for both climate and soil conditions.

(2) Fertilize, water, and mow correctly.

(3) Plant only pure lawn seed.

(4) Be certain that soil for top dressing is free from viable weed seed.

(5) Destroy weed seed where turf is to be planted by frequent watering and killing seedlings when they germinate.

(6) Destroy weeds before they make seed (most weed seed have the ability to remain in soil and germinate several years later).

(7) Destroy all nearby sources of weed seed infestation (seed from some species are carried by the wind).

TROUBLESOME WEEDS IN OKLAHOMA TURF GRASSES

Winter Weeds

Winter weeds (Figure 12) are common in Bermuda turfs since they germinate and grow while the grass is dormant. Bermuda-grass will resist most broadleaf weeds that germinate in the summer.

Dandelion. — This is a long-lived perennial common throughout the state. Reproducing from seed and old plants, the dandelion starts growth in the fall months after rains. The leaves form a rosette with yellow flowers borne on top of a hollow seedstalk. Most of the flowers appear in April and May—but under some weather conditions, they may bloom every month of the year. Dandelions have a parachute of hairs attached to allow the wind to scatter them profusely.

Chickweed. — This plant comes up from seed each year, usually in the fall months—but it may germinate in the winter and spring months. The small leaves and branched stems form a dense mat of growth. Tiny white flowers are numerous, and they produce an abundance of seed. This plant prefers shady areas, but in early spring it may be found almost anywhere.

Henbit. — This is a hardy winter-growing, short-lived annual. It will germinate any time from September until June and has the ability to produce seed in mid-winter. The plant sends slender branches up to 8 inches in height. The leaves are circular, and the flowers are purple. It is spreading rapidly in the state, and a common sight in early spring is the purple landscape in lawns, parks, parking lots, etc. This plant is a serious problem in flower gardens and around shrubs that are cultivated. It is rapidly spreading into cultivated fields.

Some other common plants found in turf grasses in the winter are speedwell, plantains, clovers (bur, white, hop), black medic, and annual bluegrass.

Chemical Control of Winter Weeds

Most of the troublesome weeds can be killed with 2,4-D sprays if the spraying is done at the proper time. This spray is dangerous to use near shrubs, flowers and gardens. Fortunately, the best time for using it on turf for winter weeds is in November after frost. At this time it can be sprayed without danger to desirable plants, and the weeds

