TURF CULTURE

Volume 2 MARCH, 1942 Number 4

TURF FOR AIRFIELDS AND OTHER DEFENSE PROJECTS

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The present crisis has developed a need for an unprecedented expenditure of public funds for turf in connection with airfields, defense highways, housing projects and other facilities for war activities. The agencies that are endeavoring to establish this turf are encountering many of the problems with which our regular readers have been dealing for many years. In a few instances the long experiences of those who have worked with turf have been utilized, but it is hoped that in the near future such valuable experiences may be taken advantage of more fully in the present national effort to produce durable turf quickly.

In the past little or no experimental work has been conducted in this country on problems immediately concerned with turf on airfields. Fortunately, however, many of the facts which have been learned from former research programs on turf for other purposes are applicable to the present problems. The practical experiences of men who for many years have been growing large areas of turf for various needs likewise have provided information that may be extremely helpful in these

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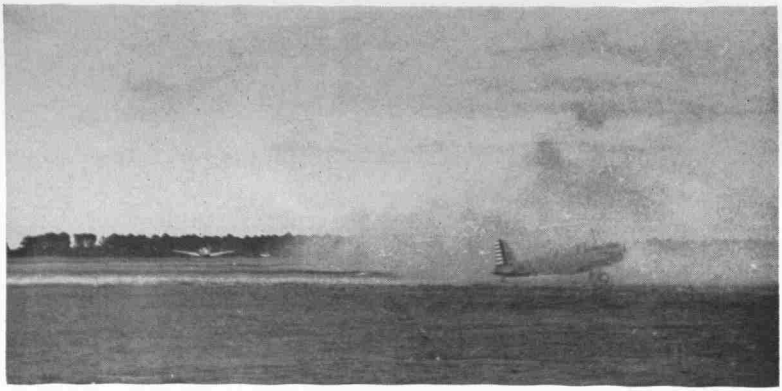
new applications. For instance, the problems of producing a tough, dense cover of turf on airfields in many ways resembles those encountered on fairways. Although the turf on airfields is subjected to more abuse it has the advantage that it can be



Dust from propellor blast on poorly grassed airfield. The plane on the left has created a dust cloud which is enveloping the plane and pilot in the foreground. Such a condition has been reported to reduce the life of airplane motors by as much as 90 percent.

cut higher than on fairways. On other areas the problems are essentially the same as those encountered in the rough of golf courses. The development of lawns for housing projects presents problems which are every-day routine to many of our readers. The present call for speed of establishment is a familiar one to most of those who read TURF CULTURE regularly.

During the past year the Green Section has been called upon on numerous occasions for advice on establishing turf in connection with the national defense program. These experiences have emphasized the need for a summary of available information on this subject. Therefore the following discussion was prepared by the Green Section staff, with the help of

John W. Bengtson, a former member, who is now specializing on turf for the U. S. Engineers at Mobile, Alabama.

It is fully recognized that past neglect in providing funds for a more critical study of turf culture leaves many problems for which no immediate solution is available. This failure, however, can in no way justify an additional failure to use to the best advantage the information and experienced personnel that is now available to most rapidly and efficiently provide the turf that is needed immediately and to rapidly improve present cultural methods.

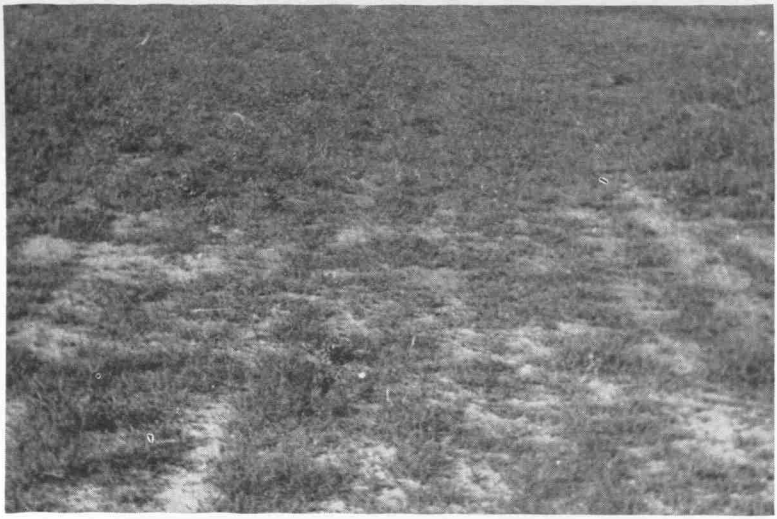
Soil

In preparing an area for turf one of the first problems which presents itself is whether or not to save the topsoil. The physical properties and plant food content of the topsoil in relation to the subsoil are the chief factors affecting the solution to this problem.

In many cases the practice has been to save the topsoil on areas requiring extensive grading. The saving and replacing of large quantities of topsoil involves considerable delay and expense. Assumption that this operation is an absolute necessity should be challenged in view of the fact that in some localities the subsoil is suitable from a physical standpoint and should produce a satisfactory turf provided enough plant food of the right kind is added. The advisability of saving topsoil is particularly questionable in much of the Bermuda grass region where the topsoil itself is poor. The cost of fertilizer represents only a small fraction of the cost involved in moving or saving the topsoil.

Freedom from competition by weeds is another point in favor of using subsoil exposed by grading operations. Topsoil which

is badly infested with weed seed becomes a serious handicap to the establishment of a good stand of grass. There are few viable weed seed on areas from which topsoil has been removed.



Bermuda grass turf which has been sprigged on an airfield. Foreground, on subsoil; background, on topsoil. The difference in amount of vegetation in the two areas is due to a larger number of annual weeds on the topsoil in the background rather than to a heavier stand of grass. Weeds retard the growth of grass and then die in late summer or early fall. A poor cover will remain on the area in the background after the weeds have died.

Soils on which turf must be grown may vary from heavy clays, to loose sands through wide variations in mixtures of sands, silts and clays. Soil mixtures which combine the sand, silt and clay in certain proportions are called loams. When, by fortunate accident, a sandy loam type of soil is present, it provides the most favorable physical condition for grass turf.

Soils on which establishment of turf is difficult because of unfavorable physical conditions can be corrected sometimes by

the addition of suitable soil amendments. Sandy soils may be improved by the addition of clay and possibly organic materials such as peat and muck. The important thing is to add sufficient fine mineral soil to stabilize the sand and retain moisture for plant growth. On the other hand, the addition of sand may help to prevent the development of dangerous slick surfaces on heavy clay soils.

Variation of physical properties of soils is so great in many places that soils ranging from heavy clays to loose sands exist on the same project. Where a great deal of cutting and filling is being done on projects having a considerable range of soil types it may be feasible to use a mixture of light and heavy soils for the top 4-to-8-inch layer of the fill.

Detailed information on soil stabilization studies is available in "Classification of Soils and Control Procedures Used in Construction of Embankments," *Public Roads*, Vol. 22, No. 12, February, 1942. Therefore, the subject will not be discussed here. In general, the improvement of soils from the physical standpoint will help in the establishment of turf provided similar careful consideration is given to the improvement of soil fertility.

Mucking

The term "mucking" is commonly used, particularly in the South, to designate the process of incorporating muck into sandy soil or simply the spreading of it on the surface. The significance of the mucking operation naturally hinges on what is meant by muck.

Loose usage of the word "muck" has given it a variety of meanings which have led to misunderstandings and misinter-

Trench 10 feet wide at the edge of an airfield runway excavated in preparation for "mucking." A 4 to 6-inch layer of muck is used to fill the trench. Natural vegetation growing in the muck is expected to produce a dense cover along the edge of the runway. The muck has already been placed in the trench in the background.

pretations. As the word is often carelessly used, it applies to almost any kind of soil or related material which is black or very dark in color, occurring in poorly drained areas. Due to this incorrect use, the word may include a dark clay or silt material which is essentially a sticky mud with little organic matter, or at the other extreme it may include a well-preserved peat containing practically no clay or silt.

