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Controlling Grubs and Earthworms with Arsenate of Lead

By B. R. Leach

Arsenate of lead is being extensively used on golf courses in the United States for the control of grubs, earthworms, and weeds. It has been conservatively estimated that more than 200 tons were employed during the 1928 season in the Philadelphia district alone, which is near the center of the Japanese beetle infestation. Although the use of this chemical is fast becoming a recognized part of greenkeeping, it must be remembered that it is a relatively new practice and that therefore each year will see new developments, for some time at least. The purpose of this article is to review briefly the developments of the season of 1928.

Those who have followed the previous reports of my experimental work with arsenate of lead will recall that it has been conducted at Riverton, N. J., near Philadelphia. The grasses used in these tests were bent grass grown from seed, bent grass produced from stolons, Kentucky bluegrass, and some of the other grasses common in this section. Nothing was done with Bermuda or other grasses commonly occurring on golf courses in the South. As the use of arsenate of lead began to spread to other sections, including the South, I must confess that I viewed with no little apprehension the possibility of trouble arising from the application of this chemical to Bermuda grass, since we had no information regarding what the results might be. Recently inquiries were made to obtain opinions from those in the South who had used arsenate of lead on Bermuda grass. All of the 25 or more answers received indicated that the effect of the chemical upon Bermuda grass was entirely satisfactory. It would appear therefore that southern golf courses will be able to use arsenate of lead with impunity in the control of one of the South's greatest turf insect enemies, the June beetle.

In the Philadelphia and New York districts much is being done in rendering turf, especially on greens, proof against grub infestation in order to prevent injury by grubs of the Japanese beetle, the Oriental beetle, and the Japanese garden beetle. However, the following remarks apply equally as well to those sections where injury by our native species of grubs is more or less prevalent. Greens treated under these conditions are proof against the attack of the grubs, but the untreated approaches and fairways are often badly damaged before those in authority are aware of the true state of affairs. Although arsenate of lead applied at this late stage will quickly check the feeding of the grubs and kill them in about three weeks, it will not restore the turf to its former vigorous condition. Such grub-riddled turf goes into the winter in a decidedly weakened condition, serious winterkilling results, and much money must be spent the following season to restore the damaged areas.

In 1928 I supervised the treatment of extensive areas of fairways in order to kill the grubs which were rapidly ruining the turf. Golf clubs faced with a fairway crisis of this sort are usually in more or less of a financial predicament. No allowance has been made in the annual budget for an emergency of this kind, and yet something must be done if the fairway turf is to be maintained. Under these conditions the golf club involved invariably asks for treatment at the lowest possible cost. In view of the limitations imposed by their budget for the current year they are not, at that time, particularly interested in treating the turf so that it will be proof against grub infestation for a period of years; they desire simply to kill off the grubs for the time being. Under the circumstances it will not be amiss at this time to detail the method I have found most practical and inexpensive for a temporary grub campaign for those finding themselves in this predicament.

I have sought during the season to standardize the application of arsenate of lead at the rate of 5 pounds to 1,000 square feet of turf, or 250 pounds to the acre. This dose will render turf proof against grub infestation for a period of at least three years, and probably longer. However, those who wish simply to kill off a grub infestation, with no thought to making the turf immune to future infestation, can do so with an application at the rate of 3 pounds to 1,000 square feet, or 150 pounds to the acre. I have made extensive tests with this lower rate of application during the past two years and have determined that within a week after the application of the chemical it will sicken the grubs to such an extent that they will cease feeding; within three weeks most of the grubs will be killed and the turf will be reasonably proof against further infestation during the following year.

In the last analysis the initial cost of the 150-pound rate of application is lower for material, but the effects do not last as long as with the 250-pound rate.

In treating large areas of turf with arsenate of lead the chemical is mixed with a dry filler and applied by means of a lime spreader. Until recently the filler employed has consisted of dry, sifted sand or soil, and where these are available in quantity they are entirely satisfactory. Unfortunately, these materials are not generally available in quantity, and the cost of drying sand or soil by artificial means is prohibitive. During the past season in large-scale operations I have had very successful results by using one of the organic fertilizers as a filler for adding bulk to the application. In addition to the plant food value, some of these pulverized fertilizers possess certain qualities which render them particularly desirable as fillers for use with arsenate of lead. These finely ground types of organic matter are easily mixed with arsenate of lead, and the exceedingly fine particles of the chemical cling tenaciously to the larger particles of the fertilizer. Consequently, when a lime spreader is used for applying the mixture it flows readily through the openings in the bottom of the spreader and very little of the arsenate of lead is lost by blowing, since most of the chemical clings to the particles of fertilizer. The past season's work has shown that the two materials should be mixed at the rate of 1 pound of arsenate of lead to about 5 pounds of fertilizer. As the mixture falls upon the turf it filters down through the blades of grass and comes in contact with the soil. In this situation

it is acted upon by rains and dews, the arsenate of lead killing the grubs as it is washed into the soil. As soon as the grubs cease feeding, the grass which remains begins to develop new roots and make new growth. At this point the fertilizer in the mixture becomes apparent, hastening the recovery of the turf, fortifying it against the approach of cold weather, and reducing winterkill to a minimum.

All my recommendations regarding the application of arsenate of lead to turf have been based on the use of a mixture of the chemical with some dry or slightly moist filler, such as sand, soil, or, of late, a dry organic fertilizer. That there are reasons for my dislike of the system of applying arsenate of lead to turf by mixing the chemical with water and making application by means of watering cans or sprayers is fairly obvious. Arsenate of lead, although a fluffy, impalpable powder, is, nevertheless, much heavier than water, and settles to the bottom of the container very rapidly unless the mixture is constantly agitated. Sufficient agitation is impossible when using watering cans, buckets, or barrel sprayers. As a consequence the chemical is applied unevenly to the turf and an uneven grub control results. When power sprayers are employed and the mixture with water is applied by means of fine-jet nozzles, the wind becomes a factor to be reckoned with, and again an uneven application frequently results. If coarse nozzles are employed, a flooding action results, the low spots in the turf receiving more than their share. My chief objection to the use of water as a carrier for arsenate of lead is that much of the chemical clings to the blades of grass, which are very tender, and surface burning results, with a consequent temporary check in the growth of the grass.