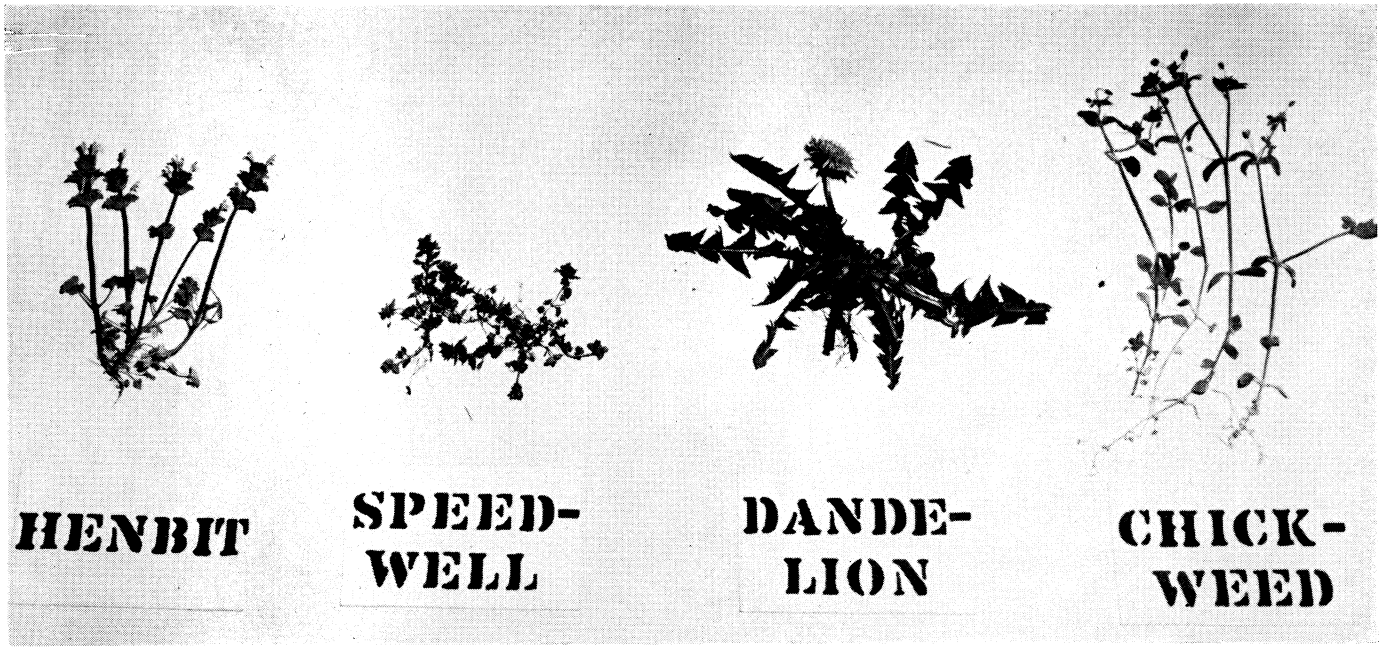


Fig. 12.—These weeds are pests in Oklahoma turfs during winter months. They usually germinate after fall rains. Most of them can be killed with 2, 4-D sprays. (See page 26 for their control.)

are young, small, and very susceptible to 2,4-D. After the weeds reach full growth and start blooming, 2,4-D will not destroy them, but may prevent them from producing seed. Early spring spraying, before weeds bloom, is the next best time to treat winter weeds. If the weeds are in an advanced stage of growth a contact spray is superior to 2,4-D.

Directions for Using Chemicals

If directions are not given on the 2,4-D container, use one pound of actual 2,4-D per acre in sufficient water to give good spray coverage (depending on type of sprayer used). For small areas, use 2 tablespoons of commercial 2,4-D (containing 3 to 4 pounds actual 2,4-D per gallon) in sufficient water to cover 1000 square feet.

If White clover is a pest in grasses, 2,4,5-T is preferred for fall treatments.

A common practice on home lawns in April and May is to dig or spud the scattering dandelion plants. This gives only temporary relief unless the plants are cut off several inches under the surface of the soil. A better practice is to use 1 tablespoon of 2,4-D in 1 gallon of water and treat each plant by using a flat sponge nailed to an old broom handle. Dip it in the 2,4-D solution and touch each plant with the sponge. This method is less work: it is faster, and the results are more permanent. Dandelions should be treated in the fall when plants start growth, or in the spring before the blooming period.

CAUTION: Bent grasses are susceptible to 2,4-D and 2,4,5-T.

Winter weeds in full bloom that cannot be killed with 2,4-D can be destroyed by fortifying diesel oil with pentachlorophenol or dinitro (dinitro ortho secondary butyl phenol). A suitable spray for killing weeds on one acre can be made by adding 4 pounds of pentachlorophenol or 1 to 2 quarts of dinitro to 40 gallons of diesel fuel. One gallon of mixture is required for each 1000 square feet.

These chemicals may be purchased from most seed stores. Apply the spray two to three weeks before summer turf grass starts to grow in the spring (March). For best results, apply on warm, sunny days. This treatment will destroy all annuals. It temporarily retards dandelions, but they will survive the treatment and start growth again in the fall months. This contact spray cannot be used on winter turf grasses—it causes excessive burning.

Summer Weeds

Crabgrass is a common pest well known to all who have had experience in turf management. It is a vigorous plant in the summer under favorable growing conditions, and the prostrate habit of growth makes it a strong competitor with other grasses. Only a few of the 26 grasses in the test resisted crabgrass invasion in the turf plots. After *Zoysia matrella* was established it was never infested with crabgrass. U-3 Bermuda-grass and Centipede grass were resistant to crabgrass invasion. The winter growing grasses (Kentucky bluegrass, ryegrass and fescue) furnished little competition to crabgrass in the summer months.

Crabgrass can be controlled to some extent by frequent mowing of the turf in late summer to prevent seed production. Frequent light watering of the turf should be avoided since it encourages germination of crabgrass seed.

Other summer plants that are common in Oklahoma turf grasses are knotweed, puncture vine, prostrate verbena, pigweed, goosegrass, stinkgrass, sandbur, and the foxtails. Many native annual grasses invade Buffalo grass in western Oklahoma. Dallis grass is a pest in Bermuda-grass lawns in southeastern Oklahoma.