Technically the term "muck" ordinarily is limited to organic matter, dark in color, granular in structure, and in such an advanced stage of decomposition that the original plant remains are no longer recognizable. The commercial mucks ordinarily used for modifying soil contain less than 15 percent mineral matter, but the mineral fraction may reach 50 percent and the material still be called muck. When above 50 percent it is classed as a mineral soil of high organic content.

A true muck therefore falls in Group 8 in the Public Roads Administration's booklet, referred to under "Soil." In this

Ten-foot strip of muck which has been in place along edge of airfield runway approximately one year. Note the dense growth of natural vegetation on this strip which prevents soil from washing onto the runway. Often the vegetation obtained in this way will not survive the dry conditions on airfields since it is usually brought in from low swampy areas.

booklet the "general stability properties" of peat and muck are classified as being "incapable of support."

For airfields and roadsides where load-bearing capacity is important, muck, or peat which is often erroneously classed as muck, is of little permanent value on sandy soils unless combined with marl or other suitable mineral soils which will serve to stabilize the sand. The organic matter will soon decompose when spread out on the surface or worked into the soil. The decay will be hastened if fertilizer is applied. Marl or mineral soils found in many hammock areas in the South or clay or loam soils elsewhere are far more beneficial than muck. Likewise clay and silt soils containing moderate amounts of organic

matter, which are frequently erroneously called muck, are superior to the true muck for improving sandy soils for airfields and similar purposes. The fine soil particles they contain in abundance have a permanent stabilizing effect on the sand and improve the water-retention qualities of the sand throughout the years.

When establishing turf on areas such as lawns for housing projects some classes of muck are helpful. Such materials should be free from sticky plastic residues which harden upon drying. Where muck is incorporated into sand before planting grass it will encourage the growth of grass, particularly if it is reinforced with some fertilizer. On stiff clay soils muck may help in loosening the soil and its use in some instances may be justified for this purpose.

Mucking is also used in the establishment of vegetation by the process described elsewhere in this issue as topsoil planting. While good stands may be established in this manner, it should be remembered that the vegetation naturally growing in the swampy areas from which muck is obtained is usually not of the kind suitable for turf and is not likely to survive long under the drier conditions it will encounter in many places where muck is now being used extensively.

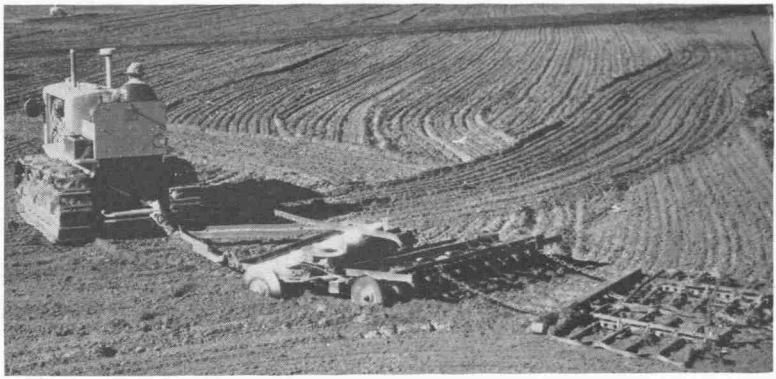
Drainage

No discussion of turf can be considered complete unless it points out the great importance of drainage in the establishment and maintenance of turf grasses. It is impractical, however, to discuss here the subject of drainage systems. It should be borne in mind that water drains more slowly from turf than from pavements and that, therefore, more pitch is required to remove water quickly from a turfed area than

from a concrete or asphalt surface. Poor drainage often unnecessarily delays the use of turf after rainy periods. Any irregularities in the surface, such as those caused by tires in wet weather, are more troublesome in flat areas than those with more pitch. Porous loams or mixtures of loam and clay soils with more than 50 percent of sand, are of great advantage in establishing turf from the standpoint of drainage.

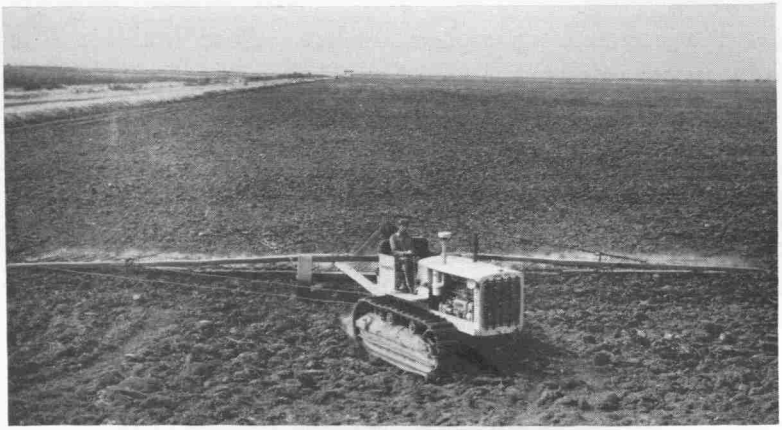
Preparing the Seedbed

The purpose for which turf is to be planted, size of the area, and soil type are all factors which influence the methods to be



In preparing large areas for turf, a double disk may often be used to advantage. A machine such as this one, having a rear disk which throws the soil in only one direction opposite to the front disk, produces a level seedbed. The spike-tooth harrow dragged behind the disk helps to further pulverize and smooth the soil.

used in the preparation of a seedbed. On large areas such as airfields the preparation of soil for planting after the final grading has been done usually can be accomplished in one operation by the use of a disk. This operation may leave the



In preparing the seedbed on some soils, harrowing may be necessary in addition to disking. On large areas, this type of spike-tooth harrow may be used to advantage. The comparatively light draft of the spike-tooth harrow makes it possible to pull a large number of units with a relatively small amount of power. The use of such a harrow tends to level as well as to further pulverize the soil.

seedbed in a rather rough condition but because of the dust problem on dry areas the rougher seedbed is superior to one on which the soil has been finely pulverized, except in cases where good appearance is important.

On lawns or other small areas where the use of a disk is impractical other methods must be employed. Small disks, plows, or motorized tillers may be used on larger lawn areas, but on very small lawns it is often necessary to spade the area by hand to a depth of 3 to 6 inches, depending on the soil type. The practice of hand raking is employed on these smaller areas to smooth and pulverize the soil sufficiently to make it suitable for seeding.

On many large areas regular farm disks may be used satisfactorily. On airfields, however, most farm disks are not suitable for use, unless followed by a drag or harrow, because

they are constructed so that they throw the soil two ways. The use of this type of disk leaves alternate ridges and furrows, and unless these are leveled by some type of drag they cause a great deal of vibration in planes traveling across the field at high speed. Disks can be obtained which throw all the soil in one direction, thereby eliminating the "washboard" effect caused by the ordinary disk. In tightly packed clay soils it may be necessary to disk the area more than once in order to prepare the soil properly. If fertilizer is applied before the final disking, that operation can be used to accomplish two objectives; that is, to work the fertilizer into the soil and to break up the soil properly for planting. The fertilizer should not be disked into the soil so deeply, however, that it is placed below the level at which most of the grass roots will grow.

Fertilizing

The fertilizer requirements of grasses for turf purposes are very different from those of most field crops. Grass produces a large amount of foliage for which nitrogen is primarily required. Because of this, together with the fact that nitrogenous salts are readily leached from the soil, nitrogen usually is the element which is likely to be depleted most rapidly from soil under turf. In general, therefore, the fertilizers which are recommended for use on turf are usually high in nitrogen. Fertilizer mixtures containing approximately half as much phosphoric acid as nitrogen and still less potash have been found to give the best results at the minimum cost in tests made under various climatic and soil conditions.