In earthworm control, arsenate of lead is being used all over the country, and very satisfactorily. In spite of all that has been written on the subject, there is still a marked tendency among golf course officials to stop at the edge of the green in applying the chemical. It must be remembered that earthworms—and this applies also to the grub of the June beetle—are migratory, constantly creeping into the green from the surrounding turf. Although the turf of the green may have been poisoned with the chemical, wormcasts will, nevertheless, be in evidence, since these invading creatures must make at least one burrow before they get a dose of the poison. If you want a green entirely free from wormcasts, it is therefore absolutely necessary to apply the arsenate of lead to the turf for a distance of at least 15 feet beyond the edge of the green. When this is done, earthworms creeping toward the green are poisoned before the green is reached. A golf course manager from Chicago told me not long ago that on some of the older courses in that vicinity the wormcasts were so numerous on the fairways that they had to drag a mat over the turf before it could be mowed. He added that on his course the difficulty had been rectified by the application of arsenate of lead at the rate of 250 pounds to the acre.

From now on we may expect to hear rumors of injury to turf following the application of arsenate of lead, whether justified or not. It would be unwise, however, to give credence to unfavorable reports until the evidence is fully sifted. If you, as a user of the chemical, find that something of an untoward nature subsequently develops with your turf, do not be in haste to lay the blame on the arsenate of lead. Review carefully the steps in your greenkeeping program,

being sure in particular that your drainage and your top-dressing materials are what they should be. As a prominent golf architect said to me not long ago, "Greens are always going bad, more or less." In golf turf, arsenate of lead gradually loses its toxicity and becomes chemically inert, as so much sand or cinders. The cumulative action of this chemical is improbable, if not impossible.

A Classification of the Bent Grasses

We have recently received a pamphlet entitled "Commercial Bent Grasses (Agrostis) in Canada," written by Dr. M. O. Malte, botanist in charge of the herbarium of the National Museum of Canada, Ottawa. This treatise appears in the annual report of the museum for 1926 (Bulletin No. 50). It is a technical discussion, but since it contains much of interest and value to those interested in the production of bent turf, we offer this brief review for the benefit of our readers to whom this information might not otherwise be available.

The increased interest in recent years in fine turf, especially for putting greens, has stimulated the demand for bent and has led to the opening of new seed sources in the maritime provinces of Canada, especially in Nova Scotia and Prince Edward Island. Dr. Malte expresses the opinion that the production of commercial bent grasses will be of increasing importance in that section of Canada. "In the writer's opinion, however," he says, "the success with which seed growing on a commercial scale may be met will, to a very great extent, depend upon the confidence which seedsmen as well as the purchasing public will have in the genuineness and trueness to name of the seed produced. Such confidence can be obtained only if the characteristics of the 'varieties' can be precisely defined and if, based thereon, a supply of pure seed, true to name, can be offered to the trade. At present, tens of thousands of dollars are wasted annually on account of a loose and, in many cases, quite misleading application of so-called scientific names to commercial varieties of bent grasses. For this the seedsmen must not be criticised too seriously as there exist, as will be seen in the following, very great differences of opinion among taxonomic botanists as to the systematic relationship between the various species and forms, differences which are quite natural on account of the perplexing variability of the different species." It is the purpose of Dr. Malte's treatise to give his "conception of the relationship of the various species and varieties of the genus Agrostis which are of commercial interest to Canada."

"In most Canadian seed catalogues," he writes, "only three so-called varieties of bent grasses are listed, viz. redtop, creeping bent, and Rhode Island bent. Occasionally the names 'herd's grass' and 'fiorin' occur, and quite recently the name 'Prince Edward Island bent' has been introduced by a few seedsmen."

Concerning redtop, the tallest and most important agriculturally of the bent grasses in Canada, he writes, "It grows anywhere from 1 to 3 feet high or more and generally possesses runners or stolons which are either wholly underground or from a subterranean start develop into upright, aerial, leafy shoots. On account of its upright growth and plentiful foliage, it is of importance as a hay grass, especially on wet land. Its relative coarseness, however, and in many

cases rather pronounced lack of durability, when cut close to the ground, make it not nearly as well adapted to lawns and greens as some of the other bent grasses."

"Creeping bent grass," he states, "as the name implies, is a grass of a spreading habit. . . . By means of runners or stolons which trail on the surface of the soil and freely root at the nodes it quickly forms a dense and continuous sod. It thrives best on moist land and is particularly well suited for lawns and greens which can be adequately supplied with water. Creeping bent is not a uniform variety, in a botanical sense, but under that name are included many more or less sharply defined races of a similar creeping habit. The majority of the creeping bent races produce comparatively few and short, scantily leaved stems."

"Rhode Island bent grass," he continues, "grows upright like redtop, but is of a lower stature and of a much finer texture. It is generally rather loosely tufted, with a dense bottom growth of short, leafy shoots. In some of its many races creeping surface stolons are developed, but these are as a rule only a few inches long and never as luxuriant as in creeping bent. It, therefore, spreads comparatively slowly and does not form as matted and compact a sod as that produced by the latter. Nevertheless, it makes a fine turf and is much superior to redtop for lawns and greens. It is much less exacting in its demand for moisture than creeping bent and, as it will thrive even on dry, sandy soil, it has a much wider range of usefulness than the latter."

Herd's grass, as applied to a species of bent grass, is the same as redtop.

Fiorin, apparently a corruption of the Irish "fiorthan," is applied to a grass belonging to the creeping bent group. This name is now in many cases applied indiscriminately both to redtop and to stoloniferous bent grasses allied to the latter.

Browntop is botanically the same as Rhode Island bent. Prince Edward Island bent is another name for the same grass.

Colonial bent is a bent grass grown in New Zealand. Historical evidence is given to indicate that the stock of Colonial bent came originally from the Canadian maritime provinces and that it is identical with Rhode Island bent.

Velvet bent, or brown bent, occurs in mixtures, but is now being harvested practically pure on Prince Edward Island. "Velvet bent," he writes, "is a more or less loosely tufted grass with short, very narrow-leaved basal shoots and commonly also with creeping surface runners. It grows to about the same height as Rhode Island bent which, to some extent, it also resembles habitually. It produces, however, a much smoother turf and is no doubt the finest of all the bent grasses for lawns and greens."

