TURF CULTURE

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TURF CULTURE

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TURF SEED OF HIGHER QUALITY

JOHN MONTEITH, JR.*

In purchasing any commodity a buyer must have some knowledge of the quality available if he is to make an intelligent choice. This is as important in buying seed as in buying anything else. Like other industries, the seed industry has made many improvements in recent years. Because of the introduction of improved growing, cleaning, and handling methods there are now available quantities of seed of a higher quality than was possible in the past. The improvements in turf grass seed have been in the preparation of the seed for sale, rather than in the introduction of improved varieties or strains. The plants that develop from the recleaned seed will not be superior to those from poorly cleaned seed, but there will be more of them and fewer weeds for each pound of seed sown.

BASIS OF QUALITY

Quality of seed depends primarily upon three factors, purity, germination, and the presence of weed seed. The purity of the sample is expressed as the percentage by weight of pure seed of the kind designated. The germination is expressed in terms of the percentage of pure seed that will grow. The germina-

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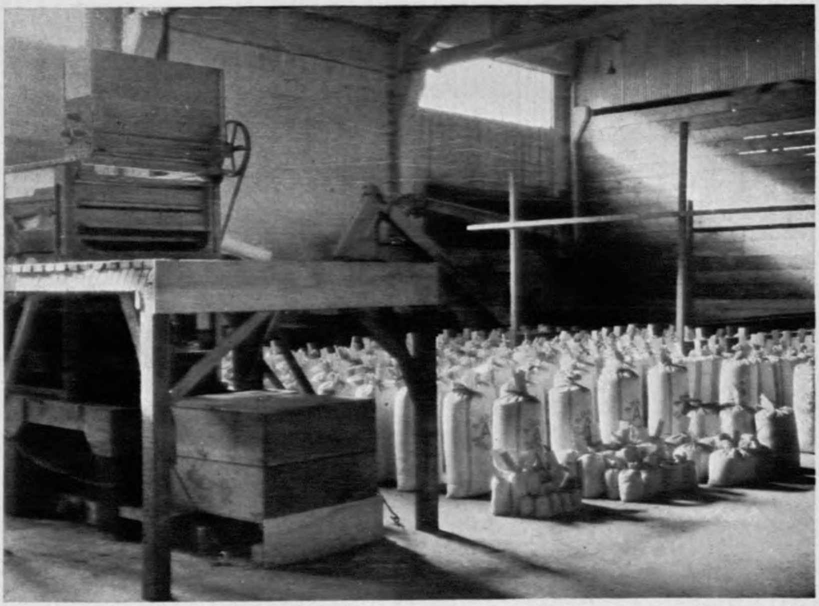
tion times the purity, expressed as decimals, gives the percentage of pure live seed or the real value. Thus one lot of seed with a purity of 90 percent and a germination of 85 percent contains 76.5 percent pure live seed. Another lot with a purity of 95.6 percent and a germination of 80 percent also contains 76.5 percent pure live seed. If there is no difference in weed seed content, these two lots are for all practical purposes of equal value and should bring the same price.

Since under ordinary conditions the seed buyer is not interested in either the purity or the germination, as such, but in the amount of pure seed that will grow, he should compare values on the basis of percentage of pure live seed. To compare the actual value of two lots of seed at different prices the buyer need only determine the pure live seed content of each, as discussed above, and divide this figure into the cost per pound. The resulting figure will be the actual cost of a pound of pure live seed.

The impurities in seed may be chaff, foreign seed, even though more expensive, and weed seed. Ten percent chaff is merely so much waste; ten percent weed seed is quite a different matter. This is especially true where heavy seedings are made. Thus if the impurities are merely inert material, seed with a low purity may be a more economical purchase than recleaned seed. However, to be of comparable quality with respect to weed seed the impure sample must show a lower percentage of weed seed than the purer sample, for the increased seeding rate necessary with impure seed would naturally increase the number of weed seed deposited on a given area.

In order to supply seed buyers with up-to-date standards for comparison, a study of the records of the seed-testing



Modern seed cleaning machinery used for grass seed. In recent years there has been a decided improvement in the quality of grass seed available on the market. This is due largely to improvements in methods of cleaning rather than to the development of seed of improved strain. On the left is shown the equipment used for cleaning bent seed. On the right are sealed and tagged bags of inspected seed ready for the market.

laboratory of the United States Department of Agriculture was undertaken and several large and reputable dealers in grass seeds were consulted.

The results of this inquiry are included in the following discussion of the various kinds of seed commonly used for turf. The table on page 137 gives the minimum percentages of purity, germination and pure live seed; and the maximum percentage of weed seed which may now be expected in high quality seed of the more important turf grasses. These standards were set high enough so that only the best seed available in quantity would qualify. For seed of such quality the dealer will ask a somewhat higher price to compensate for the extra cleaning and for the seed lost in this extra cleaning. The discriminating buyer will pay this difference if he wants the best.

In the table it will be seen that the quality possible depends on the kind of seed. For instance, the buyer may expect a high pure live seed content in ryegrass of even medium quality. This figure may be considerably higher than is possible in the best red fescue. This is brought about by differences in the germination of the fresh seed, in the difficulty in cleaning the seed, and in the length of time the seed will remain alive under various storage conditions.

It must be borne in mind that the standards suggested are for the average season. If the season is particularly wet or if there is a drought in the producing areas at harvest time the quality of the seed will suffer, especially in germination. After particularly favorable growing conditions these standards might well be a trifle higher.

Under the discussion of each of the grasses is given the pure live seed content to be expected in high or top quality seed. A second figure, representing good or above average seed, is given in each instance to show the range of material available. In many cases a grade somewhat under the highest quality may be the best buy. The buyer may determine this by comparing various lots on the basis of cost of a pound of pure live seed, keeping in mind any differences in weed seed content.

Kentucky Bluegrass

The large producing area for Kentucky bluegrass is in the Middle West, extending northward from the southern borders of Missouri and Kansas. Kentucky produces about one-sixth as much seed as this western area, and various other states produce smaller amounts. Selections of superior types for turf have been made but no commercial supply of seed of these is as yet available.

Buckhorn plantain (*Plantago lanceolata*) and yellow dock (*Rumex crispus*) are objectionable weeds sometimes found in Kentucky bluegrass seed. Sometimes Canada bluegrass has been used as an adulterant. Its presence is an indication of intentional adulteration as the two grasses do not seed at the same time, and hence could not be found in seed harvested at a single time. Kentucky bluegrass with a pure live seed content of 86 percent is of high quality, while a 75 percent pure live seed content is good.

Trivialis Bluegrass

Most of our *Poa trivialis* has been imported from the Scandinavian countries. Because of war conditions, however, importation of this seed has been cut off temporarily, so it will probably not continue to be available. *Poa trivialis* with a pure live seed content of 86 percent is considered high quality, and 75 percent is good.

Redtop

Over 90 percent of the redtop used in this country is produced in southern Illinois. Buckhorn plantain, ox-eye daisy (*Chrysanthemum leucanthemum*) and yarrow (*Achillea millefolium*) are often found in redtop seed. High grade redtop should contain 90 percent pure live seed. Redtop containing 85 percent pure live seed is of good quality.

Colonial Bent

The mixed bent which was used so much in former years was imported from Europe and was made up largely of Colonial bent, with some velvet and a trace of creeping bent. Colonial bent is now generally seeded in pure stands for putting green purposes and large quantities are used in lawn and fairway

Certification of seed. Some of the grass seed on the market is now certified by state agricultural authorities. For several years members of the staff of the Oregon State Agricultural Experiment Station have been certifying bent seed grown in that state. For this certification, the fields are inspected before harvest. After threshing, the seed is brought into the warehouses for further inspection. Open bags such as those in the two rows on the right are brought in from designated fields. Samples are taken from the bags by a sampler like the one shown leaning against the post in the center of the picture. The samples are laid out on a table for examination. After examination and certification, the bags are tagged and sealed.

mixtures. Most of the Colonial bent seed now on the market is produced in the Pacific Northwest. Some seed is also produced in Rhode Island, New Zealand, and Canada. The Oregon-grown Colonial bent must meet the same standards for certification as are described for creeping bent. The purchase of

Oregon blue tag quality in the original sealed bags will assure good quality seed. Seed with a purity of 99 percent, a germination of 91 percent, and not over 0.2 percent weed seed is available.

Creeping Bent

Most of the creeping bent seed on the market is grown in Oregon and Washington. This creeping bent, called seaside bent, and sometimes Coos County bent or other names, produces plants that vary in their adaptability to lawn and putting green conditions. A considerable number of selections of good types of creeping bent have been made and some of these selections, such as Washington and Metropolitan bent, are now widely used. These selections do not come true from seed, so all plantings of improved types must be made with stolons.

Seaside creeping bent seed of very high quality is now being produced in the Pacific Northwest. Much of it is obtained by a combination of weed prevention in the fields and careful cleaning and handling of the seed. In Oregon, state officials inspect and certify the best grades of seed before they are marketed. The buyer of Oregon seed, therefore, who gets his seed in the original sealed bags is assured of seed of good quality.

If a bag of bent seed from Oregon is to carry the blue tag, indicating the highest grade certified, it must not contain more than 0.3 percent of other strains of bent grass, not more than 0.25 percent of total weeds, must have a minimum purity of 98 percent and a minimum germination of 85 percent. Considerable quantities of bent seed may be had which exceed these standards, some seed even showing an official count of 0.00 percent weeds. Blue tag seed should satisfy most needs, but considerable amounts of seed are available which are 98 percent pure, have 92 percent germination, and less than 0.2 percent weeds. There seems to be little reason for accepting a lower grade of seed than Oregon blue tag for use in pure stands, for it has been estimated that about one-half of the creeping and Colonial bents used in this country last year met these requirements.

Velvet Bent

Most of the velvet bent seed is produced in Rhode Island and nearby states. Velvet bent does not seed heavily, and the price is correspondingly high. Seed of velvet bent is very light in weight and it is difficult to remove chaff from it without considerable loss of good seed. For this reason the purity of the velvet bent seed on the market is not so high as that of the creeping and Colonial bent seeds. Indications are that velvet bent seed containing 80 percent pure live seed is of high quality, and 70 percent pure live seed is above average.

Red Fescue

Most of our red fescue, with the exception of Chewings, is imported from Europe. Red fescue containing 81 percent pure live seed and not over 0.2 percent weed seed is of high quality. Good quality red fescue contains about 75 percent pure live seed.

Chewings Fescue

Large quantities of Chewings fescue, a variety of red fescue, are imported each year from New Zealand. Due to poor shipping and storage conditions, this imported fescue is subject to loss in germinating power, as described in the February, 1940, issue. American production has recently been started on the west coast, and the chances of getting high germination are better with this seed than with imported seed. High grade Chewings fescue should test 99 percent pure and have a germination of 86 percent. Chewings fescue containing 70 percent pure live seed is above average. Chewings fescue seed deteriorates more rapidly than that of any other turf grass under improper storage conditions, and its germination should be carefully watched.

MINIMUM PERCENTAGES OF PURITY, GERMINATION, AND PURE LIVE SEED AND MAXIMUM PERCENTAGES OF WEED SEED TO BE EXPECTED IN HIGH QUALITY SEED OF THE MORE IMPORTANT TURF GRASSES, TOGETHER WITH THE APPROXIMATE NUMBER OF SEEDS IN A POUND OF EACH.

	Minimum purity	Minimum germination	Minimum pure live seed content (purity x germination)	Maximum weed seed	Approximate number of pure seed in a pound
Kentucky bluegrass	98	88	86	0.3	2,250,000
Trivialis bluegrass	98	88	86	0.3	2,500,000
Redtop	99	91	90	0.5	5,000,000
Colonial bent	99	91	90	0.2	8,000,000
Creeping bent	98	92	90	0.2	6,000,000
Velvet bent	94	85	80	0.4	10,000,000
Chewings fescue	99	86	85	0.2	600,000
Red fescue	95	85	81	0.2	600,000
Bermuda grass	99	91	90	0.2	1,750,000
Italian ryegrass	99	95	94	0.2	225,000
Perennial ryegrass	99	93	92	0.4	300,000
Crested wheatgrass	98	92	90	0.3	330,000

Bermuda Grass

Bermuda grass sets seed well only in arid regions, so most of our seed comes from Arizona and adjacent areas of California and New Mexico. Small quantities are imported from

Australia. The principal source of seed occurs as a byproduct of alfalfa (*Medicago sativa*). In arid regions alfalfa fields badly infested with Bermuda grass are allowed to produce seed, and when the alfalfa is cut the Bermuda grass is harvested and threshed at the same time. The two kinds of seed are separated in the threshing. High quality Bermuda grass seed should contain 90 percent pure live seed and good quality about 85 percent.