Soil analyses, when considered in relation to the requirements of the grass to be planted, are useful in helping to determine the types and amounts of fertilizers to be applied. Inorganic

fertilizers of 10-6-4 and similar grades, however, usually should be applied at the rate of not less than 400 pounds to the acre. If fertilizers with different percentages of nitrogen are used, the rate should be modified so that corresponding amounts of nitrogen would be applied. On areas such as roadsides or other places where fertility is extremely low, it may be advisable to apply two or even three times this amount during the preparation of the original seedbed. It should be borne in mind that although phosphorus and potassium may not be rapidly depleted from land planted to turf, the soil may be naturally deficient in these elements. For this reason it may be necessary in some cases to apply larger amounts of phosphoric acid and potash than are present in a 10-6-4 fertilizer. Here again the results of soil tests should be considered in estimating the amounts of these nutrients needed. Where topsoil is involved, the agricultural history of the land may supplement the information obtained from soil tests.

After turf has become established it usually will be necessary to apply fertilizer occasionally to maintain a heavy stand. The frequency and rate of applications will depend on the fertility of the soil and the quality of turf required. A 10-6-4 fertilizer is satisfactory for general use, but where there is ample phosphoric acid and potash in the soil an occasional light dressing of sulfate of ammonia is all the fertilizer that is needed to speed up the development of turf. It is not safe to apply inorganic fertilizers at rates heavier than 40 pounds of nitrogen to the acre (400 pounds of 10-6-4 or 200 pounds of sulfate of ammonia) because of the danger of burning the foliage. Also, to avoid serious burning of the grass, applications should be made only when the blades of grass are dry. Inorganic fertilizers should not be applied to young seedling grass.

In general, inorganic fertilizers should be applied to turf just prior to the time of most rapid growth of the grass concerned. In the cool-humid regions, late summer or early fall applications are to be desired because they encourage the maximum growth of the turf grasses after the annual grasses and weeds have been killed by the first light frosts. In these regions fertilizer applications, if made in the spring at all, should be made very early. In the warm-humid regions, on the other hand, turf of Bermuda grass and other summer-growing grasses should be fertilized in the spring to encourage the spring and summer growth. On light sandy soils, in either region, where the nutrients in inorganic fertilizers leach rapidly, it is advisable to make several small applications during the growing season rather than to make one large application.

For most conditions the inorganic mixtures are more satisfactory than the organic from the standpoint of cost as well as quick availability to the grass. There may be cases, however, where large local supplies of organic waste materials, such as activated sludge, are available. Advantage should be taken of the availability of such materials, but it should be remembered that while their effect may be more lasting than is that of the inorganic mixtures, the immediate response of the grass will not be so quick. The organic fertilizers are often used to good advantage on sandy soils where inorganic fertilizers are leached rapidly. The chemical analysis of such materials should be determined and they should be applied at such rates as to furnish at least 40 pounds of nitrogen to an acre.

In some parts of the country minor elements may be lacking to such an extent that turf may suffer from their deficiency. Such deficiencies may be corrected by including in the fertilizer small amounts of the minor elements which are lacking. These

If the addition of lime is necessary before planting, it may be effectively distributed by inexpensive spreaders such as the above which operate behind an ordinary 1 or 1½-ton truck. This machine can be used also for distributing fertilizer and is less expensive than the side-wheel type.

include boron, zinc, manganese, copper, and other elements of which very small amounts are necessary for the normal growth of plants. Most soils naturally contain sufficient amounts of these elements, but in certain limited areas deficiencies may occur.

Lime may be used to good advantage in some cases in which the soils involved are highly acid. Lime should not be applied, however, until soil analyses have indicated the advisability of using it. Since plants vary widely in their tolerance of acidity or alkalinity, the grasses composing the turf should be considered. Lime is also known as a "soil conditioner." It tends to loosen tight clay soils and to tighten loose sandy soils. Its value for this purpose is rather limited, however, since excessive amounts are usually required to produce a noticeable effect.

Controlled experiments have shown that lime is likely to encourage turf weeds and clover to the extent that turf grasses cannot successfully compete against them, particularly where soil fertility is low.

Finely ground limestone is commonly used. It is usually cheaper than hydrated lime and fully as effective. Unless soil is very strongly acid, the rate need not exceed ½ to 1 ton to the acre. If hydrated lime is used it should not be applied within a period of 2 weeks of the time of application of fertilizers containing ammonium salts.

Planting

Many grasses are propagated either by seed or by the use of fragments of actively growing plants which are known variously as vegetative material, stolons, rhizomes, or sprigs. Also, pieces of established sod may be transplanted with the soil held together by the grass roots. In the establishment of turf throughout the country for various purposes, many different terms have been applied to the several methods used, resulting in considerable confusion. The synonymy among these terms has been carefully considered and has been discussed with members of the Roadside Development Committee of the Highway Research Board, with various workers in the Bureau of Plant Industry, and others who are interested in the terminology. Since these discussions disclosed the desirability of a uniform terminology, the following terms were agreed upon as a recommendation for general use throughout the country. In each case other terms which are applied to the same method are given in parenthesis.

The methods of planting are discussed in the order of increasing amounts of plant material required as well as the increasing

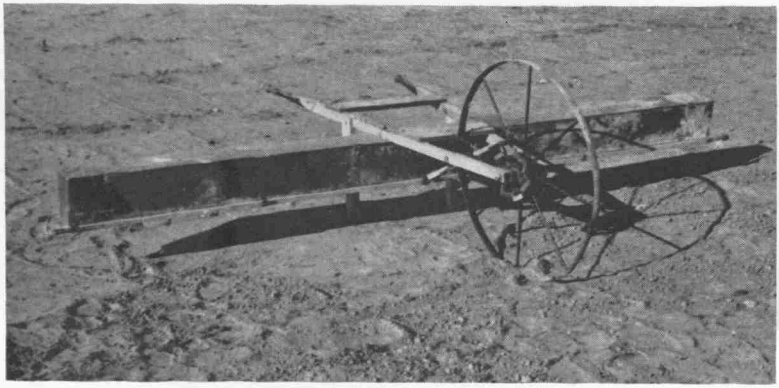
Result of lack of grass cover on airfield. Note the soil which has been washed onto the runway from adjacent bare areas. Such a condition might be prevented if a good grass cover were established.

cost of planting; that is, seeding, sprigging (frequently called vegetative planting), and sodding. In planting seed, even under most favorable conditions, the young seedlings are extremely tender for some time before a tough sod is established. This is associated with the fact that in seeding it is actually the minute embryonic plants within the seeds which are planted. In sprigging, more mature plant material, and larger amounts of it, are used, and therefore a wear-resistant turf is much more quickly established than by seeding. By the planting of sprigs, moreover, it is possible to propagate grasses which do not produce viable seed in large quantities, and also to propagate selected strains which do not come true from seed, as is the case with the creeping and velvet bents. For the actual transplanting of sod, still larger amounts of plant material are used. On the other hand, this is by far the quickest way to

Bermuda grass turf five months after planting in August. Left, seeded; right, sprigged. Had seeding been possible earlier in the season, the area on the left no doubt would have had a much better cover of grass than is indicated in this photograph.

get a tough wear-resistant turf. There are locations on steep slopes and in drainage channels where the use of solid sodding may be recommended. However, combinations of mulching with seeding methods have recently been developed on highway slopes which have largely replaced solid sodding formerly practiced on such areas.

When dealing with grasses which may be established by any of the methods, such factors as cost and the requirements of the turf as well as the speed with which it is necessary to establish the turf should determine the method to be used. In most cases the establishment of turf by the use of seed is much less expensive than by the use of sod or sprigs. On the other hand, a durable turf is produced more quickly by the planting of sod or sprigs than by seeding. This factor is particularly important from the standpoint of some of the southern grasses.



The wheelbarrow grass seeder affords an effective means of distributing seed evenly over the seedbed. Like the cyclone seeder it is limited to use on small scale plantings.

When circumstances require late planting of these there is a danger that seedlings may not survive over winter. In such cases as this, plantings of sod or sprigs are better able to establish themselves sufficiently to withstand the cold.