Carpet bent occurs in so-called South German mixed bent and is one of the many forms of creeping bent.

He refers to the great variety of scientific names under which these grasses are listed in the seed catalogues and even in textbooks and different editions of the Seeds Act. From this it is obvious, as he states, "that there exists a very confusing instability in the application of technical names to at least some of the most important trade varieties of bent grasses, an instability paralleled by the divergency of opinion, concerning the systematic status of the various

forms, which is found in North American floras and other scientific publications dealing with the subject." He lists a number of authoritative publications which show as great variation in the scientific naming of the bent grasses as is found among the seed catalogues. He attempts to bring some kind of order out of the existing chaos by determining the systematic relationship between the various forms and what technical names should be applied.

Dr. Malte points out that "the term 'species' is in many cases applied more or less at random and, as a consequence, in very many cases to systematic units of manifestly widely different rank. In this connection, however, it is of less importance to argue what the term 'species' should or should not imply than to set forth how it is applied, i. e., to make clear what systematic units the writer has in mind when speaking of 'species.'" He recognizes the need for minute character differences in plant breeding, but chooses for this type of taxonomic work to use the term "species" in a wide sense. Accordingly, he suggests, "It will be employed to designate groups of forms which, although in several respects differing from each other rather considerably, yet have morphological characters in common which clearly indicate that they are of a very close systematic relationship." Individuals of different species do not usually intercross, and when they do, "their progeny is, as a rule, characterized by a high degree of sterility in both the male and female organs." Progeny of such crosses, "generally termed hybrids in descriptive, systematic botany, are not uncommonly met with in grasses, although, so far, slight attention appears to have been paid to them by North American botanists." He refers to several foreign works, and states, "In the genus Agrostis several hybrids are well known, and in all cases their hybrid nature manifests itself by a very high degree of sterility."

The writer then gives a technical discussion of the characteristics of the different species that have been described and points out his reasons for making his classification. He traces several errors in nomenclature back through the old literature and establishes his names under the international rules of biological nomenclature. As an example of misleading characteristics, he points out that the stoloniferous habit, which by some writers is regarded as characteristic of a species, may occur in forms of all the species of Agrostis.

Dr. Malte recognizes only three distinct species: *Agrostis stolonifera*, *A. tenuis*, and *A. canina*.

Agrostis stolonifera is an extremely variable species and includes two distinct varieties which are well recognized in agricultural writings. Redtop he considers as belonging to this species, and is designated as variety *major*. Creeping bent, also a variety of this species, is variety *compacta*.

Agrostis tenuis is given as the most acceptable scientific name for the grass known commonly as Rhode Island bent, browntop, Prince Edward Island bent, or Colonial bent. He recognizes two distinct varieties within this species, but since they do not occur pure they are as yet of no practical importance.

The third species is velvet bent, *Agrostis canina*. There are also two distinct varieties of this species which are not sufficiently abundant to have any practical value. He also mentions two hybrids, which are rare in Canada: *A. stolonifera* x *tenuis* and *A. canina* x *tenuis*.

Winter Grass Experiments at Gainesville, Florida

By Charles R. Enlow

The winter grasses were seeded on a plot of ground adjoining the permanent turf plots near the state experiment station building. Before seeding, this ground was covered with a 3-inch growth of *Crotalaria striata*, a clover-like plant, which was spaded under about the middle of October, 1927.

On November 1, 1927, the plot was fertilized with a 4-8-4 fertilizer at the rate of 1,000 pounds to the acre, which was well worked into the soil. It was then divided into plots of 5 by 22 feet. These plots on the next day were planted with the following grasses: redtop, Italian rye grass (domestic seed), English rye grass (imported seed), Kentucky bluegrass, bulbous bluegrass (*Poa bulbosa*), annual bluegrass (*Poa annua*), Westernwolths rye grass, and Oregon rye grass. An additional plot of annual bluegrass was seeded for further fertilizer study. The seed was broadcast by hand, lightly raked, and rolled. The plots were watered daily. The bulbous bluegrass was sown with both bulbs and bublets in order to insure a good stand.

On November 5 Bermuda grass sod was seeded with Italian rye grass, Kentucky bluegrass, redtop, bulbous bluegrass, and Westernwolths rye grass. These various plots were top-dressed with about ⅛ inch of soil, rolled, and kept moist. A portion of each plot was not seeded, in order to observe the effect of the winter grasses on the spring growth of Bermuda as compared with the growth made by the Bermuda where not planted to winter grasses.

A good stand of all the rye grasses and redtop was secured by November 8, while the bluegrasses were much slower. Bulbous bluegrass and annual bluegrass first appeared November 9, and Kentucky bluegrass November 10, but germination and early growth were so slow with these that numerous weeds developed. A similar condition was noticed where seedings were made on Bermuda sod. The rye grasses and redtop were green by November 14, while bulbous bluegrass and Kentucky bluegrass were just emerging.

One-half of each plot of the winter grasses which had been seeded alone was cut with the putting green mower, and one-half with the lawn mower. One-third of each half was fertilized with sulphate of ammonia, beginning December 1, at the rate of 1 pound to 1,000 square feet, applied every 15 days during the growing season; one-third was fertilized with sewage sludge at the nitrogen equivalent of the sulphate of ammonia; and the remaining third was left without treatment. No particular effects from the sulphate of ammonia and sludge were noticeable until January, due no doubt to the Crotalaria which had been turned under and the application of fertilizer previous to planting. At this time, however the areas which had been fertilized with sulphate of ammonia began to show a darker green color and more vigor. The sludge was slower in taking effect, but gave good results. On the extra plot of annual bluegrass, the phosphate of ammonia which had been applied gave much better results than sulphate of ammonia when applied at the same rate; the sod was established earlier, and was denser throughout the winter.

It was necessary to weed the bluegrass plots, but the plots of redtop and the rye grasses were free from weeds.

All of the grasses made splendid sod. Bulbous bluegrass, Kentucky bluegrass, and redtop were very fine and dense. The annual bluegrass was very good also. The rye grasses were coarser in texture.