Ryegrass

Large quantities of Italian and perennial ryegrass are imported each year because of their extensive use as cover crops and in pasture work. American-grown ryegrass, 90 percent of which is grown in the Wilmette Valley, is of higher quality than the imported seed. Good Italian ryegrass should be over 99 percent pure, have 95 percent germination, and contain not over 0.2 percent weed seed. This is equivalent to 94 percent pure live seed. Perennial ryegrass apparently does not run quite so high in germinating capacity, so a pure live seed content of 92 percent may be considered high. Most of the Italian ryegrass on the market contains at least 90 percent pure live seed and 87 percent pure live seed is above average for perennial ryegrass.

Crested Wheatgrass

Crested wheatgrass is a cold and drought resistant grass of particular interest in the Northwest. It was used chiefly in pastures until the Fairway strain for lawns was developed. Some crested wheatgrass seed is produced in Oregon and Washington, but the bulk of it comes from Saskatchewan, Canada. High quality crested wheatgrass seed should contain at least 90 percent pure live seed and good quality about 85 percent.

Weed Seed Content

Grass seed varies widely in its content of weed seed. Annual bluegrass and carpet grass nearly always carry a large quantity of weed seed, while most bent seed is either harvested with few weed seed or is well cleaned before it is marketed.

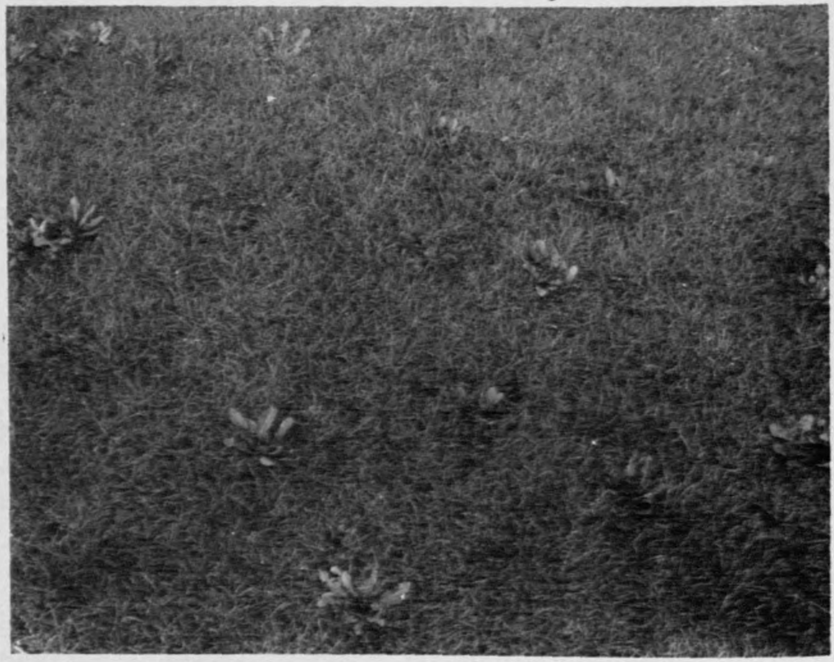
The kind of weed seed is more important to the turf culturist than the quantity. Many weeds, the seeds of which may be found in grass seed, need give the turf culturist little concern as the plants will not survive close mowing and the competition of good turf. Seeds of such weeds as lambsquarters (*Chenopodium album*) and pig-weed (*Amaranthus* sp.) may be present in grass seed but the plants will not survive the first season.

The labels required on seeds in most states must give the total weed seed content, the number and kind of seed of noxious weeds, and the quantity of "other crop seeds" present. These labels were designed primarily for the protection of the farmer, so the term "noxious weeds" refers to certain weeds which are particularly offensive on the farm in cultivated fields.

Some so-called noxious weeds are not dangerous in turf. Dodder (*Cuscuta* sp.), corncockle (*Agrostemma Githago*), horsenettle (*Solanum carolinense*), mustard (*Brassica* sp.), and others will not survive. On the other hand, such noxious weeds as plantains (*Plantago* sp.) and dandelions (*Taraxacum officinale*) may present serious problems in turf. Yarrow, not listed among noxious weeds in most states, may be very bad in turf.

Some crop seeds may be more undesirable than many weed seeds, including those designated as noxious in seed analyses. Seeds of certain grasses of value for hay may be most undesirable in turf seed. For example, timothy (*Phleum pratense*) seed is sometimes found in Kentucky bluegrass seed, but when this is used for some turf purposes the timothy may be more of a pest than many noxious weeds.

The quantities of weed seed allowable will depend on the use made of the grass seed. On putting greens only the very best



Sample of turf showing the abundance of weeds in a new area seeded with Colonial bent seed containing 0.1 percent hawkweed seed. The seed was sown at th rate of 3 pounds to 1,000 square feet. The distance between the hawkweed plants can be estimated from the fact that the plants themselves measured 3 to 4 inches in diameter. No plants of this weed appeared in the adjoining plots of turf where other seed had been used.

of grass seed should be used. Bent grass seed contains about 8 million seeds to the pound. Seeded at 3 pounds to 1,000 square feet, 24 thousand seeds will be placed on every square foot. If this seed contains only one-tenth of 1 percent of weed seed by weight and if these weed seeds are about the same size as bent seed, 24 weed seeds will have a chance to grow on every square foot. No exact statement is possible as to the weight of the weed seeds in bent grass but the illustration will serve to emphasize the point that one-tenth of 1 percent of weed seed is important in any lot of seed that is to be sown so heavily.

It is not possible for a buyer to judge the pure live seed content by casual examination, but the present state and federal labeling laws make it possible for him to avoid impure or poor seed. It is still possible that a sample with a high pure live seed content may contain undesirable weed seeds. The Federal Seed Act, which is reviewed in the February, 1940 issue, does not prohibit the sale of seed containing weed seeds. It provides that the total weed seed content must be stated, but when heavy seedings are to be made the kind of weed seed present may be of great importance. Where weeds may be particularly important it probably will be well worth while to have a special analysis of the seed made to determine the content of harmful turf weeds.

On many lawn, fairway, and park areas the weed content is less serious, chiefly because the soil nearly everywhere is filled with weed seeds and when such a turf is first laid down many weeds must be expected. The number that may be added by seeding a good grade of grass seed will not materially affect the situation. While weed seeds are of course undesirable, there seems to be no reason for undue alarm if a few weed seeds are present in the grass seed used in such places.

PRINCIPLES UNDERLYING FERTILIZATION OF TURF

JOHN W. BENGTSON AND GEORGE E. HARRINGTON *

A fertilizer may be defined as any material which is added to the soil to increase its productivity. In the early history of agriculture, long before anything was known of mineral elements, it was recognized that the waste products of animals and plants would perform this function. Even the early Greeks, Romans, and Chinese used animal and bird manure and wood ashes to enrich their soils. Today, these as well as the various ground meals prepared from bone, blood, cotton seed and many other natural sources are used to encourage plant growth.

FERTILIZER ELEMENTS

With an increasing knowledge of chemistry it has been learned that the essential mineral elements which the plants must obtain from the soil are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), boron (B) and possibly zinc (Zn) and copper (Cu). The first three of these, nitrogen, phosphorus and potassium, are used in the largest quantities by crops and are therefore removed most rapidly from the soil. They are consequently the elements which must be added in fertilizers, and are the only elements recognized in legislation covering the manufacture of fertilizers.

Nitrogen stimulates leaf development rather than seed production and when present in excess it may even delay flowering,

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Mining of phosphate rock by means of the hydraulic method in Polk County, Florida. Note jets of water coming in from the right.

fruiting and maturation processes. Phosphorus has a marked effect on root growth, stimulates flower, seed and fruit production and maturation processes. Potassium affects the plants indirectly in that its presence influences their general growth processes.

Calcium, the active ingredient of lime, is necessary for plant growth but most soils contain a sufficient amount of it for that purpose. Its primary function in the soil is to correct soil acidity or to improve the physical condition of the soil. It is, therefore, not considered in the trade as a fertilizer.

The remaining elements are known variously as minor, trace, or micro elements because, although essential for plant growth, they are not needed in large quantities. These elements are required in such small amounts that their presence and importance were overlooked for many years. In a large majority of fertilizing programs, however, these elements are not important because in most soils they are present in sufficient quantities to support a satisfactory growth of plants. Moreover, these elements are frequently present in common fertilizers either in chemical combination with the essential ingredients or as impurities accompanying the crude materials which are used in the fertilizers. Whether present as impurities or deliberately added to certain fertilizers, the percentage of these minor elements cannot be included in statements covering the grade of the fertilizer.

Availability of Plant Food

Although all of the essential elements may be present in the soil in quantities sufficient to support growth, they may not be present in a form which plants can use. Such materials as sulfate of ammonia are quickly soluble in water and the nutrients which they carry are therefore readily available for use by plants. Other fertilizer materials such as bonemeal must first be broken down by soil organisms and converted into soluble salts after which the nutrients become available to the plants. The elements contained in such materials are considered slowly available. Still other materials such as the phosphates are soluble, but when they are introduced into the soil part of them may immediately react with the salts of calcium, magnesium, iron or aluminum to form relatively insoluble salts and therefore become more slowly available or even unavailable to plants. In some states fertilizer labels distinguish between the quickly available nitrogen (water-soluble) and that which is more slowly available (water-insoluble). Likewise "available phosphate" is distinguished from the "total phosphate."

Organic and Inorganic Fertilizer Materials

In adding plant food to the soil, the nitrogen, phosphorus and potassium are the elements which are primarily to be considered. These may be added in the organic or inorganic forms.

Organic materials are substances derived from living matter such as cottonseed meal, dried blood, bonemeal, activated sludge and manures. A large part of the ingredients added in the form of these natural organic materials are slowly available to plants because nutrients must be released by bacterial decomposition in the soil and converted into soluble salts before they can be used. In some instances organic compounds may be manufactured, as for example, urea which contains 46 percent of nitrogen. It behaves, however, much more like an inorganic compound than like the natural organics in that it is soluble and its nitrogen is readily available to plants.

The inorganic sources of fertilizer ingredients are for the most part of mineral origin. Inorganic compounds are prepared commercially from natural mineral deposits and as byproducts of gas and coke plants and other industries. These contain nitrogen, phosphorus and potassium in forms readily available for use by plants. Since they are usually readily soluble some tend to leach out of the soil unless plants are present to absorb them. Others combine chemically with compounds already present in the soil. When organic fertilizers have been subjected to the processes of decay so that the organic nitrogen has been made available it is just as accessible to plants and is leached out as readily as the inorganic.

Repeated Use of Nutrient Elements

In most virgin soils the elements are present in sufficient quantities to support vegetation, since those which are absorbed from the soil are returned to it by the decay of plant and animal refuse. In the process of growth, plants remove nitrogen, phosphorus, potassium and other elements from the soil. Within the plants, these elements are used in the building up of proteins and other organic compounds of which living tissues are composed. The plants may be eaten by animals, in which case the elements remain in the complex organic state within the animal body. Eventually, either in plant or animal refuse, these organic compounds containing the nitrogen, phosphorus and potassium which were used by the plants are returned to the soil. Living plants are unable, however, to utilize the elements as they occur in these complex and insoluble compounds. The decay producing micro-organisms which are universally distributed in the soil attack the plant and animal refuse and break down the tissues and the compounds which they contain into soluble salts. In this form the nutrients can be absorbed again and used in growth processes of plants.

The nitrogen-fixing bacteria which live in the nodules on roots of legumes such as alfalfa, vetch and clover furnish another natural source of available nitrogen. They are capable of using the elemental nitrogen present in the air spaces in the soil and converting it into nitrates which can be used by plants.

Mining of phosphate rock with dragline in Polk County, Florida.