Chemical Control of Summer Turf Weeds

The broadleaf weeds can be treated with 2,4-D as outlined for winter weeds. However, many desirable plants are susceptible to 2,4-D, and caution must be exercised. It is not recommended that lawns be treated in summer if flowers, shrubs, or gardens are nearby. Spraying 2,4-D on a large lawn could injure tomatoes and some species of flowers several hundred feet away. Large turf areas such as golf fairways and roughs, highways, and utility lines lend themselves very well to the use of 2,4-D and 2,4,5-T.

Several chemicals for crabgrass control are on the market. If these herbicides are used properly, they are effective on crabgrass and many other summer annual grasses. Killing one grass without destroying another where they are growing together offers a difficult weed control problem. Fortunately, Bermuda-grass is more resistant to chemicals used for crabgrass control than most turf grasses. Usually, heavier dosages than recommended on the container can be used on Bermuda-grass, unless the directions are given specifically for use on Bermuda-grass turf.

Tests made in Bermuda-grass turf on the Oklahoma A. & M. College football practice field show that: (A) Most of the commercial

crabgrass killers are effective when the weeds are germinating or small, (B) After the grass becomes established with several leaves it is almost impossible to eradicate, and (C) One to two pounds of 2,4-D per acre will destroy many annual grasses if applied before they germinate, but treatments are effective for only a few days.

Sodium Arsenite. — Low concentrations of sodium arsenite will kill crabgrass, while leaving Bermuda-grass discolored but undamaged. Recommended rates are 4 to 6 pounds of sodium arsenite in 100 gallons of water per acre. Crabgrass should be treated when small (two- to three-leaf stage).

CAUTION: This chemical is very poisonous and is not used on a large scale for home lawns, but has wide use on golf fairways.

Potassium Cyanate. — Potassium cyanate has recently become a promising crabgrass killer. It is easy to spray, fairly cheap, and non-poisonous. The best rates for use are from 8 to 16 pounds per acre, applied in 100 gallons of water, or 2½ gallons of this mixture for 1000 square feet. Best results come from applications made while crabgrass or annual grasses are germinating or are very small. Some discoloration appears on the turf grasses for a short time after application. Treatments at seeding time will prevent crabgrass from producing seed for infestation the next year.

Phenyl Mecuric Acetate (PMA). — Phenyl mecuric acetate is effective for killing crabgrass and many other annual grasses when properly applied. Like most crabgrass killers, it should be used while the grass is germinating or very small. With PMA it is possible to destroy crabgrass without noticable injury to turf grasses. Injury is prevented by making two or three light applications spaced 10 days apart. Several golf course maintenance men in Oklahoma are using PMA on Bent grass putting greens to prevent crabgrass invasion. The application must be often and regular, with light concentrations.

CAUTION: This chemical is poisonous and should be used with care.

Table I.—Rating of Grasses on Basis of Turf Characteristics for Oklahoma Conditions.*