A cold period early in January, when the temperature at Gainesville reached 15 degrees Fahrenheit, browned the tips of the leaves of all the rye grasses, but the other grasses were not damaged.

The first trouble with brown-patch occurred early in January, on the redtop. Several attacks of both large and small brown-patch occurred on this grass during the winter. Small brown-patch also attacked the rye grasses, Kentucky bluegrass, and annual bluegrass in February. Both large and small brown-patch were controlled by the use of one of the chlorophenol mercury compounds. In the case of redtop it was necessary to make these applications every ten days or two weeks.

Bulbous bluegrass began to turn yellow during a warm spell during early March, but recovered to some extent as cool weather followed. It died down completely in early April, before the Bermuda grass had well started to show green. Annual bluegrass and bulbous bluegrass began to form seed heads in March, even though closely mowed, which made them rather unsightly.

No difference could be noted between the imported and the domestic rye grass until early May. The imported was then much darker green, and it has remained so since that time. The domestic rye grass was affected more adversely by the warm weather. The imported lasted ten days longer than the domestic; this is a feature which may be of importance in case it always holds true.

The accompanying table has been prepared to give a comparison of the rates of disappearance of the winter grasses and development of the Bermuda grass during the spring and early summer.

ESTIMATED PERCENTAGES OF STAND OF WINTER GRASSES AND BERMUDA GRASS AT INTERVALS DURING SPRING AND EARLY SUMMER

Date, 1928	Italian rye grass on Bermuda		Kentucky bluegrass on Bermuda		Redtop on Bermuda		Bulbous bluegrass on Bermuda		Westernwolths rye grass on Bermuda		Bermuda alone
	Rye	*Bermuda*	*Bluegrass*	*Bermuda*	*Redtop*	*Bermuda*	*Bluegrass*	*Bermuda*	*Rye*	*Bermuda*	
April 18...	85	10	90	5	90	5	10	20	85	10	20
May 7.....	50	40	65	35	35	35	0	50	15	50	80
May 28....	30	50	60	40	40	45	0	65	10	70	85
June 12...	5	60	40	50	5	60	0	85	5	75	90
June 25...	0	75	10	75	0	80	0	95	0	90	95

Where these grasses and other winter grasses were grown alone, the dates of complete disappearance of the respective grasses were as follows:

Bulbous bluegrass	April 10
Westernwolths rye grass	May 20
Oregon rye grass	May 25
Redtop	June 5
Italian rye grass	June 10
English rye grass	June 20
Annual bluegrass	June 20

When the last observation was made, June 25, there was still a 10 per cent stand of Kentucky bluegrass.

Although the redtop seemed to have disappeared completely June 5, it revived a number of times later during periods of damp, cool weather.

Changes in the Bent Grass Seed Market as Viewed by the Seed Analyst

By Helen H. Henry

Seed Laboratory, United States Department of Agriculture

Because of the growing interest in golf turf, the production and sale of bent grass seed has become a subject of interest to many. The seed laboratory of the United States Department of Agriculture in examining samples of seed of bent grass, including those representing the importations, is in a position to note changes occurring in the character and kinds of seed offered for sale. Comparing the bent grass seed on the market today with that available 10 years ago, one is impressed with the greater dependability of names, the greater number of kinds offered, the decrease in the number of cases of deliberate mixing or substituting, and the improvement in the character of the seed offered, with respect to the quantity of chaff and inert matter contained.

The improvement noted has dated from the publication in July, 1918, of the United States Department of Agriculture Bulletin No. 692, entitled "The Agricultural Species of Bent Grasses," by Charles V. Piper and F. H. Hillman. The work of Dr. Piper in describing the plants and clarifying the nomenclature is responsible for the more intelligent use of common and technical names among seedsmen and botanists, and the work of Mr. Hillman in discovering and describing differences in the seeds has enabled analysts to detect mixtures so that the practice of adulteration and substitution by seedsmen both here and abroad has been greatly discouraged.

Previous to the publication of that bulletin, the name *Agrostis canina* was commonly applied to Rhode Island bent, and the name *Agrostis stolonifera,* appearing on importations of bent grass seed which were supposed to contain creeping forms of Agrostis, was applied to all bents then on the market. These mistakes were due largely to the confusion existing among botanists as to the botanical identity of the plants. Piper's work in the clarification of the nomenclature was followed by a more careful use of technical names by seedsmen. Mention might be made of certain apparently unavoidable inconsistencies which still prevail in the use of common names. The name "creeping bent" is commonly used for any bent regardless of whether or not the plant is stoloniferous, and the name "Rhode Island bent" is applied to seed of *Agrostis capillaris* [1] whether it grows in New Zealand, Europe, Canada, or the State of Washington. At present, there is no common name for *Agrostis capillaris* applied to the seed of this species irrespective of the locality in which it is grown. The name "Rhode Island bent," correctly used, should apply to *Agrostis capillaris* grown in New England, but in the absence of any other common name for this species, the name "Rhode Island bent" has been used for seed produced in various regions. Many seedsmen, however, are using names which clearly indicate the source of the seed, as for example "Prince Edward Island-grown Rhode Island bent" and "Washington-grown Rhode Island bent."

[1] *Agrostis capillaris* L.—*Agrostis tenuis* Sibth. *Agrostis vulgaris* With.

INCREASE IN NUMBER OF KINDS FOR SALE

Previous to the World War, the purchaser of bent grass seed had the choice of buying either Rhode Island bent (*Agrostis capillaris*) or South German mixed bent, the latter usually consisting of *Agrostis capillaris, Agrostis canina,* and *Agrostis stolonifera major.*[1] The Rhode Island bent (*Agrostis capillaris*), grown in New England, contained a high percentage of leafage and chaff and generally a little redtop (*Agrostis stolonifera major*). The South German mixed bent was very chaffy and the percentages of the different ingredients varied considerably in different lots, many of them consisting of more than half redtop.

Today, seed of the following kinds can be bought: Rhode Island bent[2] (*Agrostis capillaris*), South German mixed bent consisting of *Agrostis capillaris* and *Agrostis canina,* seaside bent (*Agrostis stolonifera palustris*),[3] and velvet bent (*Agrostis canina*).