When nature is left alone soils tend to remain fertile, but when crops are removed annually those elements which are utilized in plant growth are withdrawn from the soil. To be available to plants, the materials must be soluble in water to some extent. Because they are soluble they are washed from the soil by the rains. In view of the fact that 90 per cent or more of most soils is composed of inorganic material arising from the slow disintegration of the rocks of the earth's surface there remains a reserve supply of minerals in the soil which continues to become available slowly.

FERTILIZER REQUIREMENTS OF CROPS

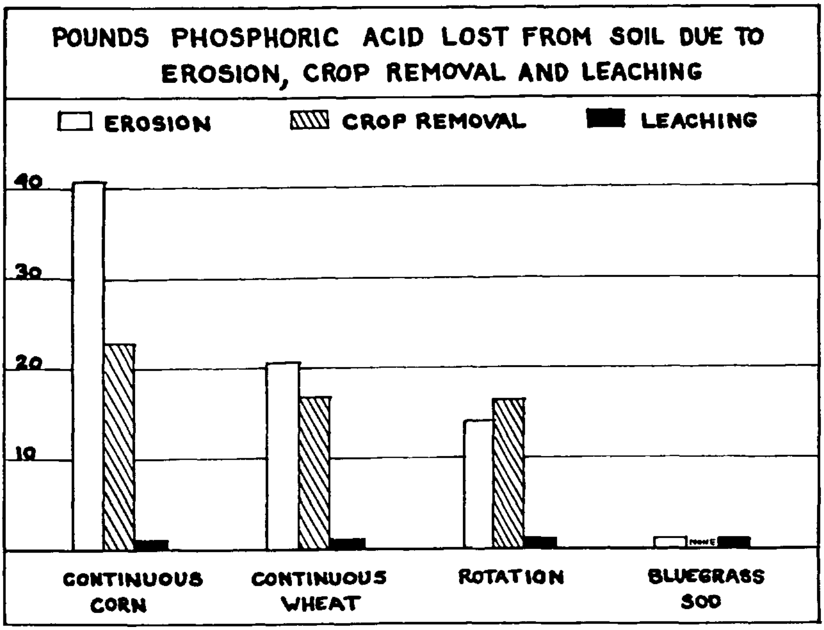
The function of fertilizers is to add to the soil elements in which it is naturally deficient and to assist in the replacing of those elements which are removed from the soil by crops and leaching. In most crops minerals are needed which will encourage the development of stalk, flower, fruit and seed. In most farm and truck crops, maturation of the crop is of primary importance. For these purposes phosphorus is particularly important, although potassium is used in smaller quantities and some nitrogen is needed to encourage a good vegetative growth. Since an excess of nitrogen may delay the maturation processes it is not usually added in large amounts. Most farm fertilizers, therefore, are relatively low in nitrogen.

FERTILIZER REQUIREMENTS OF TURF

In turf, on the other hand, the elements which are needed are those which will encourage a vigorous production of healthy leaves. At the same time it is desirable to discourage flower and seed production and delay the maturation processes. Fertilizers for grass, therefore, include large amounts of nitrogen and less phosphorus and potassium.

In turf, the removal of nutrient elements from the soil by erosion, crops, and leaching is much less than it is from soil planted to field crops. Figures are available from the Missouri Agricultural Experiment Station showing that only 0.2 pound of phosphorus per acre was lost annually by erosion from land planted to bluegrass, whereas 90 times as much was lost from land of the same soil type on which corn was grown continuously. Even land which was under the corn, wheat, clover rotation lost 31 times as much phosphorus as did that which was under bluegrass continuously.

On fairways and lawns where the grass clippings are per-



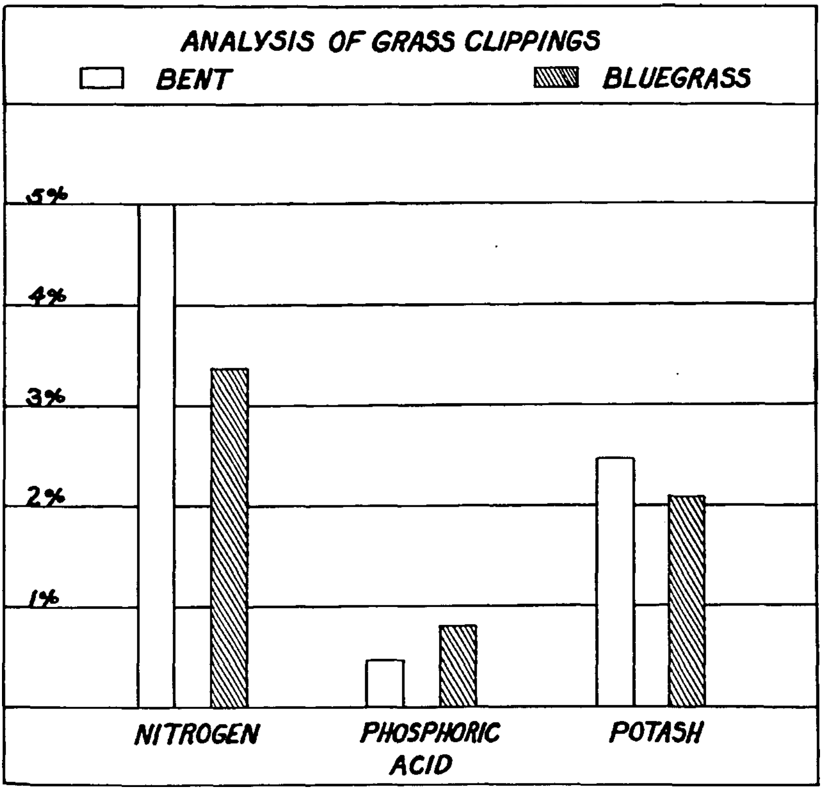
Note the great amount of phosphoric acid lost by erosion and crop removal when land is under cultivation as compared with that lost from land used for turf. The amount lost by leaching is the same regardless of the crop grown.

mitted to fall on the turf the mineral elements which are removed from the soil in the process of growth are returned to the soil so that there is practically no permanent loss of phosphorus from the soil as there is by field crops or in pastures. A normal corn crop will remove nearly 25 pounds of phosphoric acid per acre per year, whereas bluegrass turf to which clippings are returned will remove none. From calculations on losses by erosion and farm crops it is seen that about

70 pounds of phosphoric acid are removed per acre annually when such a corn crop is grown and 350 pounds of superphosphate would have to be supplied to maintain the soil fertility. On the other hand, when this land is in turf, losses from these two causes do not occur and the addition of large amounts of phosphoric acid to correct for these two losses is not necessary. On bluegrass turf, therefore, the amount of phosphoric acid and potash which must be added to replace the nutrient elements lost by erosion, crop removal, and leaching is much less than that which must be applied for the same purpose to land which has been planted to field crops. Results from fertilizer trials on field crops, therefore, should not be used for making recommendations for the fertilization of turf.

On putting greens and bent lawns from which clippings are removed, however, large amounts of the mineral elements are removed in the clippings and fertilizers must therefore be applied at higher rates than is necessary for turf to which the clippings are returned. Figures have been obtained for the amounts of mineral elements removed annually from bent grass in the clippings from some of the well-kept plots at the Arlington Turf Garden. The results obtained from these determinations at Arlington indicate that some 2 tons of field dry material containing a total of approximately 200 pounds of nitrogen, 20 pounds of phosphoric acid, and 100 pounds of potash may be removed annually from each acre of turf. When clippings must be removed, it is advisable to use them in the compost pile or to scatter them on poor turf so that the plant food they contain may be returned to the soil.

An analysis of bluegrass clippings shows that about 4 times as much nitrogen as phosphoric acid is removed. The return of the clippings replaces practically all of the phosphorus but some of the nitrogen is lost. Therefore to replace the nutrients that the grass is actually removing from the soil a fertilizer



This chart shows the relative amounts of these nutrients that are present in the clippings of bent and bluegrass. Note that in both grasses the quantity of nitrogen is many times that of phosphoric acid.

supplying a larger quantity of nitrogen than phosphoric acid is needed.

As a result of considering both the demands of the crop and the quantity of nutrient elements lost by erosion and by crop removal, therefore, it is evident that the problem of fertilizing turf is quite different from that of fertilizing agricultural crops.

Naturally Occurring Fertilizers

The compounds which are used to furnish the fertilizer elements to soil vary in their nature and origin. Naturally the ones which were used earliest were those originating as waste products of animals and plants.

The first organic fertilizers to be used were the natural manures. More recently, however, many different finely ground products have been prepared from naturally occurring organic materials such as bone, dried blood, sewage, cottonseed, soybean, and others.

The first inorganic fertilizer was wood ash, which has been used to increase the fertility of the soil as far back in antiquity as human records go. Although of plant origin, wood ash is really an inorganic fertilizer, since in obtaining the ash the organic material is driven off by heat leaving only the mineral salts. About 1840 the possibility of using naturally occurring crude mineral salts as fertilizers was given an impetus by Lawes and Gilbert, who at that time established the Rothamsted Experimental Station in England. They demonstrated the benefits to be derived from the use of crude nitrate of soda, mineral phosphates and potash salts as fertilizers.

This use of the naturally occurring crude salts led to the development of methods of manufacturing organic as well as inorganic compounds which would act as carriers for the three principal fertilizer elements. The characteristic which all of these manufactured compounds have in common is that they are water soluble and that the nutrients which they carry are, therefore, readily available for use by plants.

Mixed Fertilizers

While in some instances the application of only one of these plant nutrients is necessary, in many cases two or three are needed at the same time. In such cases it is cheaper to mix compounds containing the desired elements and apply the mixture rather than to apply each separately. These mixtures are termed mixed fertilizers and when they contain all three of the principal elements in appreciable amounts they are called complete fertilizers. It is possible in preparing these fertilizers to get mixtures containing the three elements in almost any desired proportion.

The need for mixed fertilizers has become so universal in this country that they are prepared commercially and sold in large quantities. In 1934 the total tonnage of fertilizer sold in 1,053 different mixtures was 3,227,000. Of these mixtures 175 were sold in quantities exceeding 1,000 tons a year. Some fertilizers are also put out under trade or brand names. These trade names may or may not be significant to the user. Although these names may sound attractive many are meaningless and the best of them usually add to the cost of the fertilizer because of the sales value of the name.

Use of Waste Products

Certain waste products from industrial plants may often be used to advantage as fertilizers. As turfed areas are frequently located near such industrial plants the cost of transporting these waste products is small and when they can be secured at low cost their use may be advantageous. Even though they are low-grade fertilizers and their supply is too limited for them to be considered as agricultural fertilizers, it may nevertheless be well worth while to consider them for the purpose of fertilizing nearby turfed areas. Some of these materials may be used to advantage in compost piles or in soil beds for the preparation of top dressing material or in preparing the soil for seeding. Not only do they add plant nutrients but many of them supply large quantities of organic material to improve the physical condition of the soil.

This group of materials includes waste from silk, wool and cotton factories; tea and coffee grounds; cocoa-shell dust; brewers' grain; peanut shells; bagasse from sugar refineries and many others. In some of these instances the fertilizer value is surprisingly high. For instance, waste from felt-hat factories has been found to contain 14 percent of nitrogen. Hair and feather waste may contain anywhere from 8 to 16 percent of nitrogen. Shoddy and felt waste may contain from 4 to 12 percent of nitrogen. Sweepings from powder mills have been found to contain as much as 10 percent of nitrogen and nearly 35 percent of potash. Local supplies of sewage sludge and ground garbage tankage are often used to good advantage on turf.

As a result of cooperative efforts of agricultural scientists and men in the fertilizer industry, the number of grades of fertilizer on the market was reduced from approximately 1,300 grades in 1934 to slightly less than 1,000 in 1939. Important economies would result from further reduction in the number of grades.

BUYING FERTILIZERS FOR TURF

GORDON H. JONES *

Thousands of tons of fertilizers are applied annually to turf in the United States. Some turf culturists are familiar with the needs of turf and with the relative value of fertilizers. Many, however, have but vague notions of what to apply and how to buy advantageously, and are confused by the large number of grades of fertilizers on the market. Salesmen urge the use of certain brands said to be complete foods for grass. These may be good fertilizers but the prices often charged are not warranted by the value of the contents. The buyer usually pays well for a widely advertised name, whereas he may often buy at a great saving the equivalent amount of plant food in a standard grade of fertilizer without a fancy name.