Seeding

The chief points of concern in seeding are: even distribution of seed, depth of planting and rate and time of seeding. The matter of even distribution is usually taken care of, if mechanical seeders are properly employed. The depth of planting will vary somewhat with the type of seed used. The small seeded grasses such as bluegrass, redtop, Colonial bent, Bermuda grass and carpet grass should be covered only slightly. The brome grasses, ryegrass and the fescues can be safely planted to a depth of one-half inch.

Since rates of seeding are dependent upon the species of grass used, they are discussed separately under each grass listed. Par-

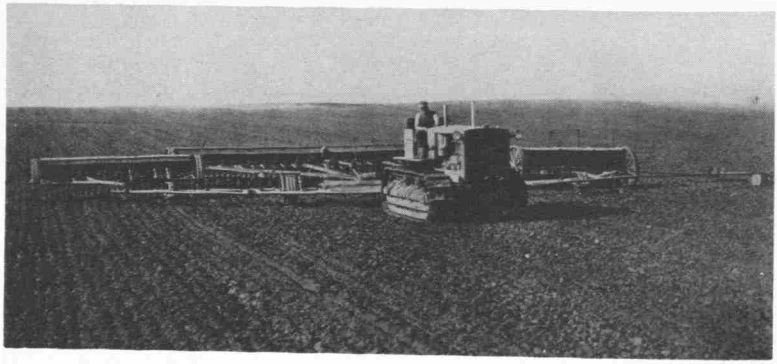
Hand operated cyclone grass seeder which distributes seed by centrifugal action. Such seeders are very useful on small areas such as lawns or roadbanks that are inaccessible to other types of seeders.

ticular consideration should be given to the most favorable time of year for seeding, in order to give the grass the best possible chance for survival. Since the time varies with the climatic regions as well as to some extent with the kind of grass to be seeded, this problem is discussed in general in the presentation of climatic regions and specifically under certain of the grasses.

The several types or methods of seeding commonly used are described in the following paragraphs. In general, the method used should be determined by the size of the area to be seeded, and the nature of the equipment at hand.

Broadcast seeding may be done by hand or with mechanical seeders such as the wheelbarrow or the cyclone types. To insure even distribution of seed it is suggested that half of the seed be sown over the entire area in one direction and the remaining half be sown crosswise. A rake, drag, cultipacker, or harrow may be used to cover the seeds to the desired depth.

Drill seeding is often practiced on fairly large areas, especially with the larger seeded grasses. Drills have the advantage of



Large scale seeding and fertilizing may be accomplished in one operation by the use of tractor-drawn drills.

being able to distribute seed and fertilizer in the same operation. Drill tubes on most drills are spaced 4 to 8 inches apart and spaces between the rows are ordinarily covered within a few weeks. Care must be taken in drilling the finer seeded grasses to see that they are not covered too deeply. Drills may be used to good advantage in reseeding thin, poor turf because seeds can be placed in the ground without damaging the turf already on the area.

Row seeding may be used where mechanical row seeders are available or by the use of drills in which part of the holes are closed. This method also presents the difficulty of planting seeds deeper than is desirable. It is not commonly used except in the planting of nurseries, where it is desirable to have the plants in rows.

Hay mulch seeding is a method sometimes used, particularly in the dry regions of the western states, in seeding certain native grasses, the seed of which is difficult to harvest. Hay is cut from native stands of such grasses after the seed is mature and scattered over the area to be seeded. The straw acts as a mulch or cover and is beneficial in protecting the young seedlings when not applied too heavy.

Sprigging

The term sprigging is recommended for the method of propagation which makes use of fragments of the growing grass plants. This method can be used particularly successfully in the case of grasses which spread rapidly by the production of runners either above or under ground. Runners produced above ground are called stolons, while those produced underground are known as rhizomes or rootstocks. Each node or joint of these runners will produce roots when covered with soil and provided with sufficient moisture. It is suggested that fragments of runners which contain nodes either with or without roots be called ***sprigs***, and the method of propagation which involves the planting of this material be called ***sprigging***.

With this method, sprigs which are dug out of a meadow or nursery with little or no soil attached are chopped or separated by shredding and are then planted. Sprigs with roots

Sprigging Bermuda grass on a southern airfield. Note the "army" of men necessary for large scale planting by the hand method. Bermuda grass sprigs are being placed in furrows by hand, after which they will be covered. Some mechanical planting method would not only greatly reduce the time required for this operation, but would prevent the drying out of sprigs before covering.

are preferred, but roots are not necessary when weather conditions are favorable. Sprigs must be covered immediately after planting to prevent drying out. The time of planting is very important when this method is used. Moisture and other climatic conditions must be such as to encourage the rapid growth of the newly rooted plants. As compared with sodding, sprigging is a relatively cheap method of planting, because little or no soil is taken up with the sprigs and less plant material is used.

Various types of sprigging are in common use. These types are described in the following paragraphs in the order of increasing amounts of plant material required.

Check sprigging is the planting of sprigs at regular intervals in rows. This method requires the least amount of planting

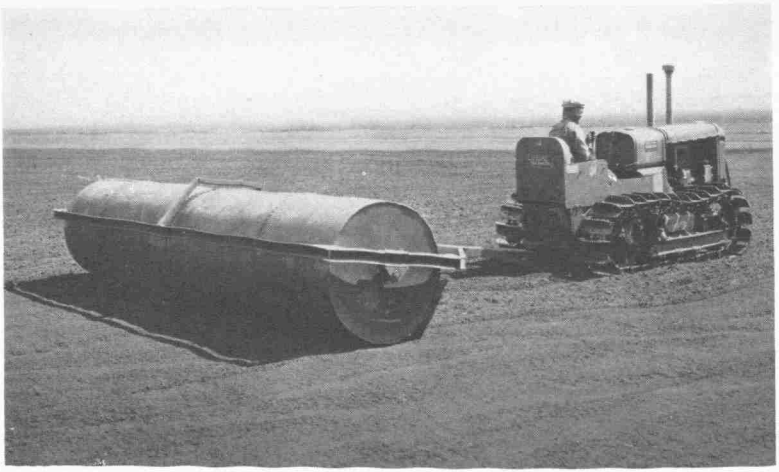
Bermuda grass sprigs may be scattered with a manure spreader such as the above much more rapidly than they can be planted by hand. When planting large areas in turf, the use of power equipment will often save much time and labor.

material of any of the methods listed. While check sprigging does not require as much planting material as the other methods mentioned, it should be borne in mind that when less planting material is used a longer period of time is required to establish a dense cover of turf.

Row sprigging is the planting of sprigs more or less continuously in rows. This may be accomplished by placing the stolons in furrows and covering with a plow, drag or hand rake; by dibbling in the sprigs by hand; or by the use of mechanical planters. These latter machines are still in the experimental stage but considerable progress has been made in the development of such equipment. In row sprigging, more planting material is used than in check sprigging.

Broadcast sprigging refers to the method by which shredded

or chopped stolons are broadcast over an area. This may be accomplished either by hand or by the use of machinery. Where small areas are being planted, the chopped stolons are merely scattered by hand, rolled, and then covered with a thin top-dressing of soil or compost. This method is commonly used in propagating selected strains of creeping bent on golf courses



After seeding or sprigging, the soil should be firmed by rolling. This process places the soil in close contact with the seed or sprigs and thereby aids in more rapid germination of seed or more rapid growth of sprigs.

and is known as vegetative planting. Naturally, hand methods are much too laborious for use on large areas. If large-scale plantings are made, the stolons may be distributed over the prepared surface by a manure spreader. Only grasses which produce stolons, however, should be distributed by this method. In order to cover the stolons lightly and firm the soil, the spreader must be followed by a disk and roller.