Rhode Island bent (*Agrostis capillaris*).—The seed of Rhode Island bent (*Agrostis capillaris*), on the market at the present time, is grown in various places and much of it is free from the seed of the other species of Agrostis. Seed from New Zealand, called "brown top," "Waipu," or "Colonial bent," and from the state of Washington is, as a rule, all *Agrostis capillaris.* That grown in Prince Edward Island, Canada, contains sometimes a little seed of velvet bent (*Agrostis canina*). The South German mixed bent as imported today usually is not mixed with redtop (*Agrostis stolonifera major*). Its principal ingredient is *Agrostis capillaris,* and the *Agrostis canina* present varies from a trace to a third of the sample.

Seed believed to be that of *Agrostis capillaris* has been grown in Oregon and has been put on the market under the names of "Golfalawn" and "Astoria bent." This is said to be a creeping form. The seed examined appears to be all *Agrostis capillaris,* but our present knowledge is not sufficient to determine whether or not the seed represents only the creeping form.

Seed of an Agrostis, also believed to be a variety of *Agrostis capillaris,* has recently appeared on the market in small quantities under the name of "Oregon bent." This seed can be distinguished from that of other bents, and has been recognized in bent seed from New Zealand.

Seaside bent (*Agrostis stolonifera palustris*).—Seed of seaside bent was for sale for the first time in this country in 1924, and since that time has been available in considerable quantity. While this plant grows abundantly on both seacoasts in the northern United States and Canada, most of the seed commercially available is produced in Oregon and Washington.

Velvet bent (*Agrostis canina*).—Seed of velvet bent (*Agrostis canina*) formerly was not obtainable except as an ingredient of the South German mixed bent. It appears also in very small proportion

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[1] This name as applied to redtop is preferred to that of *Agrostis alba* by Dr. A. S. Hitchcock, principal botanist in charge of systematic agrostology, United States Department of Agriculture. Dr. M. O. Malte also uses this name in "Commercial Bent Grasses (Agrostis) in Canada," published in 1928, in the Annual Report for 1926, National Museum of Canada.

[2] Rhode Island bent; name used here in the absence of a common name to apply to *Agrostis capillaris,* irrespective of the region in which it was grown.

[3] *Agrostis stolonifera palustris* Huds.—*Agrostis maritima* Lam. *Agrostis stolonifera palustris* Huds. is the name recommended by Dr. Hitchcock. Dr. Malte is using the name *Agrostis stolonifera compacta* Hartm.

in seed of *Agrostis capillaris* from Prince Edward Island. This year, for the first time, importations of velvet bent seed have been received. The seed received was grown in Alberta and the official samples examined were of high purity with only a trace of *Agrostis capillaris*. The importations were small, but there is every reason to expect in the future larger shipment of this seed.

Creeping bent.[1]—Agrostis sp. Small quantities of this seed have been produced, but as yet it can not be said to be on the market. The plant does not produce seed readily and because of the success in reproducing the plant vegetatively, by the planting of stolons, the demand for seed is not urgent.

Decrease in Number of Cases of Mixing

The great similarity in the appearance of seed of redtop and seed of the bent grasses, and the high price obtained for bent with the low price of redtop seed, have led to the mixture of bent grass seed with that of redtop and the substitution of seed of redtop for that of bent. Previous to the studies of Mr. Hillman on the distinguishing characters of the seed, analysts were unable to detect mixtures and this practice went on unchecked. Our main supply of seed came from Holland and Germany, where dealers made a practice of importing American redtop for the purpose of adulterating their seed. To quote from Mr. Hillman in United States Department of Agriculture Bulletin No. 692: "The importations of Agrostis during 1916 represented 48 lots, totaling 46,664 pounds. Two lots, amounting to 1,508 pounds, consisted of redtop only. One lot only, of 3,900 pounds, was South German mixed bent grass seed. The remaining 45 lots, totaling 41,255 pounds, came from a single firm in Arnheim, Holland. The seed in each of these lots was chiefly redtop, together with South German mixed bents, varying in quantity from a mere trace to an appreciable proportion. Of the 48 lots imported in 1916, 27 were entered as "creeping bent," 17 as "Rhode Island bent," 2 as "*Agrostis canina*," 1 as "*Agrostis stolonifera*," and 1 as "redtop." One of the two lots of redtop was imported as "redtop," the other as "creeping bent."

No data are available showing exactly how extensively the practice of mixing was carried on, as the adulterated seed investigation carried on every year by the Federal seed laboratory has never been extended to cover bent grass seed. The laboratory has on hand only the records of examinations of samples sent in voluntarily for examination or test. As samples of the same lot of seed may have been sent in from several sources, the information taken from the analyses can not be interpreted as an exact picture of trade conditions. However, a study of the analyses over a period of 10 years does show the changes in the character of a large part of the seed on the market.

The records show that from July 1, 1917, to June 30, 1918, inclusive, 35 samples of Agrostis seed were received bearing one or another of the following labels: "Rhode Island bent," "creeping bent," "German bent grass," or "South German bent." Of these, 15 were all redtop, 2 contained only a trace of bent, and 2 were mixtures;[2] one of the mixtures contained more than 50 per cent of redtop.

[1] Technical name undetermined.

[2] The words "mixture" and "mixed" as here applied to seed of bent grass and redtop imply that when the two are present as component parts the smaller part must be at least 10 per cent of the entire sample.

The next year's analyses include those of Colonial bent, and as this seed is imported free from the seed of redtop, one would expect a larger proportion of unmixed samples. Thirty-five samples were received labeled with one or another of the following names: "creeping bent," "English creeping bent," "Rhode Island bent," "German creeping bent," and "Colonial bent." Twenty of these were mixed with redtop. Of the 18 samples of "Colonial bent" received for test, 8 were mixtures.

Judging from the number of samples of bent grass seed received for test which were mixtures of redtop and bent, conditions remained about the same until July, 1922. From July 1, 1922, to June 30, 1923, inclusive, 62 samples were received, of which only 10 were mixtures. Of the 52 samples which were not mixtures, 8 were reported as appearing to contain no redtop, and 9 as containing only a trace.