Many of those who use fertilizers on turf do not understand the terms used in the trade. Consequently, they are likely to be confused by any discussion of fertilizers and easily deceived by statements concerning them. Although there are many complicated technical phases of fertilizers and their most effective utilization, the subject as it need concern the buyer for turf purposes is by no means as complicated and awe-inspiring as it is sometimes presented.

It is the purpose of this discussion to present the subject of selecting and buying fertilizers in as simple terms as possible in order that those who are responsible for the spending of the usually inadequate funds for turf fertilizers may use those funds to the best advantage. Throughout this discussion it is assumed that the principles of fertilizing turf as discussed

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in the article by Bengtson and Harrington on pages 142 to 154 of this issue are understood by the reader.

Analysis, Grade and Formula

In the trade, the amount of nitrogen present in mixed fertilizers is expressed in terms of percentage of elemental nitrogen (N), that of phosphorus in terms of percentage of phosphoric acid (P_2O_5) and that of potassium as percentage of potash (K_2O). The percentage composition of each mixture of fertilizer is determined by chemically analyzing the product. To protect the consumer, laws in 47 out of the 48 states provide that every bag of fertilizer must be marked with a statement which shows the minimum percentage of each of the principal nutrients contained in the bag. These percentages are now always given in the order: nitrogen, phosphoric acid and potash. This minimum analysis is known in the trade as the grade of the fertilizer. The actual analysis may show a higher percentage of the nutrients than that guaranteed on the bag.

A grade of 6-6-5, for instance contains not less than 6 percent nitrogen, 6 percent phosphoric acid and 5 percent potash. A 6-0-5 grade contains at least 6 percent nitrogen and 5 percent potash but no phosphoric acid, whereas a 6-6-0 grade contains 6 percent nitrogen and 6 percent phosphoric acid but no potash.

It is important that the buyer of fertilizers for turf understands the meaning of the grade and looks for it on the bags of each lot of fertilizer purchased. The grade not only helps him to calculate the quantity to be used but also enables him to figure the relative money value to him of different mixed fertilizers.

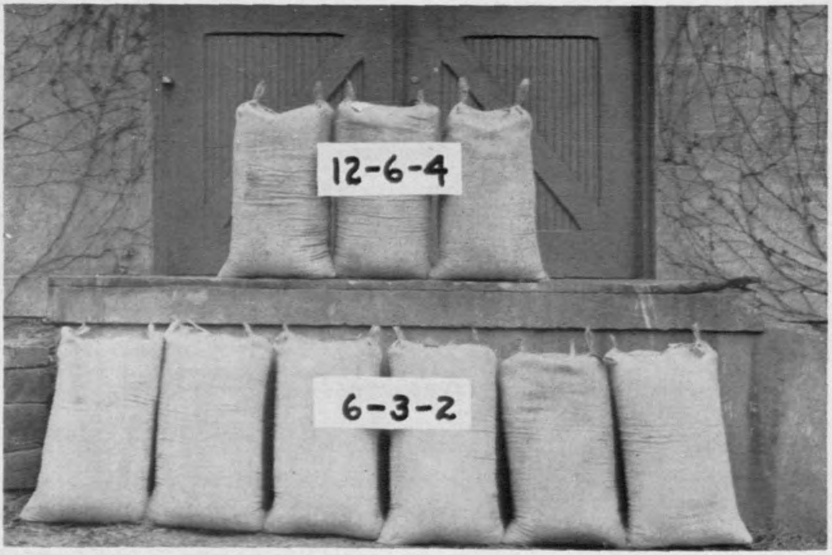
Mixed fertilizers are rated as high and low grade according to the number of units of plant food in the mixture. One percent of plant food in a ton of fertilizer is known as one unit. A 6-6-5 fertilizer contains 6 units of nitrogen, 6 of phosphoric acid and 5 of potash, or a total of 17 units. In general a fertilizer containing about 20 or more units of plant food is considered a high grade fertilizer.

The analysis on the bag gives the minimum percentage of each of the plant nutrients but it does not furnish information regarding the materials (carriers) which are used to carry these nutrients. This information is given in the formula which may or may not appear upon the bag. The formula gives the number of pounds of each carrier which has been used in making up the fertilizer.

Fertilizers for Turf

As described in articles in the December, 1939, issue of TURF CULTURE a 6-12-4 fertilizer has given about the same results as a 12-6-4 when the two were applied at rates giving the same quantities of nitrogen to each unit area. The same amount of nitrogen was applied with one-half as much of the 12-6-4 as the 6-12-4 fertilizer. While a 12-6-4 was used in the experiments a 6-3-2 might have been used. To simplify the comparison of these two fertilizers therefore, they may be considered in terms of the two grades 6-12-4 and 6-3-2. Both contain equal quantities of nitrogen but the 6-12-4 contains four times as much phosphoric acid and two times as much potash as the 6-3-2. Naturally a ton of 6-3-2 is exactly equivalent to one-half ton of a 12-6-4. The fact that the effect on the turf was about the same whether a 6-3-2 (12-6-4) or a 6-12-4 fertilizer was used indicated that at least on these soils small amounts of phosphoric acid and potash were as effective as large amounts.

Similar results might have been expected from the use of a 10-6-4, a 6-6-5 or many other grades commonly carried in



The three bags of 12-6-4, a high grade fertilizer, furnish as much plant food as the six bags of the low grade fertilizer, 6-3-2.

stock by fertilizer dealers had they been applied so as to give equivalent quantities of nitrogen.

These and numerous other experiments indicate that a mixed fertilizer for turf purposes should be high in nitrogen, need not contain more than one-half as much phosphoric acid as nitrogen and requires only a small percentage of potash. In many cases a fertilizer with no potash at all gives equally satisfactory results.

The user of mixed fertilizers in large lots will do well to study both analysis and price so as to determine the grade that will give the desired results at the lowest cost. The price of standard mixtures is largely determined by the nature of the carriers which were used for the different elements. Organic materials are usually more expensive than the inorganic. It has been calculated, for instance, that at present the cost of nitrogen in sulfate of ammonia is less than half that in the natural organic materials. This means that a mixed fertilizer in which the nitrogen comes from sulfate of ammonia should cost less than one in which the nitrogen comes from tankage, cottonseed meal, or some other natural organic material. The tendency of the fertilizer trade has been in the direction of greater economy. In 1910 statistics showed that 55 percent of the nitrogen in mixed fertilizers came from natural organics, while in 1936 only 15 percent came from these sources.

Cost of Fertilizers

Another factor which affects the cost of mixed commercial fertilizer is the labor involved in mixing the ingredients. The smaller the amount of mixture which is prepared, the greater is the proportionate expense of the mixing, since it costs little more to mix a large quantity than a small quantity. A specially prepared mixture may therefore cost more for each unit of plant food than a standard grade. If a standard grade high in nitrogen is available locally it will probably be more economical to use it than to have a special grade made. Unfortunately most of the standard grades offered are prepared for use with farm crops and are relatively too high in phosphoric acid and potash and too low in nitrogen for economic use on sports turf. For park areas and for many lawns where some white clover is not objectionable it may be depended upon for a part of the nitrogen and a fertilizer lower in nitrogen than that which is most satisfactory for sports turf may be used.

The actual cost of the ingredients for each unit of nitrogen, phosphoric acid and potash may be calculated. For example, in 1938, the prices per unit of plant food in the New York district were the following:

Nitrogen	$1.90 a unit
Available phosphoric acid	.70 a unit
Potash	.60 a unit

Such prices vary from year to year and place to place and therefore the actual values of these figures are of little use. Nevertheless the cost of nitrogen as compared with that of phosphoric acid and potash remains more or less constant and these relative costs are demonstrated in the figures cited. From these figures it can be seen that nitrogen is the expensive part of a fertilizer and that any mixture which is high in nitrogen will generally be more expensive than one low in nitrogen.

For example, two grades with which the Green Section has been experimenting, 12-6-4 and 6-12-4, each have 22 units of plant food. The first has 12 units of nitrogen, 6 of phosphoric acid and 4 of potash. Calculated on the basis of the 1938 cost figures given above for the New York district, the ingredients in a ton of this mixture would cost $29.40 as compared with $22.20, the cost of the ingredients in a ton of the 6-12-4 mixture.

In this latter mixture there is only half as much nitrogen. To apply 12 units of nitrogen it is necessary to use 2 tons of the 6-12-4 grade at a total cost of $44.40 as compared with 1 ton of the 12-6-4 grade at a cost of $29.40.

Figuring Comparative Costs

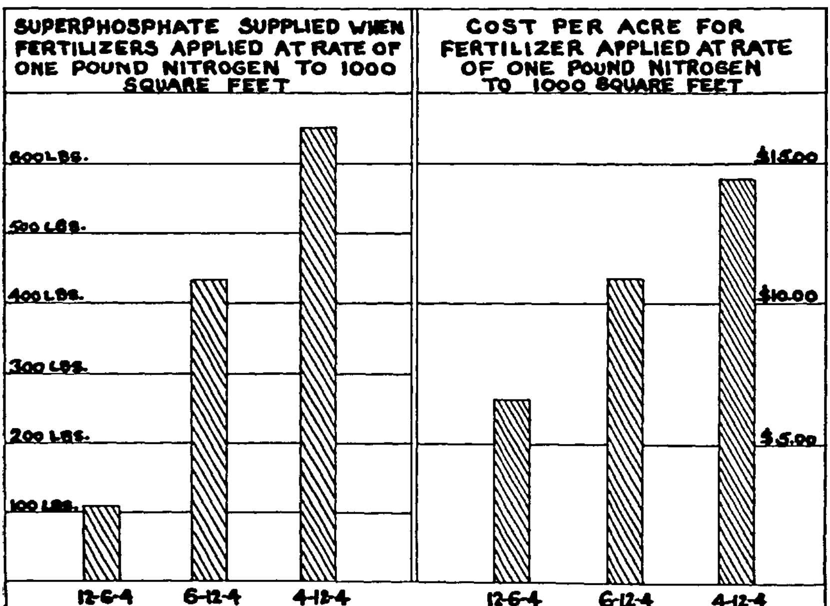
Perhaps the most satisfactory basis for comparing the cost of fertilizing turf with several different fertilizers is the cost per acre of applying nitrogen at the rate of 1 pound to 1,000 square feet. This should include not only the cost of the fertilizer itself but also the labor of distribution and the losses involved in the process of distribution due to the physical condition of the product.

To illustrate the comparison in cost of fertilizers to apply nitrogen at the above-mentioned rate, the two fertilizers 10-6-4 and 4-12-4 may be used. These are both standard grades offered in 1941. The prices of the grades vary with the locality but for purposes of comparison the lowest price of each grade delivered in the Washington area is used. The 10-6-4 sells for $33.22 a ton; the 4-12-4 for $26.87. To apply fertilizer to an acre at the rate of 1 pound of nitrogen to 1,000 square feet would require 435 pounds of the 10-6-4 and 1088 pounds of the 4-12-4. At these prices and rates of application the 10-6-4 will cost $7.29 an acre and the 4-12-4 will cost $14.58.

Moreover, everything else being equal, it would cost more to distribute the 1088 pounds of 4-12-4 than the 435 pounds of 10-6-4. In considering the costs of distribution the physical properties of the product should not be overlooked. A product which is lumpy cannot be distributed uniformly or efficiently and when handled in a distributor may cause mechanical difficulties, and dry powdered products when applied on windy days may be blown into areas where no fertilizer is required.

A similar comparison can be made between any two fertilizers. When differences in the percentages of nitrogen are pronounced, as in this case, the differences in cost for a unit area are more striking.

Generally speaking the high grade fertilizers which are high in nitrogen are the most economical to use. Freight charges, mixing and distributing costs as well as other expenses incidental to the use of fertilizers are just as great for a fertilizer containing a low percentage of plant food as for one with a high plant food content. Therefore, although the original cost of the ingredients in a high-grade fertilizer may be higher than



for a low grade, the later handling costs may make it advantageous to use the higher grade. This is recognized by the trade which is now encouraging more and more the use of high-grade fertilizers. Many of the higher grades tend to burn foliage when they come in direct contact with it. In ordinary agricultural practice this objection is not serious, since the fertilizer is usually applied to the soil before planting. On turf the fertilizer comes in direct contact with the leaves and the danger of burning must be recognized. Extra care must, therefore, be exercised in applying high grade fertilizers to turf.