Sodding

The transplanting of sod with the soil held together by the grass roots is known as sodding. Thin sod is obviously cheaper to move than thick sod. Also, thin sod cut at 1 inch or even three-quarters of an inch has more surface roots exposed, and therefore becomes anchored more quickly than does thick sod, but it dries out much more quickly. Thin sod should not be used, therefore, unless plenty of moisture is assured either in rainfall or through available watering facilities. On the other hand, sod cut at 2- to 4-inch depths will not dry out so quickly but the grass will be more slow to become anchored and established. Several kinds of sodding are in general use. These are listed below in the order of increasing amounts of plant material required.

Check sodding (block sodding, tuft sodding or spot sodding) involves the planting of small blocks of sod at regular intervals. This method should be employed only when the grasses to be used are species which spread rapidly from stolons or rhizomes. The method is used chiefly in areas subject to periods of drought where plantings by methods such as sprigging are likely to fail. Buffalo grass which is slow to start growth and requires a small core of soil and undamaged roots in order to survive periods of drought, is the species most commonly planted by this method. It is important not to cover buffalo grass with soil after planting.

Strip sodding (trench sodding) requires more sod than check sodding but less than solid sodding and may be used successfully in many cases on slopes which are too steep for other planting methods to succeed. Spaces between strips may be seeded or sprigged.

Solid sodding (block sodding, also frequently simply referred to as sodding) is the complete covering of an area by strips or blocks of sod. This method is by far the most expensive because of the large amount of material and labor required. It may be used to advantage, however, on lawns, drainage channels, and areas adjacent to catch basins along highways and runways where immediate cover is necessary.

Topsoil Planting

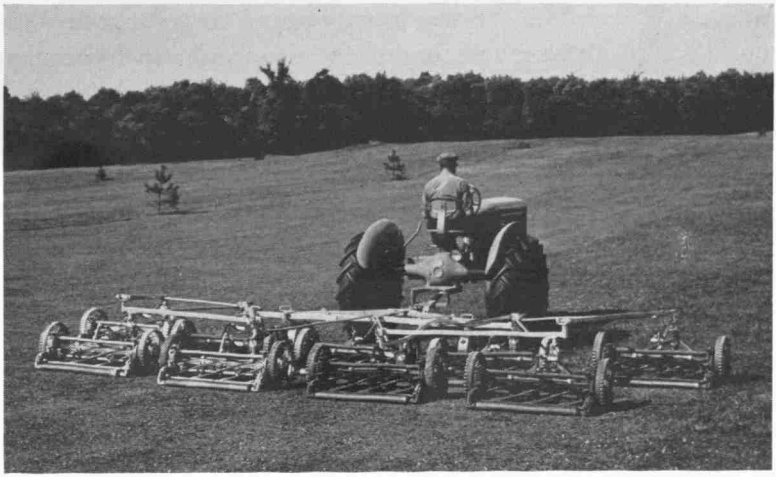
This method, which is otherwise known as broadcast sodding, mulch sodding, or grass mulching, has been used rather extensively in the establishment of turf, particularly in the South. It is a method which combines the spreading of topsoil and planting in one operation.

The area to be planted is graded to any desired depth below the finished grade, sometimes as little as 1 to 2 inches. Topsoil obtained from a field upon which a desired grass is growing is then spread over the area to fill up to grade. The grass is indiscriminately mixed with the topsoil during the moving process and under favorable conditions resumes growth in the new location. When the soil used is dark in color and obtained from swampy areas, this operation is usually referred to as "mucking," which has already been described.

Mowing

One of the most critical periods in the establishment of grass is that time between germination, or beginning of growth in the case of sprigs, and the development of a good cover. If weeds are allowed to grow unmolested during this period the grasses suffer badly or may die due to competition. Usually such losses can be prevented if sensible mowing is practiced

during the early stages of development. Proper height and frequency of mowing are largely determined by the types of grasses of which the turf is composed and the use to which the turf is to be put. Generally speaking, mowing which develops



Reel type gang mowers may be effectively used on large open turfed areas. This type of mower is operated at a higher speed and is much more effective in controlling weeds than the ordinary sickle-bar type. The time required for mowing may be kept at a minimum by using 7 or 9 unit gangs of these mowers.

the maximum density of turf and keeps down the taller growing weeds without damaging the grass may be termed sensible mowing.

Even after a good stand of grass develops, mowing is still important. In the case of airfields and similar areas, however, mowing closer than 2½ or 3 inches is not necessary and should be avoided. The best service will likely be obtained on such areas from the use of a reel or a rotary type mower rather than the sickle-bar types. Mowing should be done when the grass

requires it rather than at set dates. Naturally more frequent mowings will be necessary during the periods of greatest growth.

During seasons when there is little or no growth of grass, mowing can be eliminated entirely provided weeds are not present. If troublesome weeds are present they must be kept mowed to prevent smothering of the grass and also to prevent their seeding.

Watering

When large areas are being put into grass the high cost involved in the application of water in amounts sufficient to be of any value will probably prohibit its use. Since the addition of more than 27,000 gallons of water to the acre is necessary to equal 1 inch of rainfall, it is obvious that watering at the rates that will help the grass will be extremely costly on large areas. On small areas, where costs are not a limiting factor, watering is often advisable, particularly during the germination period, and before the start of growth in the case of sprigs.

Renovating

Whenever possible, old existing turf should be preserved, for it takes much longer to grow tough turf than is ordinarily realized. In some portions that are slightly ridged or uneven it is possible to improve the old turf by cutting in various directions with a sharp disk harrow. The harrow should be set almost straight so that it will cut into the turf but will not turn it over. If reseeding is to be done, a drill may be used so that the seeding and cutting may be done in one operation. The turf should then be fertilized and rolled. This treatment given to old Bermuda grass turf in the spring or to bluegrass

turf in the fall results in noticeable benefits. In treating old turf on stiff clay soils, an application of coarse sand in addition to this cutting will benefit the turf by improving the soil structure.

Selection of Grasses

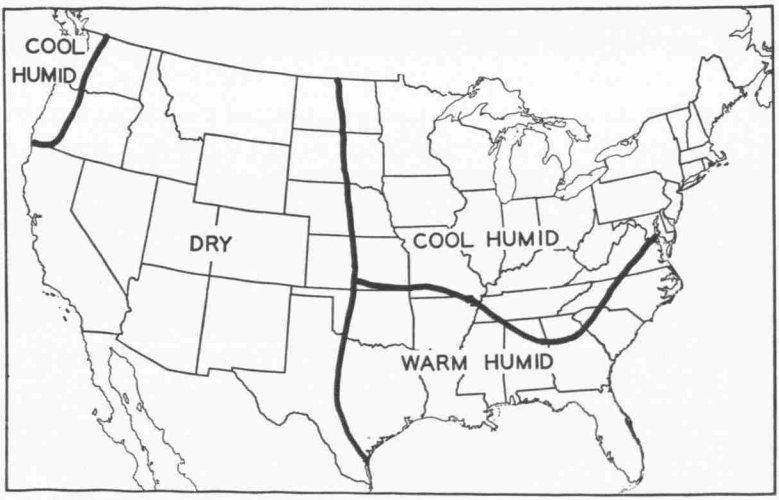
Grasses, to be useful for lawns, pastures, golf courses, etc., must meet certain specific requirements adapting them to the purpose for which they are selected. Likewise, if turf on an airport, roadside, or cantonment area is to be successful it must be composed of plants capable of meeting the requirements of such turfed areas. Among some 1,100 known species of grasses occurring in the United States only approximately 30 have been used for turf purposes. This does not mean that others may not be used. It merely indicates that in the past their use for turf has not been investigated.

A grass selected for use on airfields, roadsides, drill fields, and recreation areas should be tough and resistant to the rough usage to which such areas are subject. Far more important than the fine texture sought in lawn grasses is the ability to withstand wear and tear of heavy traffic. Since turf on many areas is often required on relatively short notice, rapid growth and the ability to "cover up" quickly are also of major importance in the selection of the grasses. In many cases, dust, so detrimental to the motors of planes and other mechanized equipment, can best be checked by the rapid establishment of a grass cover. Any turf subject to wear by planes, trucks, etc., is likely to suffer badly from scars unless it is composed of rapidly growing species which heal quickly.