From the year 1922 to the present time, the analyses show a diminishing number of cases of mixing in proportion to the number of samples received. In the period from July 1, 1927, to June 30, 1928, inclusive, 67 samples were submitted as bent. Of these, only 2 were mixtures. In addition, 77 samples of bent grass were received which were not named. Of these, 4 were mixtures of bent grass and redtop.

The greater number of unmixed lots of bent grass on the market today is due largely to the improved character of the importations, and this improvement has seemingly followed as a result of competition and the attention given by this laboratory to the samples representing the importations.

The Seed Importation Act of 1912 prohibited the entry of forage crop seed into the United States which contained 3 per cent of weed seeds or 5 per cent of an adulterant. This act did not apply to seed of bent grass except as it contained, as a component part (10 per cent or more), seed which was designated as coming under the terms of the act. As redtop was subject to the act, previous to the amendment of April, 1926, samples of bent grass seed received through the Customs were examined to determine if they contained 10 per cent of redtop. Mr. Hillman's examination of the 1916 samples showed that the Seed Importation Act of 1912 did not immediately discourage the mixing of bent grass seed with that of redtop. A few years later, however, examination showed that in many samples the redtop present amounted to 10 per cent of the pure seed (Agrostis species free from inert), but in comparatively few samples did the redtop seed amount to 10 per cent of the sample, due to the low pure seed percentage.

Toward the end of the year 1920, two years after the publication of Department of Agriculture Bulletin No. 692, the seed laboratory began to receive samples of South German mixed bent grass seed which were practically free of redtop. It so happens that the 27 samples of bent grass, representing all the importations of that seed from January, 1921, to June, 1921, are still on hand. Reexamination of these samples shows that 6 of them are practically free of redtop. Comparison of the importations of 1928 with those of 1921, shows a marked increase in the proportion of samples which are practically free of redtop. Seventy of the 82 samples of South German mixed bent received during the period from January 1, 1928, to October 1, 1928, inclusive, apparently contained no redtop.

Increase in Number of Well-Cleaned Lots

The small proportion of chaff and inert matter in the bent grass bought today is also worthy of note in view of the high proportion which was always present in the seed of 10 years ago. The highest pure seed percentage recorded for the 24 samples tested in the period from July 1, 1918, to June 30, 1919, was 73.29, the lowest 32.84, and the average 49.67. Of the 79 samples submitted for purity approximations in the period from January 1, 1928, to September 30, 1928, the highest pure seed percentage was 99, the lowest 60, and the average 82. The above comparison relates to samples received exclusive of those received from the collectors of customs.

The samples representing the importations submitted by the collectors of customs have been tested for approximate purity only since July, 1925, and only when the amount of work on hand permitted. The accompanying tables show the gradual improvement in the pure seed percentages as shown by the purity approximations made in 1926, 1927, and part of 1928. The samples examined in 1926 and 1927 represent all the samples of bent grass seed received, while those in 1928 represent only those received from May 1 to September 30. Purity approximations were not made of the samples received in the period from January 1, to April 30, 1928, on account of the great pressure of other work on hand.

South German Mixed Bent

Year	Number of samples	Highest purity	Lowest purity	Average purity	Samples between 70 and 80	Samples between 80 and 90	Samples between 90 and 100
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1926.....	127	97	52	69	23	9	2
1927.....	128	93	56	75	32	23	2
1928.....	[1]34	96	64	80	35	20	20

Colonial Bent

Year	Number of samples	Highest purity	Lowest purity	Average purity	Samples between 70 and 80	Samples between 80 and 90	Samples between 90 and 100
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1926.....	23	99	52	85	13	13	47
1927.....	18	98	92	95	..	..	100
1928.....	[1]21	99	93	97	..	..	100

Prince Edward Island-Grown Rhode Island Bent

Year	Number of samples	Highest purity	Lowest purity	Average purity	Samples between 70 and 80	Samples between 80 and 90	Samples between 90 and 100
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1926.....	8	93	89	91	..	37	63
1927.....	20	97	90	92	..	10	90
1928.....	[1]2	93	88	90	..	50	50

In reviewing the changes that have occurred in the production and sale of bent grass seed in the last 10 years, it is evident that the work of seed analysis has played an important part. The identification of

[1] All of the samples for which purity approximations were made, which include only those received in period from May 1 to September 30, 1928.

the seeds of the different kinds of Agrostis is one of the most difficult problems of seed testing. The work requires the use of a magnifier of high power (30 diameters or more), and considerable study is necessary to become familiar with the differences between the seeds of certain kinds. The appearance of new varieties makes the work more difficult, and ability to identify them requires more and more intensive study. The seed studies by Mr. Hillman and the subsequent analyses of hundreds of samples have created an interest in better seed, and the seedsmen's response to this interest has been the improvement here described.

Parasitic Control of the Japanese Beetle

Readers who live in the area already infested or threatened with the Japanese beetle will doubtless be interested in all phases of the work being done by Federal and State scientists in the control of this destructive pest. The lead arsenate method of poisoning soil is proving effective in preventing the ravages of the beetle in turf, but these insects, even though checked in turf, may seriously mar the beauty of a golf course by their destruction of the foliage of trees and shrubs. Entomologists of the United States Department of Agriculture have been trying for several years to introduce into the United States, from the Orient, some of the natural parasites which hold the pest in check in its native home. Clubs in and near New Jersey will accordingly be interested in the following report which has appeared in *The Official Record*, one of the publications of the United States Department of Agriculture:

"At the present time five species of oriental parasites of the Japanese beetle are established in New Jersey, there being two species of Tiphia wasps and one each of the flies Centeter, Dexia and Prosena. *Tiphia vernalis* has been recovered for the first time from a colony that was established two years ago. The same species has been recovered from three colonies established last year. *Dexia ventralis* has been recovered, both this year and last year, from the first colony established. Twenty-three thousand Tiphia cocoons have been received this year from India, and a shipment of 3,000 adult *Tiphia vernalis* from Japan arrived in good condition, with 42 per cent alive. Five thousand *Prosena sibirita* were received from Japan on parasitized grubs."

Notice of Annual Meeting

The annual meeting of the United States Golf Association will be held on Saturday, January 5, 1929, at the Hotel Commodore, New York City, at 12 o'clock noon.