HOME-MIXING OF FERTILIZERS

There are conditions under which it is advantageous for the consumer to mix his own fertilizer. This is particularly true when facilities for mixing the ingredients are at hand or when help is available which is not being used for other purposes. One of the chief advantages in the home-mixing of fertilizers is that any desired formula can be prepared. The expense of labor is no greater in mixing a fertilizer high in nitrogen than one low in nitrogen.

In calculating the cost of mixing any particular fertilizer at home, several items must be considered in addition to the cost of the ingredients. These include the labor of mixing, the filler when needed, in some cases a conditioner to prevent the mixture from caking, and bags if the fertilizer is to be stored.

The cost of the ingredients for mixing the 12-6-4 inorganic fertilizer according to formula A on page 165 has been calculated from prices in the Washington area in February, 1941. These figures are given only as an illustration since prices in other localities and at other seasons may be more or less. The price of sulfate of ammonia delivered is about $41.25 a ton; that of superphosphate $17.50 and that of muriate of potash, $36.00. Using these costs and the figures for formula A in the first column of the table on page 165 it will be found that the cost of the ingredients to mix 1 ton of 12-6-4 fertilizer is $32.39. This does not include the cost of the 67 pounds of filler, bags or cost of mixing. The price of a 12-6-4 fertilizer in the Washington market by those dealers who keep it in stock is about $37.50 a ton. The difference between this price and the cost of the ingredients is approximately $5.00 a ton, out of which must come the cost of labor, bags, and filler.

Whether home-mixing will pay must be left to individual judgment. Where a special grade is wanted and is not available locally it may pay to buy the materials and mix the desired grade at home. Much will depend on how large an extra charge the manufacturer will make for a special mixture of a few tons. In some cases such extra cost may be absorbed by the manufacturer; in other cases it may be enough to warrant home-mixing.

The important fact to be borne in mind is that a fertilizer high in nitrogen will require fewer pounds to apply a specified quantity of nitrogen to a given area of turf than one low in nitrogen. If, therefore, the grade available is low in nitrogen it may be profitable to make up or to have made up a grade high in nitrogen even at a considerably higher price a ton. When soils are known to be decidedly deficient in phosphorus or potash the above principle naturally must be modified until such time as these deficiencies are corrected.

The mixing itself is a comparatively simple matter. The materials weighed out should be spread in layers usually the most bulky first and then thoroughly mixed. This may be accomplished by a mechanical mixer or simply by shoveling over and over again. The mixture should then be screened so as to remove any lumps which remain, bagged and set aside. Where permanent employees must be kept busy, mixing fertilizers is a good job for days when outside work cannot be done. In that case all the labor expense of mixing is really saved.

Suggested Formulas

For the benefit of those who are interested in mixing their own fertilizers, several different formulas are suggested for the

Formula A. 12-6-4 Inorganic Fertilizer

Carrier	Total Pounds	Ingredients in Pounds N	P_2O_5	K_2O
Sulfate of ammonia (20% N)	1,200	240		
Superphosphate (20% P_2O_5)	600		120	
Muriate of potash (60% K_2O)	133			80
Filler	67			
Total	2,000	240	120	80

preparation of a 12-6-4 mixture. In experimental work at the Arlington Turf Garden and elsewhere fertilizers made up to this analysis have given satisfactory results with turf over a period of some 10 years or more. The essential difference between the three formulas is in the source of the nitrogen. Formula A is composed entirely of inorganic salts with some filler such as sand, or ground peat. Formula B derives about 20 percent of its nitrogen from activated sludge (Milorganite) the use of which obviates the necessity of using any filler. In Formula C several different organic sources of nitrogen and phosphorus are used. In this latter formula the nitrogen from activated sludge and from bonemeal is slowly available whereas that from urea is quickly available. Cottonseed meal, castor bean pomace or similar materials can be substituted for the activated sludge in Formulas B and C.

FORMULA B. 12-6-4 ORGANIC AND INORGANIC

Carrier	Total Pounds	Ingredients in Pounds N	P_2O_5	K_2O
Activated sludge (6% N + 2% P_2O_5)	825	50	16.5	
Sulfate of ammonia (20% N)	825	165		
Ammophos (11% N + 48% P_2O_5)	215	24	103.	
Muriate of potash (60% K_2O)	135			81
Total	2,000	239	119.5	81

FORMULA C. 12-6-4 ORGANIC FERTILIZER

Carrier	Total Pounds	Ingredients in Pounds N	P_2O_5	K_2O
Activated sludge (6% N + 2% P_2O_5)	1,080	65	22	
Steamed bone (2% N + 23% P_2O_5)	430	9	99	
Urea (46% N)	360	166		
Muriate of potash (60% K_2O)	130			78
Total	2,000	240	121	78

A mixture prepared according to Formula A should not stand long for it may cake.

METHOD OF CALCULATING OTHER FORMULAS

The above formulas are planned to give a fertilizer with an approximate analysis of 12-6-4. A formula for any desired fertilizer can be calculated by referring to a list of carriers and the quantities of each which must be used in a ton of fertilizer to give 1 percent of the nutrient concerned. Such a table is given on page 167. It will be noticed that some materials carry only nitrogen and some only phosphoric acid, whereas others contain appreciable quantities of both, and perhaps potash, as well.

In preparing mixed fertilizers from organic sources of nitrogen it should be remembered that the percentage of nitrogen and phosphoric acid in these materials is not uniform. Cottonseed meal may vary in nitrogen content from 3 to 7 percent, dried blood from 8 to 14 percent. When cottonseed meal is used as a source of nitrogen, every 672 pounds in a ton of ferti-

QUANTITIES OF FERTILIZER INGREDIENTS EXPRESSED IN POUNDS TO BE USED TO GIVE DEFINITE PERCENTAGES OF NUTRIENTS IN A TON OF MIXTURE

Ingredient	1%	4%	6%	10%	12%
Carriers of Nitrogen (N)					
Nitrate of soda (15% N)	133	532	800	1,333	1,599
Sulfate of ammonia (20% N)	100	400	600	1,000	1,200
*Ammonium phosphate (11% N)	185	740	1,110	1,850	....
*Cottonseed meal (6% N)	333	1,333	2,000	....	....
*Raw ground bone (5% N)	400	1,600	....	....	....
*Steamed bone (2% N)	1,000	...	....	....	....
Dried blood (10% N)	200	800	1,200	2,000	....
*Activated sludge (6% N)	333	1,333	2,000	....	....
Urea (46% N)	435	174	261	435	522
Carriers of phosphoric acid (P_2O_5)					
Superphosphate (20% P_2O_5)	100	400	600	1,000	1,200
*Cottonseed meal (3% P_2O_5)	672	..	...	....	....
*Raw ground bone (23% P_2O_5)	87	348	522	869	1,043
*Steamed bone (23% P_2O_5)	87	348	522	869	1,043
*Activated sludge (2% P_2O_5)	1,000	...	...	...	....
*Ammonium phosphate (48% P_2O_5)	42	168	252	420	504
Carriers of potash (K_2O)					
Sulfate of potash (50% K_2O)	40	160	240	400	480
Muriate of potash (60% K_2O)	33	132	198	330	396

*Carries both nitrogen and phosphoric acid.

lizer will add approximately 1 unit or 20 pounds of phosphoric acid. When bonemeal is used as a source of phosphoric acid a certain amount of nitrogen is also included. In raw bonemeal this may run as high as 6 percent. When bonemeal is used as a source of phosphoric acid, every 400 pounds in a ton of fertilizer may add a little more than 1 unit of nitrogen.

What Not to Mix

Certain substances which it may be desired to use on turf should not be mixed. The most striking case is that of hydrated or burnt lime and sulfate of ammonia. In the presence of water this mixture will cause a violent evolution of ammonia gas very toxic to grass.

When ground limestone is mixed with sulfate of ammonia, stable manure, cottonseed meal, bonemeal or activated sludge, small amounts of ammonia are gradually released, but not in sufficient quantity to be toxic to the grass. The chief danger in mixing these materials is the loss of fertility due to the gradual escape of nitrogen in the form of ammonia from the soil solution into the atmosphere. Dolomitic limestone, which is a calcium-magnesium limestone, can be used safely in mixed fertilizers to the extent of 200 or 300 pounds to the ton.

When lime, especially burnt or hydrated lime, is mixed with superphosphate the reaction causes a part of the phosphate to go into an insoluble form and reduces the value of the fertilizer. Lime mixed with bonemeal may cause a gradual loss of ammonia, as well as change a part of the phosphate into an insoluble form.

Calcium cyanamid mixed with superphosphate may give rise to toxic cyanide compounds. In fact, calcium cyanamid should always be applied alone and should never be mixed with any other fertilizer materials.

When it is desired to apply lime as well as the fertilizers mentioned they should be put on separately and a week or two should elapse before the second substance is applied.

A COMPARISON OF BENT TURF FROM SELF- AND OPEN-POLLINATED SEED AND FROM STOLONS †

J. A. DeFrance *

An experiment to compare turf from self-pollinated and open-pollinated seed was begun in 1928 at the Rhode Island Agricultural Experiment Station. Adjacent to this experiment were plots of turf planted with stolons, which afforded an opportunity to make a comparison of the results from the two methods of planting.

Description of Experiment

The following five different strains of bent grasses were used in the test: Piper, Kernwood, and Highland velvet bents, and Washington and Virginia creeping bents.

Special plants of the five strains were selected in the grass nursery for self-pollination purposes. Certain selected heads of the grasses were covered with tight paper bags in order to avoid cross-pollination. The self-fertilized seed was planted in flats in the greenhouse and 10 different plants were selected from a single fertilized head of each of the strains. These were planted in the nursery in order to produce sufficient stolons for later use. The open-pollinated seed was secured from seed-producing areas of the different strains.

The next step was to plant the open-pollinated seed and

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† Contribution No. 575 of the Station.

stolons of the self-pollinated material of the same strain in putting green plots. The area covered by each strain was 20 by 20 feet. The east halves were seeded with open-pollinated seed; the west halves were divided into ten 2-foot strips 10 feet long, and each strip was planted with stolons that were developed from a single seed which had resulted from self-fertilization. This arrangement of planting was followed in order to make comparisons of the plants from self-fertilized heads with the original open-pollinated type. The plots were topdressed, fertilized, mowed, and maintained at as near to putting green conditions as possible.

The plots were compared on the basis of factors affecting quality as follows; a rating of 1 being poor and 5 excellent in each case.

Vigor—Rapidity of upright growth.

Color—Darkness of green. A light green does not rate as high as a rich dark green.

Texture—Fineness of the leaf blades.

Density—Amount of crowding together of the leaves.

Uniformity—General appearance with regard to all quality factors but especially color.

Invasion—Percentage of bent grass other than the kind planted. This indicates bent grass invasion, either from the dropping of clippings or from the aggressive turf on an adjacent plot.

Notes on the factor of color were taken monthly from April to October. Vigor, texture and density were noted during April, June, August, and October. In the tables the quality averages based on the scale of 1 to 5, for the season, were multiplied by 20 in order to express the ratings in percentage. The ratings are made on a basis of comparison with other putting green plots of Colonial and creeping bents.

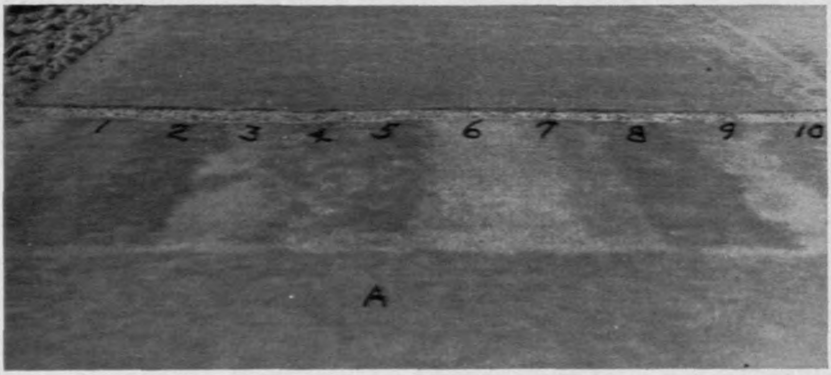
Method of procedure and execution of the experiment was the same with the various velvet and creeping bents and results were much the same. However, instead of giving data for all five grasses used, Piper velvet only will be discussed as it has been rated as producing the best putting green turf at the Rhode Island Experiment Station based on a comparison with other popular bent grasses over a period of several years.