The selection of grasses that require minimum maintenance costs is of considerable importance. Other factors being equal,

low-growing species should be used in preference to the tall, upright ones, since mowing costs often involve large sums of money.

Finally, planting material, either seed or stolons of the grasses to be used, should be readily available commercially. Seeds of some turf grasses are imported and as a result are not



Map depicting three general climatic regions of the United States. The grasses to be used in each region are determined by the climatic factors of that region.

available at this time. Also seed of some recently developed strains of turf grasses must be increased before they are available in large quantities.

Even for airfields or other specific requirements, no one or several grasses can be recommended for general use in turf throughout the country. Rather, the types of grass to use will depend primarily on the geographical location of the particular areas in question. Grasses, like most plants, are pecu-

liarly adapted to growth in certain specific geographical and climatic areas. Attempts to use species outside of their range of adaptability almost invariably meet with failure. The final selection of grasses within each geographical area will depend on the soil and moisture conditions of the locality and a consideration of the naturally occurring grasses within that specific area.

For the present treatment the United States has been divided into three climatic regions (see accompanying map), and in the table on page 224 a number of grasses are suggested for use in each region.

The correct time of planting various grasses is determined primarily by the location of the region in which the grasses are used. Most seeding in the cool, humid regions should be done in late summer or fall. In the southern portion of the region this is an absolute necessity if a good stand is to be expected. In the northern part of the cool, humid region satisfactory turf may sometimes result from early spring seeding. Turf grasses of this region are not ordinarily used singly, but in mixtures.

Grasses of the warm, humid region should be planted either during the spring or summer months—not in the fall. One may find rare exceptions to this in the extreme South where Bermuda grass stolons have been planted in February. If stolons are planted at this time they merely remain dormant in the soil until conditions become favorable for growth.

In contrast to the northern grasses, those of the warm, humid region are usually used singly rather than in mixtures. There are a few exceptions to this rule. For example, carpet grass is often used in combination with Bermuda grass and other species.

The time of planting in the dry region will depend primarily on the method of planting employed. If sprigs or sod are used they should be planted in the spring or early summer. Seeding is done either in the spring or fall, depending on

GRASSES AND LEGUMES WHICH CAN BE USED FOR TURF IN THE THREE CLIMATIC REGIONS OF THE UNITED STATES. THE ACCEPTED METHOD OF PLANTING IS GIVEN FOR EACH. WHERE A PLANT MAY BE PROPAGATED EITHER BY SEEDING OR SPRIGGING, THE MOST COMMONLY USED METHOD IS GIVEN FIRST.

Common Name	Scientific Name	Method of Planting	Page No.
Cool Humid Region			
Kentucky bluegrass	*Poa pratensis* L.	Seed	226
Canada bluegrass	*Poa compressa* L.	Seed	227
Trivialis bluegrass	*Poa trivialis* L.	Seed	227
Redtop	*Agrostis alba* L.	Seed	228
Red fescue	*Festuca rubra* L.	Seed	228
Meadow fescue	*Festuca elatior* L.	Seed	228
Perennial ryegrass	*Lolium perenne* L.	Seed	229
Annual ryegrass	*Lolium multiflorum* Lam.	Seed	229
Common ryegrass	*L. perenne* and *L. multiflorum*	Seed	229
Colonial bent	*Agrostis tenuis* Sibth.	Seed	230
Creeping bent	*Agrostis palustris* Huds.	Sprigs and Seed	230
Quackgrass *	*Agropyron repens* (L.) Beauv.		231
White clover	*Trifolium repens* L.	Seed	231
Warm Humid Region			
Bermuda grass	*Cynodon dactylon* (L.) Pers.	Sprigs and Seed	231
Centipede grass	*Eremochloa ophiuroides* (Munro) Hack.	Sprigs	233
Narrow-leaved carpet grass	*Axonopus affinis* Chase	Seed	233
Broad-leaved carpet grass	*Axonopus compressus* (Schwartz) Beauv.	Seed	233
Japanese zoysia	*Zoysia japonica* Steud.	Sprigs	234
Manila zoysia	*Zoysia matrella* (L.) Merr.	Sprigs	234
Bahia grass	*Paspalum notatum* Flügge	Seed and Sprigs	236
St. Augustine grass	*Stenotaphrum secundatum* (Walt.) Kuntze	Sprigs	236

Common Name	Scientific Name	Method of Planting	Page No.
Common lespedeza	*Lespedeza striata* (Thunb.) H. and A.	Seed	237
Korean lespedeza	*Lespedeza stipulaceae* Maxim.	Seed	237
Perennial ryegrass (temporary)	*Lolium perenne* L.	Seed	229
Annual ryegrass (temporary)	*Lolium multiflorum* Lam.	Seed	229
Common ryegrass (temporary)	*L. perenne* and *L. multiflorum*	Seed	229
Dry Region			
Buffalo grass	*Buchloë dactyloides* (Nutt.) Engelm.	Sprigs and Seed	237
Kikuyu grass	*Pennisetum clandestinum* Chiou.	Sprigs	238
Smooth brome	*Bromus inermis* Leyss.	Seed	239
Downy brome *	*Bromus tectorum* L.		239
Blue grama *	*Bouteloua gracilis* (H.B.K.) Lag.	Seed	239
Sideoats grama *	*Bouteloua curtinpendula* (Michx.) Torr.	Seed	239
Bermuda grass	*Cynodon dactylon* (L.) Pers.	Sprigs and Seed	231
Crested wheatgrass	*Agropyron cristatum* (L.) Beauv.	Seed	239
Western wheatgrass	*Agropyron smithii* Rydb.	Seed	239
Kentucky bluegrass	*Poa pratensis* L.	Seed	226
Curly mesquite *	*Hilaria belangeri* (Steud.) Nash		239
Russian wildrye	*Elymus junceus* Fisch.	Seed	239
Sand dropseed *	*Sporobolus cryptandrus* (Torr.) A. Gray	Seed	239

* May be established by the hay mulch seeding method or natural stands may be utilized when available.

whether or not one is located in the northern or southern dry regions. In the North, spring seeding may bring good results, whereas in the South fall seeding is to be preferred, unless a southern grass, such as Bermuda grass, is used.

It is realized that conditions vary widely even within each climatic region and the fact that a number of grasses are suggested for use in each of the climatic regions should not be taken to mean that all or any of these can be used successfully in all locations in any one area. There are certain situations where, under present conditions, it will be extremely difficult, if not impossible, to grow any grass at all. Attempts to produce turf on such places is merely a waste of time, effort, and planting material.

In establishing turf for defense purposes it may be necessary to depend on temporary covers for short periods of time. There are a number of plants including grasses which may be used for this purpose and information regarding their use may be obtained upon request.

Kentucky Bluegrass

As this species produces a dense durable turf over a wide range of soil conditions in the cool humid region of the United States, it should be the chief component of most plantings in that area. Where it is watered, it also thrives in the northern half of the dry region. Unlike the southern grasses, the growth of the bluegrasses is confined to the cooler seasons of the year. Growth starts early in the spring, is retarded during the hot summer months, and is accelerated in late summer or early fall. This species is slower to produce a strong turf than are some of the southern grasses, but once it has become established it forms, with proper management, a dense, permanent sod. A number of strains of Kentucky bluegrass have been selected which differ widely in texture, height, ability to spread, and disease resistance. Among these some of the coarser, spreading types are better adapted for airfield and general turf use than are the usual commercial strains.

On lawns and similar areas bluegrass is seeded at the rate of approximately 4 pounds to 1,000 square feet. For larger areas, seeding at the rate of 50 to 75 pounds to the acre should be adequate. When possible, seeding should be done in late summer or early fall rather than in the spring, **never in midsummer.** This is especially important in the southern part of the bluegrass range. In the North, early spring seedings may sometimes be successful.