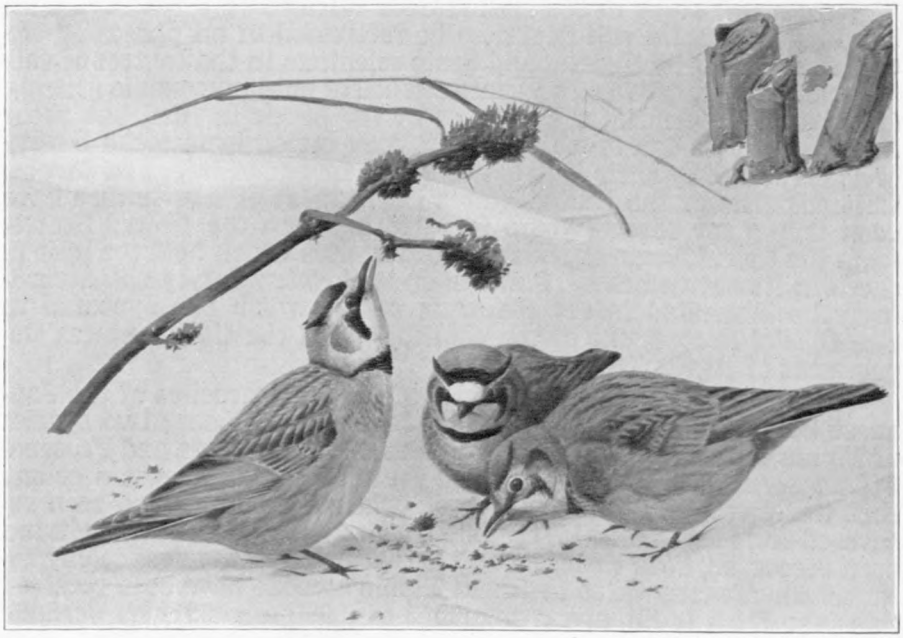
The Green Section Committee of the United States Golf Association has arranged to hold meetings at the Hotel Commodore, New York City, on Friday, January 4, at 10 a. m. and 2 p. m.; also a meeting on Saturday morning, January 5, at 9 o'clock. A number of interesting papers will be read, supplemented by a report of the work of the Green Section during the past year.

Birds of the Golf Course

The Horned Lark

By W. L. McAtee

Over the links at St. Andrews, and we presume over any in western Europe, on a bonny May morning skylarks fill the air with song. It is a vivacious tinkling melody delivered both on the ground and on the wing. It has a swing as if the songster were coming nearer and going farther away from the hearer, like a pendulum in the air. It continues in crescendo as the bird circles higher and higher, although finally becoming very faint, and is ended by a headlong pitch to the ground where the bird alights softly as a feather and utters perhaps a few more deliberate grace notes.



Drawing by Louis Agassiz Fuertes

The horned lark, a welcome golf course visitor, feeding on amaranth

We have in this country a relative of the skylark, namely the horned lark, that is equally at home on golf courses, and behaves much in the same way, its song, however, being not as loud nor as frequently delivered. These birds are vinaceous brown on the back with black feathers on each side of the tail. The throat is whitish or yellowish, set off by a black crescent on the breast; there is a black line from bill through eye and curving downward below it, and a tuft of black feathers each side of the crown, that can be erected; these have suggested the popular name. Horned larks nest in the northern and western states, and wander more or less to the southward in winter; they are of irregular occurrence in the vicinity of the District of Columbia, and are more frequently seen on golf courses than elsewhere.

This is because they are birds of the open; they fear not snow-covered fields nor wind-swept prairies. They are strictly ground-loving birds, being rarely seen perched on any elevated object. When disturbed they rise in a straggling manner, uttering short, whistled notes, and are as apt as not after a brief flight to return to or near the point of departure.

Horned larks have a useful relation to golf courses through their food habits. They are fond of weed seeds, making nearly two-thirds of their food of them, and consume large numbers of the seeds of such turf pests as crab grass, smartweeds, foxtail grass, chickweeds, dandelion, and others. Among insects and other crawling nuisances on golf courses that are eaten by horned larks are white grubs, wire-worms, dung beetles, clover leaf and clover root weevils, grass-hoppers, leaf-hoppers, chinch bugs, ants, and earthworms.

Horned larks do no harm on golf courses and little anywhere else; they help to control both weed and insect pests of turf, and are attractive in appearance, action, and music. They are among the most interesting of our bird friends, and should be treated as such.

Chestnut Blight Spreading

Of interest to many southern golf courses is a recent statement of the Department of Agriculture to the effect that the chestnut blight is continuing its rapid spread in the southern states. The department, in a statement sent to the press, advises owners of chestnut timber to consider carefully the salvage feature involved, particularly in regard to the smaller trees suitable for poles or for the manufacture of tannic acid, as the chances appear to be that due to the spread of the blight these trees will not reach maturity. It is expected that within the next ten years the blight will have killed most of the chestnut timber in the southern Appalachian region. The spread of the blight covers the states of West Virginia, North Carolina, South Carolina, Georgia, Tennessee, and Kentucky. The Department of Agriculture now has a botanist searching the wilds of Formosa and Korea for new species of chestnut trees for introduction into the United States in the hope of obtaining a blight-resistant tree.

Compost Pits.—A well-screened, out-of-the-way spot in or adjacent to woods on any golf course is an ideal location for the construction of compost pits. Into this pit weeds, leaves, and rakings may be dumped, and the dampness which collects naturally in such low places will quickly aid in the decomposition of the material and in rendering it suitable for use as compost. Sand, clay, or loam can be advantageously added to the contents of the pit from time to time. The addition of lime hastens the decomposition and counteracts any excess of acidity that may develop in the decomposing process. The addition of nitrate of soda or sulphate of ammonia speeds up decomposition remarkably, and may be used to advantage if quick results are desired. It will also help to turn the contents over with forks occasionally. On most golf courses over the country oak leaves are available in great abundance. It is true these contain tannic acid, but it has been found that the tannic acid disappears in the process of decomposition.