Results and Discussion

The table on page 174 shows the quality relationship of 10 plants developed from seed of one selected self-fertilized head as compared with turf from seed of open-pollinated heads. The latter turf will be designated hereafter as the type. Regarding color, there was quite a wide range of variation. As can be noted in the photograph on page 172, plants numbers 1, 2, 5, and 8 were darker green than the type form; number 10 was on a par with the type form; while numbers 3, 4, 6, 7, and 9 were lighter green.

Turf from plant number 1 was practically as dense as the type, was of very fine texture, very uniform, and not subject to invasion. Turf from plant number 3 was comparatively low in density, coarse in texture, and very subject to invasion although a rapid grower. Number 3, being low in density, was thus subject to invasion in spite of high vigor. On the other hand, numbers 1, 2, 8, and 10 had lower vigor than number 3 but their density was greater and therefore they were not so subject to invasion. Number 9, with low density, low vigor, and comparatively coarse texture, had the highest amount of invasion.

With reference to vigor, in general, the turf from the individual plants was quite similar to the type, with the exception of plant 8 which was the slowest upright grower. A rapidly growing vigorous turf alone without good density will not hold off invasion. A good putting green turf cannot be judged by vigor alone, but density, texture, and color must



Comparison of turf from open- and self-pollinated seed of Piper velvet bent. Plot A, turf from open-pollinated seed. Plots 1-10, strips of turf producd from 10 selected plants grown from self-pollinated seed of a single head of Piper velvet bent and planted vegetatively here.

also be considered. The fastest growing grass may not necessarily produce the best turf for putting greens.

The lateral growth of number 6 is very rapid, as is evident in the photograph by its encroachment on the adjacent turf of plant number 7 to such an extent that only one-half of 7 remains evident. Invasion in the case of number 7 was due to its close proximity to number 6, which was very aggressive with regard to creeping qualities but was not a vigorous turf as measured by rate of upright growth. This adjacent invasion is different from the interior invasion that is due to the dropping of clippings of different plants and their subsequent rooting and intermingling with the local turf. In general, the plants that produced the most open or least dense turf were quite subject to invasion of other grasses, as can be noted in numbers 3 and 9 in the table and also in the photograph. Plants 1, 2, 6, and 8 were rated as slightly more uniform in appearance than the type.

Based on average quality ratings, plants 1, 2, and 8 were slightly superior to the type form. Number 1 was more uniform than the type and the color was dark green; number 2 was darker in color but the texture and density were not so good as the type; and number 8 possessed a slightly darker green color and was more uniform in appearance. Since these plants showed some improvement over the type, they have been propagated vegetatively and planted in larger plots to be further observed and compared.

Further study of the average quality ratings showed plant number 10 to be slightly inferior to the type and numbers 3 and 9 to be decidedly inferior. It should be noted in the table on page 174 that the factors which pulled the ratings of these two poor strains down were uniformity, texture, and density. Vigor is not necessarily an index of the best turf since often it is the slow-growing grass that has fine texture and other high quality factors. Also, a grass which is slow in producing upright growth does not require so much cutting as a more vigorously growing grass.

The six best plants had an average rating of 92, which is identical with the average quality rating of the type form. The two poorest plants had an average rating of 80 percent, which, in the light of the method by which these average ratings were determined, is considered a large and significant difference. In seeding turf with open-pollinated material of improved velvet bent, therefore, it would seem that the number of desirable plants will far exceed the number of undesirable individuals.

Comparison of Turf From Self- and Open-Pollinated Seed of Piper Velvet Bent. Figures Are Given in Percentage and Are Based on Observations Made in 1940 of Plantings Made in 1931. The Self-Pollinated Plots Are Arranged in Order of Their Freedom From Invasion by Other Strains.

	Rating Expressed in Percentage					
Plot	Density	Texture	Vigor	Uniformity	Average quality *	Invasion of other velvet bents
Open-pollinated						
22E	100	98	79	90	92	0
Self-pollinated						
22W-1	99	97	80	98	94	0
22W-2	98	97	80	92	93	trace
22W-8	98	98	76	94	93	5
22W-6	96	80	78	92	86	5
22W-10	96	96	80	86	91	8
22W-5	97	98	80	80	90	14
22W-4	93	95	82	76	88	50
22W-7	98	97	80	85	91	52
22W-3	88	80	84	62	81	60
22W-9	88	90	78	50	79	70

* This average includes color, density, texture, vigor, and uniformity.

Another experiment, consisting of over 100 selected plants of velvet and Colonial bents developed from selfed and open-pollinated material, shows considerable variation in quality factors between the turfs from the different selections. Several promising and improved plants are under observation for disease resistance, color, texture, density, and other quality factors.

The following table shows a comparison between turf of

Piper velvet bent planted with stolons and that planted with seed. The 1940 ratings for different quality factors are given

COMPARISON OF RATINGS OF PIPER VELVET BENT TURF RESULTING FROM STOLON AND SEED PLANTINGS. UNDER EACH QUALITY THE PERCENTAGE RATING FOR 1940 IS GIVEN FIRST AND FOLLOWED BY THE AVERAGE RATINGS FOR THE PLOTS SINCE THEY WERE ESTABLISHED. THE AVERAGE RATINGS FOR PLOTS 16 AND 22E ARE FOR THE YEARS 1931 THROUGH 1940. THOSE FOR PLOT 34N FOR 1932 THROUGH 1940, AND THOSE FOR PLOTS 18NW FOR 1936 THROUGH 1940.

	Rating Expressed in Percentage			
	Stolon-planted plots		Seeded plots	
Quality	Plot 16	Plot 34N	Plot 22E	Plot 18NW
Color				
1940	99	98	95	95
Average	87	88	88	85
Density				
1940	98	98	100	98
Average	94	93	92	86
Texture				
1940	97	98	98	98
Average	98	94	97	92
Vigor				
1940	79	80	79	78
Average	75	74	76	76
Uniformity				
1940	98	97	90	96
Average	89	92	91	92
Average quality *				
1940	94	94	92	93
Average	89	88	89	86

* This average includes the five preceding qualities.

together with the total averages based on observations of 10 years for plots 16 (planted with stolons) and 22E (seeded); 9 years for plot 34N (planted with stolons); and 5 years for plot 18NW (seeded), depending on the dates of establishment. In considering the average figures it should be remembered that plot 18NW is a much younger turf than the others and consequently did not rate as high in some quality factors on a comparative basis as the older turfs, as can be noted in color, density and texture. In uniformity it rated higher than the older plot of seeded turf.

The turf in 1940 on plot 22E compared very favorably with that on the stolon-planted plot 16 with regard to density, texture, and vigor. However, in 1940 the stolon-planted plot was considerably superior in uniformity of color to the seeded plot which appeared somewhat mottled. This mottled appearance was not so noticeable in 1940 on the more recently seeded plot, 18NW, nor was it so conspicuous on plot 22E in years prior to 1939. The mottled color on 22E is slight and not considered objectionable at present. It is not nearly as conspicuous as on turf of German mixed bent, in which of course there are not only plants representing different strains of a single species but of several different species. However, the mottling may be expected to become more conspicuous on the seeded plots during the years to come as the plants which are off color become increasingly prominent; whereas the stolon-planted plots may be expected to remain uniform in color unless contaminated by clippings of other strains or by seeds.

Summary and Conclusions

These experiments demonstrated that from 10 selected seeds of a single self-fertilized head, the 10 resulting plants produced plots of turf which varied in quality factors such as color, density, texture, vigor and resistance to invasion by other grasses.

The turf resulting from the sowing of seed of either self- or open-pollinated heads, therefore, contained a mixture of plants with different characteristics. The indications were that in using open-pollinated seed of improved strains of velvet bent, the number of desirable plants similar to the strain type predominated, particularly during the first few years following the establishment of the plots.

The present work confirms general observations which have been made frequently that there is considerable variation in strains developed from individual seeds whether they are the result of self- or open-pollination. This fact makes possible the further improvement of velvet bent by the selection and vegetative propagation of plants which show promise of developing particularly desirable turf.

Turf developed from seed harvested from any selected plant or strain is not pure genetically as is that which results from the planting of stolons developed by vegetative propagation of single plants. As has been pointed out, however, at the Rhode Island Agricultural Experiment Station there has been very little difference in the ultimate development of total quality factors of seeded and stolon-planted velvet bent turf except in the uniformity of color. In general, seeded plots of Piper velvet bent were similar to stolon-planted plots after 10 seasons when compared with regard to density, texture, and vigor. When individual plants were studied in detail, differences were evident, but when seeded *en masse* very little difference could be observed until the turf was 7 or 8 years old, after which time the seeded areas became mottled in appearance.

WHAT OTHERS WRITE ON TURF

In this department will be given the substance of research in the various fields of scientific investigation which seems to have a definite bearing on turf improvement. The articles will summarize results of recent investigations made in various parts of the world. They are not published here as recommendations but simply as information for our readers and as suggestions which may have practical applications in many situations. Where the Green Section's tests or the information it has obtained from other reliable sources in this country substantiates or contradicts the results obtained by other investigators, comments to that effect may be included as a guide for our readers. In all other cases the reader will receive in brief the results and conclusions as given in the original papers.

WEED CONTROL AROUND THE WORLD

In these troubled times it is extremely encouraging to find that until very recently it has been possible for scientific investigators in South Africa, New Zealand, Australia, Germany, Canada, and the United States to cooperate with the Imperial Bureau of Pastures and Forage Crops in Aberystwyth, Great Britain, in the publication of a comprehensive symposium on weed control. The Bulletin of 168 pages containing this symposium was received in the office of TURF CULTURE last April. The 11 different articles appearing in the Bulletin have been written by authorities in each of these countries and present the many and varied aspects of the problem of weed control "as affected by the different types of agriculture in the countries chiefly concerned, together with the practices characteristic of these countries, and the preliminary results of the extensive research programs which have been instituted."

It is unfortunate that space does not permit a review of each of the articles. However, since 10 out of 11 articles relate to weeds in pastures and arable lands, a general summary may be sufficient to indicate the major trends in researches on weed control in the countries chiefly concerned.

In the main, weed control is being attempted by cultural, chemical, and biological means. The cultural and chemical methods are being used quite universally and are discussed in detail by A. S. Crafts and R. N. Raynor of California and B. Rademacher of Germany. Government programs for weed control are described by L. W. Kephart in the United States and by B. Rademacher in Germany. The biological method is mentioned particularly in Australia and New Zealand. This method involves the introduction of insect pests and therefore necessitates extensive tests on many species of insects to determine those which will feed on the weed or weeds concerned and which at the same time will not feed in any stage of their life history on plants of economic value.

The weeds common to each of the countries are listed in the various articles, the most completely organized lists being those given for Germany by B. Rademacher and for Australia by C. H. Currie.

Bibliographies on weed control are also included by T. K. Pavlychenko of Canada, Currie of Australia, Rademacher of Germany, and Crafts and Raynor of the United States.

Poisonous plants are also discussed. R. H. F. Manske of Canada presents the possibility of classifying poisonous plants on the basis of their chemical analysis rather than their morphological characteristics. These plants are given particular emphasis by D. G. Steyn of South Africa who states that already more than 200 poisonous plants are known in the Union of South Africa, only some of the most important of which are discussed in his article.

The only discussion of weed control in turf is given by John Monteith, Jr., who names the most common weeds in turf in the United States and discusses the possibility of controlling them by means of proper maintenance practices, by the judicious use of fertilizers, and by the use of selective herbicides such as arsenicals which will kill many of the weeds and yet not seriously burn the turf grass.