Canada Bluegrass

This species has approximately the same distribution as Kentucky bluegrass. It is most often found on soils of low fertility and may sometimes be used as a turf grass on such soils. Canada bluegrass is coarse, stemmy, and a very poor substitute for Kentucky bluegrass; however, it may serve as a ground cover on poor soils where a dense turf is not needed. This species should be seeded at the same rate as that suggested for Kentucky bluegrass.

Trivialis Bluegrass (roughstalk bluegrass)

This is definitely a shade grass and has little application for use outside of shaded moist soils or other cool moist locations. It is not a grass to be used in turf that receives any appreciable amount of heavy wear.

The fact that seed of trivialis bluegrass is produced outside of the United States and will not likely be available in quantity until after the emergency should be kept in mind when drawing up seeding specifications. Trivialis bluegrass is often recommended in seed mixtures and if such mixtures are used in seeding specifications, projects may be unnecessarily delayed due to the fact that trivialis bluegrass is not obtainable.

Redtop

In the northern part of the United States redtop is often used in varying proportions in seed mixtures. It forms a quick cover which serves as a temporary turf until the more permanent grasses have become established. It does well under a wide range of soil conditions and will tolerate poor soils much better than most grasses.

In turf, redtop does not usually persist more than 2 or 3 years if it is growing in competition with other species. After the first year's growth it becomes coarse if it is growing on fertile soils, but this would not be objectionable if used on airfields or roadsides. Seed of this species may be obtained at a much lower cost than that of other grasses, and therefore it is apt to be given undue prominence in seed mixtures. When used in mixtures it should rarely constitute more than 20 percent of the mixture by weight, and usually not more than 10 percent.

Fescue

The fescues are well adapted to the well-drained, sandy loam soils of the northern half of the United States and may also be used on some heavy soils provided drainage is adequate. Fescue invariably fails when it is used on poorly drained, heavy clay soils. So far as climatic adaptation is concerned, the range of fescue is approximately the same as Kentucky bluegrass. Fescue, however, is better adapted to shade conditions than Kentucky bluegrass. Some of the most beautiful shaded lawns in the northern part of the United States are composed of fescue. It is not ordinarily used alone but in combination with bluegrass, redtop, and the bents. In regions where it is well adapted it may constitute 50 percent of the mixture in

which it is used. Fescue seed is usually expensive, therefore the matter of cost should be carefully considered when the use of this species in seed mixtures is contemplated. This does not mean that cheap seed is recommended, but there is obviously no justification for increasing the cost of seed mixtures by adding fescue if the mixture is to be used on soils which are not adapted to the growth of fescue. For most turf purposes red fescue chewings is preferred to other species. For roadsides and other rough turf, however, meadow fescue may sometimes be used to advantage.

Ryegrass

Two species of ryegrass, perennial and Italian, may under certain conditions be used to advantage in turf. The ryegrasses are rarely used alone but usually as a temporary cover

Ryegrass seeded in late fall on area where Bermuda grass had been planted too late to produce a satisfactory cover. Left, Bermuda grass; right, Bermuda grass plus ryegrass.

or as a nurse crop for some more permanent species. In the North perennial ryegrass will, under ordinary conditions, persist in turf for a period of 3 or 4 years. However, in the

southern part of the cool, humid region and in the South ryegrass remains only as scattered plants after the first or second year. Italian ryegrass is an annual and persists for one season only. The ryegrasses are tough and will survive considerable rough treatment. The fact that they are tough, however, makes mowing them rather difficult.

In recent years a mixture consisting of perennial and Italian ryegrasses has been used extensively in this country. The mixed seed is sold under the name of "Common" or "Domestic" ryegrass. It may be used for any purpose for which perennial ryegrass is used and some tests tend to indicate that for turf purposes the mixture is superior to either of the two species used separately.

When used as a nurse crop ryegrass should compose not more than 10 percent of the seed mixture by weight. If it is used alone as a temporary or winter cover seed should be sown at the rate of 50 to 100 pounds to the acre.

Creeping and Colonial Bent

Either of these grasses may serve as satisfactory turf species in the northern part of the cool humid region. They are especially useful as roadside grasses in New England and the Northwest. When used alone bent grasses will not withstand heavy traffic. However, Colonial bent may be used in combination with bluegrass and fescue on large-scale plantings subject to hard wear. Creeping bents, with the exception of seaside, are propagated by stolons and Colonial bent by seed.

The bents when used in combination with other species should normally compose not more than 5 or 10 percent of the seed mixture.

Quackgrass

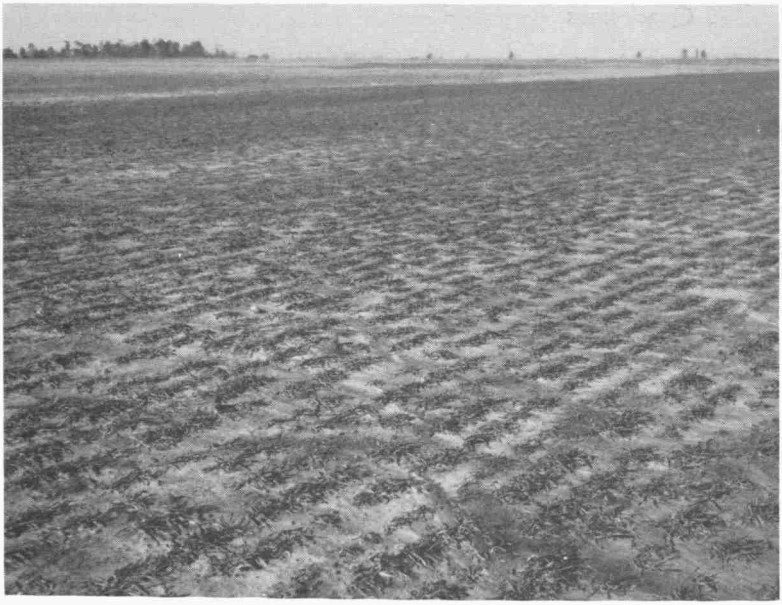
This is a vigorous, persistent, and rapidly spreading perennial which occurs in abundance north of the Ohio and east of the Missouri Rivers. This species is usually considered a weed where it occurs in abundance. It has caused enormous damage to farm lands, nevertheless it is not entirely worthless since it can be utilized in the production of a rough turf. On areas subject to hard wear quackgrass may be used to advantage since it produces a durable turf if properly mowed. Its use, however, should be limited to locations where it occurs voluntarily in abundance.

White Clover

Turf seed mixtures often include varying proportions of white clover. On many soils of the cool humid region clover may be used to advantage in combination with bluegrass, redtop, or fescue. The clover tends to remain greener during the hot, dry periods than do some grasses. Its presence therefore aids the appearance as well as the density of turf during the summer months. It should be seeded in the spring and at a rate of approximately 20 pounds to the acre.

Bermuda Grass

This grass, without a doubt, is at present more widely used in the South than any of the others mentioned. It is also fairly well adapted to the southern part of the dry region. Bermuda grass thrives under high temperatures and its rapid summer growth, together with its low creeping habit, makes it an excellent turf species in many parts of the southern United States. It does well on a wide range of soils and will survive a great deal of wear and tear. Bermuda grass, like many others,



Cereal rye planted on an airfield as a temporary winter cover. Seeding in this instance was made too late in the season to produce a good stand.

is extremely variable and several selected strains are superior to the ordinary commercial types. Most of these, however, must be increased before they are available for extensive plantings. It is also probable that other strains could be developed which would be better adapted to use on airfields than the usual commercial stock.

Bermuda grass may be planted either by seed, sod, or sprigs. Hulled seed should be sown at the rate of 20 to 30 pounds to the acre. When speed is an important factor in the establishment of Bermuda grass turf from seed, one should insist that the seed be hulled since the germination of unhulled seed is usually slow. The amount of sod or sprigs required for planting

any given area will vary with the method used. Generally speaking, 1 square foot of good sod should plant 20 square feet. If thin sod is used as a source of planting material the planting ratio must necessarily be changed. In many cases 1 square foot of sod will plant no more than 10 square feet. Bermuda grass, like most southern grasses, must be planted either in the spring or summer, since the plants are semi-dormant during the winter months.