QUESTIONS AND ANSWERS

All questions sent to the Green Section will be answered in a letter to the writer as promptly as possible. The more interesting of these questions, with concise answers, will appear in this column. If your experience leads you to disagree with any answer given in this column, it is your privilege and duty to write to the Green Section.

While most of the answers are of general application, please bear in mind that each recommendation is intended specifically for the locality designated at the end of the question.

Controlling grubs in turf.—There are several fairways and greens on our course that are badly ravaged by white grubs. These grubs seem to destroy the roots of the turf so that it becomes loosened and feels open and porous when trod on. The turf soon dies after it becomes loose. Is there any way of controlling grubs?—(New Jersey.)

ANSWER.—It is likely that the white grub which is destroying the turf on your course is the larva of the Japanese beetle, which is active in your neighborhood. However, the grubs of the May bug and June beetle also damage turf in a similar manner. The larvae of some species feed on the organic matter in the soil and the damage is done by their continual burrowing and tunneling through the roots in search of food. Larvae of other species feed on the young roots, thus causing additional destruction to that resulting from their burrowing. White grubs may be controlled by treating the turf with arsenate of lead. On fairways the arsenate should be applied at the rate of 250 to 300 pounds to the acre. The powder is best applied by mixing it with sufficient dry soil to provide adequate bulk for an even distribution. Such a mixture can be applied with any of the ordinary lime or fertilizer distributors. If the fairways are not subjected to surface wash, the poison will be effective against grubs for a year or more, depending on the soil type. On putting greens arsenate of lead should be applied at the rate of 5 pounds to 1,000 square feet per year, mixed with soil or compost, and put on as a top-dressing. When greens are thus top-dressed regularly, the arsenate of lead should be applied at intervals in order to keep the poison at the surface. For example, if the greens are top-dressed five times a year, 1 pound of arsenate of lead to 1,000 square feet should be applied with each dressing so as to keep the soil immune from injury. A green treated for grubs in this manner is also proof against injury from earthworms. In order to adequately protect the putting green from grubs it is necessary to treat the soil for a distance of 25 to 35 feet around the edge of the green, since the grubs are capable of traveling relatively long distances, and if they are not poisoned before reaching the green they are likely to cause damage. More frequent applications of the poison are necessary on steep slopes where it is likely to be washed away.

Reseeding bare spots and renovating thin turf.—We have some exposed knolls from the topsoil of which the humus has been pretty well washed out. We also have a number of small bare spots at other places on our course. We desire to thicken the turf in these places and shall appreciate your advice in the matter. Our fairway turf is still comparatively new, having been seeded in the fall of 1926.—(New York.)

ANSWER.—For the bare spots on the knolls we suggest you make a liberal application of a good grade of well-rotted manure, and plow it under, but not too deeply. The land should then be disked and harrowed until a good seed bed is obtained, when it may be sowed with a mixture of 70 per cent Kentucky bluegrass and 30 per cent redtop. After the grass has developed sufficiently to warrant cutting, an application of sulphate of ammonia mixed with dry soil would probably aid in getting a good turf quickly. The sulphate of ammonia should be applied at the rate of 125 to 150 pounds to the acre. Where turf is thin, much can be accomplished by top-dressing with a good compost in much the same manner as one top-dresses greens. We find that where there is a fair stand of grass, liberal fertilization will ordinarily do more toward thickening the turf than the scattering of additional seed. As fairway fertilizers for regular use we have had excellent results from cottonseed meal, pulverized poultry manure, and sewage sludge applied at the rate of 400 to 600 pounds to the acre. If any of these organic fertilizers are too expensive, in some sections it is possible at times to obtain dried blood meal or fish scraps, which may be applied also at the same rate.

Value and use of muck.—In constructing nine of our putting greens last spring we used a topsoil which we mixed in the proportion 70 per cent muck, 20 per cent clay loam, and 10 per cent sharp sand. We used no fertilizer. We seeded the greens in the spring, but after germination the grass was so slow in growing that it was necessary to reseed in the fall. Should we have used fertilizer?—(California.)

ANSWER.—In using muck the inert condition of the material should be considered. Muck is liberally supplied with plant food, but much of the food is unavailable for plant use until further decomposition has taken place. Plants will do better in muck after it has decayed. This decay is effected by the encouragement of microscopic life, which is best accomplished by aerating the soil and applying stable manure. Rotting manure is well supplied with various microorganisms which assist in decomposing vegetable material and in making plant foods available. When there is too much organic matter in the topsoil, a green is liable to become too soggy after a rain. For this reason it would have been better to cut the proportion of muck down to 50 per cent and increase the proportion of sand to 30 per cent.

Draining the water system.—Can you reverse the pump on a water system on a course and pump the water out so that the pipes will not freeze in cold weather?—(Indiana.)

ANSWER.—We do not know of any pump which can be reversed in the manner you mention. Usually the water is forced in an upgrade from a pump, and there should be a valve in the water system near the pump which can be opened for draining the water from the main which is backing up on the pump. Water systems on golf courses are ordinarily supplied with drip-cocks at all the low points on the course so that in the fall of the year the greenkeeper can open these drains and thus run all the water from the pipes. If your water system has not been supplied with these drip-cocks, we would advise you to have your men install them at once, as no doubt the system will be cracked and broken in many places by the ice if not drained before severe weather sets in.

Dear Santa Claus:

Please leave at our club 18 greens that will be proof against wear and tear, diseases, bugs, unreasonable members, and other pests.

Please leave at Tom Smith's home one durable, soft rubber putter which may be cast violently on the ground without injuring the turf on our greens when he misses his putt.

Please leave at Ed Jones' house one digging fork and a spade in order that he may have something to dig with in his back yard to satisfy his craving for digging and thus relieve the strain on our tees.

Please leave some message of inspiration with the Royal and Ancient which will encourage them to adopt a new cup with a diameter of at least 10 feet so that in the future it may be feasible, if there are any missed putts, to blame them on the player rather than on the green committee.

Please leave your message of good will firmly fixed in the haughty hearts of our club members and make it last for many months and make it possible for members of our committee to actually enjoy a visit to the club within a month after we have found it necessary to close the course to play for a single day.

If you will do all this, dear Santa, you need not visit our houses. We'll take care of the kids this time.

Humbly yours,

THE GREEN COMMITTEE.