THE ANNUAL WHITE GRUB

The annual white grub (*Ochrosidia villosa*) has been known to occur in various places in this country, but only occasionally has it been reported as the cause of serious turf injury. In 1937 the attention of the Green Section staff was called to a set of fairways in Pennsylvania where this insect had caused extensive and severe damage. It has been observed elsewhere causing serious damage in more limited areas of turf. It is possible, however, that in many instances it may have been responsible for some of the damage believed to be caused by one of the 2 to 4-year broods of the June beetle. C. R. Neiswander, of the Ohio Agricultural Experiment Station, has found it doing serious harm on lawns in southeastern Ohio and has described its habits in the Journal of Economic Entomology.

The adult beetle looks like a brown June bug, perhaps a bit smaller than average. The grub too would be taken by the untrained observer for that of the June bug. The life history of the bug, called the annual white grub, is different from that of the true June bugs. While the latter require 2 to 4 years to mature, this grub matures in 1 year. Eggs are deposited in Ohio through late June and July. They hatch in 19 days and the young grubs grow fast and are nearly full grown on the approach of cold weather. They then move downward and start up again in April. By May 1 most of the grubs are at the soil surface feeding on the grass roots. From 10 to 47 grubs have been found to the square foot. When so numerous they may completely destroy the grass and the turf feels soft and springy to the step.

In early June the grubs move down to about 6 inches and pupate. In the latter part of June the adults emerge to begin a new life cycle. So far the adults have not been observed feeding, and it is not yet known on what plants they feed, if at all.

Neiswander tried some control experiments with carbon disulfide and lead arsenate. While the death rate in these experiments was higher with the carbon disulfide treatment than with the lead arsenate, the latter applied in the fall at the rate of 10 pounds to 1,000 square feet gave a fairly good kill. The writer favors the arsenical treatment because of its known residual effect.

"BETTER LAWNS"

Although its name would appear to indicate that the recent book "Better Lawns" was written primarily for the home owner, its author, Dr. Howard B. Sprague, makes it clear in the opening paragraph of the preface that his book is intended "for all those who are interested in good turf, whether it be on lawns, parks, estates, golf courses, or other recreational fields." This book was published in 1940 by Whittlesey House, a division of the McGraw-Hill Book Company, and is the most recent American text on the general subject of the establishment and maintenance of better turf.

Recognizing the fact that climatic and soil conditions vary so widely in diverse sections of the country that it is impossible to make recommendations which could be applied equally satisfactorily in all parts of the

United States, Dr. Sprague has attempted to give in a clear, non-technical style the principles underlying the various turf management practices. This is done in the belief that an understanding of these principles should make possible the solution of particular problems as they arise in connection with turf maintenance under any particular set of conditions. The book is easily read and understood, and is fully illustrated with photographs, drawings, charts and tables.

The author considers that the successful establishment and maintenance of turf "depends on choosing grasses that are suited to the light conditions and other climatic factors, improving the soil to suit the needs of the turf grasses, and following the types of treatment—mowing, watering, fertilizing, etc.—that are necessary for healthy growth of the grasses under the use being made of the turf."

Accordingly, one chapter was wisely devoted to descriptions and sketches of the various grasses as they appear in turf, by means of which the reader may readily identify the grasses in his turf. Such descriptions are given for five species of *Poa* (bluegrasses), four of *Agrostis* (bents), five of *Festuca* (fescues), two of *Lolium* (ryegrasses), and *Trifolium repens* (white clover).

Other chapters deal specifically with soils, soil acidity and the use of lime, the use of fertilizers, seed germination, controlling weeds in turf, and controlling diseases and insect enemies of turf, in addition to more general chapters on planting new lawns, renovating poor turf, and general maintenance practices such as rolling, mowing, spiking, etc.

SOIL CHARACTERISTICS AFFECT TOXICITY OF HERBICIDES

It has long been recognized that the rates at which herbicides must be applied to be effective vary with the soil as well as with the weed to be destroyed. A. S. Crafts and his collaborators in California have been working with various herbicides on some 80 different soils. They are primarily concerned with killing all vegetation in weed-infested soils rather than with selective action such as we are working for in turf where the aim is to kill the weeds and leave the grass. The results which they have obtained concerning the effect of fertility and texture of the soil on the toxicity of the herbicides, however, are equally as applicable for our purposes as for theirs.

In the Journal of Agricultural Research and in Hilgardia, Crafts and his associates have published the results of their tests with arsenic compounds, borax, and chlorates. They have tried the toxicity of these chemicals at various concentrations on Kanota oats plants growing in numerous different soils and in the absence of soils in solutions containing various nutrient compounds.

From experiments with widely varied soils, the conclusion was reached that the toxicity of arsenic varied with the textural grade of the soil but not with soil fertility. Arsenic was found to be extremely toxic to plants grown in water culture in the absence of soil. Even the coarser soils reduced the toxicity many times, so that 10 to 100 times as much arsenic was needed to produce a toxic effect in soil comparable to that produced in water culture, depending on the texture of the soil. The finer the soil particles or the heavier the soil, the less was the toxic effect of arsenic. This collaborates the observation which has been made repeatedly by the Green Section that other conditions being equal, turf on sandy soil can not tolerate arsenic at as heavy rates as can similar turf on heavy clay soils.

Experiments with boron compounds such as borax gave results comparable to those with arsenic except that they seemed to leach out of the soil more quickly than the arsenic compounds. The toxicity evidently varied with the textural grade, being lower in the heavy soils, and seemed unrelated to fertility. The content of boron rather than the particular form of the compound appeared to be the major factor involved in toxicity.

With chlorates, apparently the soil texture or water-holding capacity of the soil had very little effect on toxicity, whereas the nutrients in the soil, particularly the nitrates, influenced it decidedly. The higher the nutrient content of the soil, the lower was the toxicity of the chlorates both in water and in soil cultures. Among the potassium and ammonium salts, the nitrates reduced chlorate toxicity the most, followed in order by chlorides, sulfates and phosphates, the effect of the latter being quite unpredictable.

It is believed that probably the organic matter in the soil may affect chlorate toxicity through the nitrates which are produced from it by bacterial action. In spring, the nitrate content of the soil is lowest because of the leaching which takes place during the winter and because of the slower bacterial decomposition during the cooler months. The authors also found that spring and fall were the most favorable times of the year for killing weeds with chlorates. It is not unreasonable that this may have been associated, particularly in the spring, with the low nitrate content of the soil. The authors concluded that the nitrate effects on the toxicity of the chlorates seemed to outweigh the concentration effects resulting from different moisture-holding capacities which are associated with soils of different texture.

CENTIPEDE GRASS LAWN FROM SEED

In connection with experiments concerned with improving the germination of seed of southern grasses, G. W. Burton considered the possibility of getting a centipede grass lawn from seed. An attempt was made to harvest a small quantity of seed to be used in the experimental seeding of a lawn. Five pounds of seed were harvested, cleaned, and threshed at a cost of 40 cents a pound. Samples of the seed were then scarified by treatment with 50 percent hydrochloric acid and 35 percent sodium hydroxide for 5- and 10-minute periods, with the result that germination at the end of 40 days was increased from 26 to about 35 percent by all of the treatments except the 10-minute exposure to sodium hydroxide. The 5-minute treatment with hydrochloric acid apparently gave the best results after 20 days, which was a 10 percent germination, as compared with 3 percent in the untreated seed.

On February 22, 1938, the 5 pounds of centipede grass seed, two-thirds of which had been scarified in 50 percent hydrochloric acid for 5 minutes, were used to seed 10,000 square feet of lawn surface at Tifton, Ga. From this seeding a satisfactory stand of grass was obtained, which was able to compete favorably with crabgrass and other annuals during the summer of 1938, although this was the driest season on record at Tifton.

These results were published in the Journal of the American Society of Agronomy along with studies of scarification of seed of other grasses, including Bahia grass, Dallis grass, Bermuda grass, Vasey grass, and carpet grass. A 5-minute treatment in concentrated hydrochloric acid increased germination of Bermuda grass seed. However, even after this treatment only 20 percent of the seed had germinated at the end of 50 days, as compared with 13 percent in the untreated seed. Seed of carpet grass germinated 74 percent after 32 days without scarification, and all scarification treatments seriously reduced the germination.

It will be noted that the germination of the untreated Bermuda grass seed was particularly low, indicating that the seed used was a low grade or that the conditions provided in the test were unfavorable for germination. The tests were made in flats in the greenhouse in October at a mean temperature of 70°, which is too low for good germination of Bermuda grass seed. Tests made on good commercial seed in the Department of Agriculture at the alternating temperatures, 68° and 95°, have given germination percentages varying from 85 to 95 percent, depending on the sample. Perhaps had the germination tests with seed of Bermuda grass and centipede grass been made under more favorable temperature conditions, the results might have been higher both for scarified and unscarified seed.

ACTIVATED SLUDGE AS A SOURCE OF MINOR NUTRIENT ELEMENTS

In recent years, it has been shown conclusively that certain elements such as boron, copper, zinc, and manganese, in very small quantities are essential for the growth of plants. These and certain other elements are known collectively as the minor elements. Because of the very small quantities of these elements which are necessary for the proper growth of plants, they are usually present in soils in sufficient quantities or are added as impurities accompanying the crude salts in the fertilizers which are used.

There have been cases, particularly in the very sandy soils of the southeastern states, however, where striking benefits have been reported as a result of the use of boron, copper, manganese and zinc. In these same areas, the use of Milorganite which is the dried activated sludge from the Milwaukee Sewage Disposal Plant, has apparently resulted in benefits from constituents of the sludge other than the nitrogen, phosphoric acid and potash. It was felt that perhaps the presence of the minor elements might have been responsible for at least part of these benefits.

For this reason, C. J. Rehling and Emil Truog in the University of Wisconsin conducted experiments with Milorganite which have been described in a recent issue of the Journal of the American Society of Agronomy and in an earlier paper in the Analytical Edition of the Journal of Industrial and Engineering Chemistry. In the earlier paper they demonstrated by analysis of Milorganite that it contains 23 elements. Among these were boron, copper, manganese, and zinc, significant amounts of which were present in a form available to plants.

The experiments discussed in the more recent article demonstrated that Milorganite could supply the minor nutrient elements to corn, tomato, and sunflower plants growing in nutrient solutions in Mason jars. In some jars the plants were grown in the nutrient solutions free from one or more of the minor elements until symptoms of the deficiency appeared after which time a carbonic acid extract of Milorganite was added along with the nutrient solution. The authors state that "In every instance where a minor element deficiency existed and the Milorganite extract was later added, increased yield resulted which was attributed to correction of the deficiency by the minor element contained in the extract."

In control jars in which the plants were grown in nutrient solutions containing the minor elements in addition to nitrogen, phosphorus, potassium, calcium and magnesium, the plants showed normal growth and were not stimulated to additional growth by the addition of the Milorganite extract.

Analyses of the dried tops and roots were made and in general the amounts of these elements present in the plant tissues were closely correlated with the amount of growth expressed in terms of dry weight. Increases both in plant yields and the minor element contents were associated with the addition of Milorganite extract to the cultures deficient in any of the minor elements but not with its addition to the control cultures which were already receiving the minor elements.

From these experiments the authors concluded that "Since Milorganite extract did not stimulate additional growth in control cultures which already contained all of the minor nutrient elements, it is evident that the highly stimulating effects of the extract which were observed in the other cultures, can be attributed to the presence of available minor nutrient elements in Milorganite" and that "These observations and results undoubtedly explain, at least in part, the additional unusual stimulating effects which have been noted following the use of Milorganite on certain soils."

THE USE OF POTASSIUM PERMANGANATE

Potassium permanganate is known to be an active oxidizing agent. As such it hastens the decay of organic matter. C. B. Greening, of the Wisley Experiment Station in England, has conducted a number of experiments on the use of potassium permanganate to hasten the decay of organic matter and on its value when applied directly to turf.

These experiments are reported in the Journal of the Royal Horticultural Society. Under the heading, "The oxidation of soil humus" the author describes certain experiments on hastening decay by the use of potassium permanganate. On July 23, "a heap consisting of 1 cubic yard of mixed garden refuse was soaked with 6 gallons of a solution containing 3 ounces of permanganate. The heap was lightly covered with sifted soil." The heap was turned on August 21 and 26 and on September 1. It was treated with 3 gallons of water containing 3 ounces of potassium permanganate on August 21, and 2 gallons containing 2 ounces of potassium permanganate on August 26 and September 1. A control heap was turned and watered each time without permanganate, while in a third heap crystals of potassium permanganate were "sprinkled throughout the heap and water was applied in the same quantities as used in the solutions and on the same dates."