Centipede Grass

The range of adaptability of this species is not as great as that of Bermuda grass, nevertheless in many parts of the South centipede grass forms an excellent turf. Although this grass may sometimes be killed by hard usage, this objection is partially compensated for by its rapid growth and spreading ability. Centipede grass has not been tested on airfields, but it seems likely that it will not stand up under the wear such turf receives.

A number of selections have been made of centipede grass but these need to be increased before they are available in large quantities. It is also probable that further tougher strains might be selected and developed which would be better adapted to airfield use than those which are now in existence.

Centipede grass is ordinarily planted by sprigging at a ratio of approximately 1 to 25; that is 1 square foot of good sod is used to plant 25 square feet.

Carpet Grass

This grass forms a dense heavy turf on those southern soils to which it is adapted. It requires more moisture than does Bermuda grass and it generally thrives better in soils of rather high clay content. There are many areas in the South in which

Manila zoysia growing along roadside. This grass was not mowed throughout the growing season, yet its height, as indicated by the ruler on the right, is not more than 6 inches. Note the persistence of the grass at the edge of the road where it has been subject to wear and tear of traffic.

carpet grass appears voluntarily as soon as the soil is disturbed. This fact should be taken advantage of when turf is to be established on those areas where carpet grass occurs naturally. On the other hand, an attempt to grow carpet grass on the drier, sandy soils is not likely to meet with success.

Except in special cases, carpet grass is planted by seed. Under favorable conditions seeding at the rate of 25 to 35 pounds to the acre will produce a good cover. Like redtop, carpet grass is best used in a mixture rather than alone.

Zoysia

Two species of *Zoysia,* namely Z. *matrella* and Z. *japonica,* offer possibilities as turf grasses in the South and in the intermediate zone composing the southern part of the cool humid

Load-bearing capacity of Manila zoysia. This area was driven over by a truck at a time when the soil was wet. Note how the depth of track decreased as the truck proceeded from thin to well-established sod. The load-bearing capacity of well established Manila zoysia sod is unparalleled by most grasses.

and northern part of the warm humid regions. Japanese zoysia, commonly referred to as Japanese or Korean lawngrass, is the coarser of the two species. Some strains are winter-hardy and one planting in Boston, Massachusetts, has survived several severe winters.

Manila zoysia (Manila grass) has a narrow leaf and produces a finer textured turf than does Japanese zoysia. It apparently is not as winter-hardy as is Japanese zoysia, but it has been able to survive southern New England winters.

Japanese zoysia and Manila zoysia are still in the experimental stage but have demonstrated some interesting possibilities

for turf purposes. For example, the entire season's growth is only a few inches and therefore for many situations, such as airfields and roadsides, zoysias need no mowing. They are slow in becoming established, but when once they form a thick turf they compete successfully with weeds. The turf of these species will withstand much heavy wear, as well as rather prolonged periods of drought.

Seed of zoysia is not available commercially at the present time. Therefore it must be planted by sprigging. One square foot of good sod will plant approximately 25 square feet.

These two species of *Zoysia* are very different from *Zoysia tenuifolia* and should not be confused with that species.

Bahia Grass

Temperature is the chief limiting factor in the use of Bahia grass as a turf species. Since it is able to withstand but little cold it should be planted only in the southern portion of the warm humid region. Under favorable conditions Bahia grass spreads rapidly and forms a dense durable turf. It is adapted to a wide range of soil types. Bahia grass may be propagated either by sprigging or by seed. Seeding is to be preferred even though seed germination is often low. Seed should be sown at the rate of 30 to 35 pounds to the acre.

St. Augustine Grass

Although this species forms an excellent lawn turf in the extreme South it is not well adapted to airfield and general roadside use since it requires considerable moisture for best growth. It is tolerant of both shade and sun as well as a wide range of soil conditions—provided adequate moisture is available. St. Augustine grass is planted by sprigging at the rate of approximately 1 to 20.

Lespedeza

This plant is used primarily as a forage or hay crop in the warm humid region. Nevertheless it may supplement grasses as an airfield or roadside turf component in this region. Lespedeza is tolerant of high temperatures and is extremely drought resistant. None of the annual lespedezas will withstand severe frosts. Therefore their use is limited to the southern states. Of the two available annual lespedezas, "Common" is to be preferred for turf use since it does not cease growth after flowering, as does "Korean." Lespedeza produces a satisfactory cover on many acid soils of low productivity.

Seeding is done in early spring (March or April) at a rate of approximately 25 pounds to the acre.

Buffalo Grass

This is a rapidly spreading, low growing, drought resistant species which forms a tough sod and is used extensively in the dry region. Its low growth makes frequent mowing unnecessary. The buffalo grass seed available commercially is expensive but fortunately only a small amount of seed to the acre is necessary to produce a good stand. Untreated buffalo grass seed usually germinates poorly. Certain simple seed treatments have been devised, however, which will often increase germination by as much as 50 percent or 75 percent. Information concerning these methods may be obtained from the U. S. Department of Agriculture or State Agricultural Experiment Stations.

Much buffalo grass seed on the market is non-viable. There-

fore, before large plantings are made the viability of the seed to be used should be determined by germination tests.

The species also lends itself readily to propagation by check sodding, which is the usual method employed in the establishment of buffalo grass turf. Intervals between the blocks of sod, which are usually 3 or 4 inches square, vary a great deal, depending on the speed of coverage desired and the expense justified in the particular planting job at hand. On lawns or other small areas where a rapid cover is desired, these blocks of sod may be placed at intervals as close as 12 inches. On the other hand, large areas such as airfields would require such great amounts of sod that the expense would be prohibitive if the blocks of sod were placed at very close intervals. On such areas the intervals may be extended to as much as 4 feet. Other species, particularly blue grama, which may be desirable in combination with buffalo grass, may be seeded at the same time the sod is placed. Seedlings resulting from this planting serve as a ground cover until the buffalo grass has time to establish a solid cover.

Locally adapted rather than introduced strains of buffalo and grama grass should be used whenever possible.

Kikuyu Grass

This is a perennial with heavy rhizomes which has comparatively recently been tested as a pasture and turf grass in several localized areas. It has been grown with considerable success in parts of Australia and plantings along coastal areas of California have indicated that it may be successfully grown there. It is also probable that it may be well adapted to some parts of the south Atlantic coastal plain.

Experiments in Australia indicate that kikuyu is highly drought resistant. These results have not as yet been dupli-

cated except in limited tests in this country. Kikuyu produces very little seed. It must, therefore, be propagated by sprigging. The planting rate suggested for Bermuda grass will apply also to kikuyu.

Brome Grass

Two species of brome grass, *Bromus inermis* and *B. tectorum,* are worthy of consideration for rough turf purposes. *B. inermis* is the larger and coarser of the two species and requires considerable mowing if used as turf. It does, however, produce a fairly good cover when mowed. *B. tectorum,* an annual, and a weed under many conditions, occurs voluntarily in many parts of the Mid-west and might be used to advantage on those places where it occurs in abundance. For turf purposes *B. inermis* should be seeded at the rate of approximately 200 to 300 pounds to the acre.

Grama Grass

In the southern and central plains regions, grama grass (blue and sideoats grama), produced from local seed, has possibilities for airfield and roadside use. A combination of buffalo grass sod and grama grass seed produces a sod more rapidly than either of the species used separately. The use of such a combination reduces the amount of buffalo grass sod required for planting any given area.

Russian wildrye, crested wheatgrass (preferably Fairway strain), western wheatgrass, curly mesquite, and sand dropseed grass may also be used for the production of turf in certain parts of the plains region, where they are adapted. With the exception of crested wheat (Fairway strain) these grasses are not really turf species. Nevertheless, under favorable conditions they may be used in the establishment of a rough cover on roadsides, airfields, etc.