Species	Density	Texture	Evenness	Resistance to: Heat	Drouth	Cold	Close Clipping	Wear	Shade	Weed Invasion	Disease	Encroaching habits**
Bentgrass	good	fine	excel.	fair	poor	excel.	excel.	excel.	fair	poor	poor	slow
African Bermuda	good	fine	excel.	good	good	fair	excel.	good	poor	fair	poor	med.
Common Bermuda	good	med.	good	excel.	excel.	fair	excel.	excel.	poor	good	fair	fast
U-3 Bermuda	excel.	fine	excel.	excel.	excel.	fair	excel.	excel.	poor	excel.	good	med.
Kentucky bluegrass	fair	med.	good	poor	poor	excel.	poor	fair	excel.	poor	good	slow
Merion bluegrass	fair	med.	excel.	poor	poor	excel.	fair	fair	excel.	fair	good	slow
Buffalo	good	fine	excel.	excel.	excel.	good	excel.	good	poor	good	good	slow
Yellow bluestem	excel.	coarse	fair	excel.	excel.	fair	good	good	poor	excel.	poor	fast
Centipede	excel.	coarse	good	excel.	good	fair	good	good	good	excel.	good	med.
Dallis	good	coarse	fair	excel.	good	poor	fair	good	fair	fair	fair	fast
Alta fescue	good	coarse	good	good	fair	excel.	fair	good	good	good	good	slow
Chewings fescue	good	fine	good	poor	poor	excel.	good	good	fair	poor	good	slow
Ill ahee fescue	good	fine	good	poor	poor	excel.	good	good	fair	poor	good	slow
Kentucky 31 fescue	good	coarse	good	good	fair	excel.	fair	good	good	good	good	slow
Sheep fescue	good	fine	good	poor	poor	excel.	good	good	fair	poor	good	slow
Blue grama	good	fine	good	excel.	excel.	good	good	good	poor	good	good	slow
Side oats grama	poor	coarse	poor	excel.	excel.	good	poor	poor	poor	poor	poor	slow
Sand lovegrass	poor	coarse	poor	excel.	excel.	good	poor	poor	poor	poor	good	slow
Weeping lovegrass	poor	coarse	poor	excel.	excel.	good	poor	poor	poor	poor	good	slow
Annual ryegrass	good	med.	good	poor	poor	good	good	good	good	fair	good	med.
N. Zealand Vic. rye.	good	med.	good	poor	poor	excel.	good	good	good	fair	poor	slow
Perennial ryegrass	good	med.	good	poor	poor	excel.	good	good	good	fair	poor	slow
Intermediate wheatgrass	poor	coarse	poor	poor	poor	excel.	fair	poor	poor	poor	good	slow
Western wheatgrass	poor	coarse	poor	poor	fair	excel.	fair	poor	poor	poor	good	slow
Zoysia matrella	excel.	fine	excel.	excel.	excel.	fair	excel.	excel.	good	good	good	slow
Zoysia japonica	excel.	med.	excel.	excel.	excel.	fair	excel.	excel.	good	good	good	slow

* Ratings made by the following members of the Oklahoma A. & M. College Forage Crops Group: Jack R. Harlan, Wayne Huffine, and W. C. Elder.
** Refers to nuisance factor such as habit of encroaching into flower beds, gardens, etc., either by seed or creeping stolons or rootstalks

Table II.—Information on Maintenance of Turf Grasses.

Species	Method of Establishment	Speed of Establishment	Response to Fertilizers	Soil Adaptation	Growing Season*	Clipping Heights (inches)	Seed Head Formation
Bentgrass	seed-sod	fast	excellent	special	all season	½ or less	none
African Bermuda	sod-rootstock	med.	excellent	wide	summer	¾-1½	none
Common Bermuda	sod-rootstock	fast	excellent	wide	summer	¾-1½	few
U-3 Bermuda	sod-rootstock	med.	excellent	wide	summer	¾-1½	few
Kentucky bluegrass	seed	fast	excellent	rich soil	all season	2-3	few
Merion bluegrass	seed	fast	excellent	rich soil	all season	1-2	few
Buffalo grass	seed-sod	med.	fair	clay	summer	¾-1½	few
Yellow bluestem	seed	fast	fair	wide	summer	1-2	many
Centipede	sod	slow	fair	wide	summer	1-2	few
Dallis	seed	fast	good	moist	summer	2-3	many
Alta fescue	seed	fast	good	wide	all season	1½-2	none
Chewings fescue	seed	fast	good	wide	winter	1-2	few
Ill ahee fescue	seed	fast	good	wide	winter	1-2	few
Kentucky 31 fescue	seed	fast	good	wide	all season	1½-2	none
Sheep fescue	seed	fast	good	wide	winter	1-2	few
Blue grama	seed	fast	good	dry	summer	2	few
Side oats grama	seed	slow	poor	dry	summer	3	none
Sand lovegrass	seed	slow	poor	sandy	summer	3	none
Weeping lovegrass	seed	fast	good	sandy	summer	3	none
Annual ryegrass	seed	fast	good	wide	winter	1-2	few
N. Zealand Vic. rye	seed	fast	good	wide	winter	1-2	few
Perennial ryegrass	seed	fast	good	wide	winter	1-2	few
Intermediate wheatgrass	seed	fast	poor	dry	winter	3	few
Western wheatgrass	seed	slow	poor	alkali	winter	3	few
Zoysia matrella	sod	very slow	good	wide	summer	1-1½	none
Zoysia japonica	seed-sod	slow	good	wide	summer	1-1½	none

* The term "all season" refers to year-round growth when ample moisture is available.