By the middle of September the pile treated with the solution was ready for use, while the untreated pile had not decomposed nearly so rapidly. "Although decomposition proceeded more rapidly than in the control heap, the use of crystals was not found to be as effective as that of the solutions."

The author feels that these results are important on two scores. They demonstrate a quick and simple method of producing good compost and they provide an explanation of the probable action of potassium permanganate on soil.

While the treated material is not described except as "mixed garden refuse" it seems likely that most of such refuse would consist of green matter comparable to grass clippings. Material of this sort is much more easily decomposed than are the tree leaves and strawy mixtures used in many compost piles. It should also be noted that while the pile treated with potassium permanganate did decompose more rapidly than an untreated pile, no comparisons were made with other treatments known to speed decomposition.

To test the effect of potassium permanganate on established lawns a strip of turf was treated at the rate of "¼ ounce of permanganate dissolved in 2 gallons of water to 3 square yards. A large number of earthworms came to the surface immediately and were brushed up. Within a week from the time of application it was evident that the turf had received marked manurial benefit from the treatment. The grass on the treated strip was growing more vigorously and was of a darker green than that on the untreated turf." This distinction was still evident 6 months later. There was no apparent difference between the effects of spring and fall applications. The author believes that the potassium permanganate added to the soil decomposed the organic matter already in the soil, thus causing the release of nitrates and other plant foods within the soil itself in quantities sufficient to stimulate plant growth. Similar stimulating effects were produced on geraniums, tomatoes, radishes, lettuce, and currants. Applications to new grass did not produce the same amount of stimulation, due, according to the author, to the lack of organic matter in the soil.

Accompanying the control of earthworms and the stimulation of the grass by the potassium permanganate there was a reduction in the amount of moss and an elimination of matted growth on the surface of the lawn. Very mossy or badly "matted" turf may require stronger solutions or several applications.

In tests at Arlington Farm the benefits described above have not been apparent. This difference may be due to the smaller amounts of organic matter in the Arlington soil than in the soil referred to above. In our tests potassium permanganate has affected earthworms as described but the control has not been so good as that obtained with other chemicals.

According to the *Australian Greenkeeper,* tan bark is used in Jueensland for dressing fairways and greens. On fairways a fair dressing is 75 to 100 cubic yards to an acre, and gave satisfactory results particularly when used in conjunction with fertilizers. According to Mr. Black its greatest value is as a mulch for "softening" the hard-natured surface of the fairways and for the ultimate supply of much-needed humus, of which his soils were particularly deficient. It was preferable to animal manures because of being free from weed seed. In spring and early summer it was particularly useful for the purpose of moisture conservation.

On greens, after two dressings of screened tan bark at an interval of 6 weeks, and subsequent, frequent dressings throughout the year with a good sandy material, the greens improved unbelievably in both turf and play.

OUR LETTER BOX

The Green Section receives numerous inquiries concerning local turf problems and is always glad to reply to them. With the hope that some of these questions and answers may be helpful to others besides the original correspondent, a few of them will be published. While most of the answers will have a general application, it should be remembered that each recommendation is intended for the locality designated at the end of the question.

Topdressing Greens.—Two of our greens are Cocoos bent and 16 are Washington bent. They have never been smooth. Since we topdress our greens only three times a year, I am wondering if more frequent topdressing would not help. What number of topdressings do you recommend during the six months of playing season, beginning in April? (Illinois.)

ANSWER.—Topdressing is ordinarily applied primarily for the purpose of truing the putting surface. Therefore, since your greens are not smooth, the chances are they would be improved by more frequent topdressing.

Sometimes topdressing does not work down into the grass properly due to a heavy mat of grass. In such cases the greens remain irregular even when a liberal topdressing is applied and well worked in. When this condition develops it is well to rake the green thoroughly to remove as much of the excess grass as possible. The raking should be done when the grass is growing vigorously either in late summer, early fall, or spring. The smoothness of the green should be the guide as to the time for topdressing and the number of times it should be applied during the playing season. On some greens one or two topdressings a year are ample whereas under other conditions it is best to topdress lightly every other week.

* * *

Air Circulation Reduces Severity of Brownpatch.—We have been having trouble with brownpatch on our greens each summer in a wooded section of the course. The mercury treatments seem to be less effective there than on the other greens. I should appreciate your suggestions for improving this situation. (Maryland.)

ANSWER.—If the greens which are difficult to maintain during the summer months are partly surrounded by large trees, the lowhanging branches may be cutting off the free circulation of air. It has been demonstrated that adequate circulation of air reduces the severity of attacks of brownpatch and other turf ailments. If some of the lower branches could be removed in such a way as to open air channels and permit the wind to blow across the greens, we feel sure that you would have less difficulty in maintaining the turf during the hot sultry periods each summer. Such openings need not detract from the landscaping effect of the trees and would be an advantage from the standpoint of playing conditions as well as of the maintenance of near-by turf.

* * *

Avoid Excessive Use of Fertilizers.—Playing our course one week day in the spring I was so delighted with the freshness and color of our greens that I invited the Chairman of the Green Committee of a nearby club to be my guest over the week-end. On our arrival at the course, however, I found the greens lifeless and almost a slate gray and learned that the greens had been topdressed the day after I had played. Subsequently I noticed that the same thing occurred after each topdressing.

Later, in August of the same year, when extremely high temperatures and moisture alternated for several weeks, nearly half of our greens had brown, dead spots (not brownpatch although that was a complication) averaging from 5 to 10 percent of the entire surface.

Our fertilizing program for the last several years has been as follows. The first topdressing has been compost reinforced with a liberal quantity of cottonseed meal. Thereafter we have topdressed once a month with compost to which has been added a complete organic fertilizer, 6-8-5, with a tobacco stem base, using 8 to 10 pounds to 1,000 square feet.

It has been my feeling that our applications of fertilizer have been excessive, and that consequently the turf has become tender and lacking in resistance. I should appreciate having your opinions and recommendations on this question of the fertilizing and topdressing of our greens. (Pennsylvania.)

ANSWER.—If your topdressing is of a good quality and high fertility and is applied liberally you no doubt are using entirely too much fertilizer. In figuring fertilizer rates, greenkeepers often overlook the amount of nutrients applied in compost. In recent years there has been a tendency to do less and less topdressing, and applications of fertilizers have been increased to compensate for the reduced amounts of nutrients applied in compost. The rates which you have mentioned would be entirely satisfactory on a poor soil, but if your program has been continued over a number of years you no doubt have built up a fairly rich soil which should not require so much fertilizer as you are applying. We regularly advise that the fertilizer be applied much more sparingly during the summer months than in spring or fall.

* * *

Time Required After Planting Bents Before Greens Are Ready for Play.—We are considering planting some of our greens with New Brunswick, Washington, or Metropolitan bent. Our present plan would be to plant a turf nursery and transplant the sod from there to a green when it is sufficiently far advanced to be used within a short time after being laid. How much time should be allowed for the development of the sod after the planting of the nursery and how soon after sodding can the greens be used for play? (Ontario.)

ANSWER.—For planting a nursery and doing a resodding job it would be advisable to plant the nursery this year and plan to use it next year. When sod is a year or two old it is much easier to handle than when it is much younger. When the sod in your nursery is well established it should be practical to move the old sod from your green and replace it with new sod, so as to be ready for play within 2 weeks from the time the old sod is lifted. There are many cases on record where greenkeepers have had everything in readiness and a good staff on hand Monday morning to remove the old sod, regrade the green, cultivate the surface soil, etc., lay the new sod and topdress it ready for the Saturday and Sunday play of the same week. Such newly sodded greens are by no means perfect putting surfaces but are passable and usually better than temporary greens. It does not hurt the new sod to be played on while it is growing and gradually being trued up by repeated topdressing.

* * *

Control of fairy rings.—We realize that there is not much that can be done about fairy rings, but do you think it would be worth while to try iron sulfate or corrosive sublimate? (Ohio.)

ANSWER.—So far as we know there is no satisfactory method for the control of this pest. To our knowledge wherever iron sulfate and corrosive sublimate have been given a thorough test they have failed to control the fungus. The trouble is that the fungus causing the rings grows well down in the soil. The fungicides are filtered out in the surface soil and do not penetrate deeply enough to kill the fungus. With this in mind, we have tried punching holes in the soil with an ordinary fork or with a tubular-tined fork but the results have not been satisfactory. The only method of control appears to be to remove the infested soil and replace it with new soil. Of course, this is impractical on a large scale.

* * *

Control of Turf Weeds.—The two weeds, samples of which are enclosed, infest our bluegrass turf in patches. I have been successful other years in getting rid of them by hand-weeding and reseeding. This method, however, is rather expensive. If there is a better and cheaper way to rid our turf of these weeds, I should appreciate having your recommendations. (Illinois.)

ANSWER.—The weeds you sent were the larger mouse-ear chickweed (*Cerastium vulgatum*) and purslane speedwell (*Veronica peregrina*). Both are easily killed by treatments with sodium arsenite or arsenic acid, as described in the December, 1939, issue of TURF CULTURE. You can use either the spray method or the dry method. If the patches are scattered you may find the dry method best. In that case apply the chemical at the rate of about ¾ pound to 1,000 square feet. If you use the spray method apply only 3 to 4 ounces to 1,000 square feet.

You will, of course, not be applying it solidly over 1,000 square feet, so you will have to make some tests to determine the amount of water or sand to use in which to mix the arsenicals. One of the simplest ways to determine this is to mark off an area of 100 square feet. If a knapsack sprayer is to be used, put 2 gallons of water in the sprayer and spray the 100 square feet so as to thoroughly wet the foliage without causing any noticeable run-off. Then measure the amount of water left in the sprayer. By subtracting this from the original amount you have the quantity of water necessary to spray 100 square feet with your particular spray nozzles and at the covering you are using. Multiply this quantity by 10 and use the resulting amount of water in which to dissolve the 3 or 4 ounces of sodium arsenite. If the foliage is wetted with this solution approximately the same as was that in the test plot of 100 square feet, the arsenical will be applied at the recommended rate.

A similar test with sand on an area of 100 square feet will determine for you how much sand is needed to give a fairly even distribution. You do not need a great deal of sand but you want enough to scatter it pretty well over the patch of weeds.

The patches will be brown but can be reseeded immediately after treatment. If you find the burn on the turf is a little excessive simply cut down on the amount of arsenical that you use.

If you use the spray method, get the white sodium arsenite because it dissolves more readily than does the gray. If you plan to apply it in sand the gray sodium arsenite may be used equally as effectively as the white.

* * *

Grass mixtures.—What do you consider the best grasses for seeding fairways and the rough on golf courses in the eastern part of the United States, including the New England section and in the Middle West? I should also like to know what percentage of each of these grasses is most desirable in your estimation for establishing a good turf under the respective conditions. Also, where a mixture of grasses instead of a single grass is to be used in seeding a green, what should be used? Any information which you can give along these lines will be appreciated. (Connecticut.)

ANSWER.—For fairway purposes, we generally recommend a mixture of about 85 per cent Kentucky bluegrass, 10 percent redtop, and 5 percent Colonial bent. Farther north where conditions are likely to be favorable for fescue we include anywhere from 20 percent to 60 percent fescue in the mixture to replace the Kentucky bluegrass. The amount we recommend depends on the likelihood of success with fescue. In the New England district where bent is likely to do well we usually recommend that the amount of Colonial bent be increased to 10 percent or 15 percent.

For seeding the rough, sheeps fescue is about as satisfactory as anything, although when sheeps fescue cannot be obtained we ordinarily recommend Chewing's fescue. Canada bluegrass also is satisfactory for this purpose, especially on poor soils in the more northern regions.

In the case of mixed bent greens, we have been recommending a mixture composed chiefly of Colonial bent, with from 5 to 10 percent seaside bent, and from 5 percent to 30 or 40 percent velvet bent, depending on whether the recommendation is for a district where velvet bent thrives.

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