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Turf Experiments In New Jersey

Studies of various species of grasses for golf turf since 1923 at the New Brunswick nursery. Fertilizer experiments interesting

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RAPID progress has been made in recent years in the art and practice of maintaining turf on golf courses. Nevertheless, much improvement may still be attained as the result of a diligent search for facts, and the careful testing of each theory before accepting it as a basis for management practices. This search for facts should not be left entirely in the hands of a few individuals but should be the concern of every person interested in turf management.

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In this day of specialization, it is logical that the more technical investigations should be conducted by specially trained men, but the result of such studies must be common knowledge before any marked progress will ensue. For this reason, the results of some investigations on turf, conducted at the New Jersey Agricultural Experiment Station, New Brunswick, N. J., are presented here for the consideration of those concerned with turf problems.

The Adaptation of Grasses

STUDIES on the suitability of the various species of grasses for turf have been conducted at New Brunswick on a mildly acid, heavy silt loam and on a sandy soil since 1923. Approximately 30 species and strains of grasses were under observation during the six year period. For putting greens, velvet bent (*agrostis canina*), creeping bent (*agrostis stolonifera*), and "Rhode Island" bent (*agrostis tenuis*) alone, or mixed, are proving most satisfactory. The fescues, including the red or creeping fescue, have failed to maintain themselves under local conditions when kept closely cut.

For somewhat coarser turf such as is desired on fairways and lawns, Kentucky blue grass has been used quite successfully. A close relative, called rough-stalked meadow grass (*poa trivialis*), shows some promise but is less aggressive than Kentucky blue grass. "Rhode Island" bent and a mixture of the finer bents sold as "South German mixed bent" are also desirable grasses for fairways. Favorable results have been obtained with red top although the turf is somewhat coarser and more open than that produced by the other bent grasses and by Kentucky blue grass.

When the various species of grasses are grown on very sandy soils and cut at fairway or lawn length, hard fescue, red fescue, sheep's fescue, and fine leafed fescue are the only kinds capable of surviving, and even these produce an open bunchy turf. With closer cutting, it is doubtful if such grasses would persist. On a heavy silt loam, these fescues survive but the turf is much inferior to that furnished by Kentucky blue grass and the bent grasses.

Fertilizer Experiments on Turf for Greens

THE first experimental work with various systems of fertilizing turf was begun in August 1925 with the cooperation of the late Dr. C. V. Piper. At that time an area of about 12,000 square feet was planted to two strains of creeping bent, using the stolon method of propagation. In 1926 the area was subdivided into plots 10 x 10 feet in size and the various fertilizer treatments were first applied.

Twelve types of fertilization were included in the main experiment, dealing with the value of different nitrogen-carrying fertilizers. Each material has been used continuously since midsummer 1926 in such quantity that equal amounts of nitrogen have been applied to each plot. The treatments included are listed in Table No. 1.

Since it seemed desirable to compare several additional treatments in conjunction with the fertilizer test, the series of fertilizer plots was repeated eight times. The arrangement of plots is given in the accompanying chart of "Field B." Series I, II, and III are being used to determine the effect of different textures of top dressing material. Series I receives a top dressing composed of ⅔ sand and ⅓ loam, whereas the top dressing for Series II consists of equal parts of sand and loam, and for Series III, one part sand and two parts loam.

Series IV has been used to test the effect of lead arsenate in connection with each kind of fertilizer. Series V was designed to determine the degree of injury from brown patch and other disease when no control measures are taken.

Series VI, VII and VIII have been set aside to determine the individual effect of the various fertilizers on the abundance of weeds, clover, and annual blue grass, as well as changes in soil acidity, vigor of the turf and activity of earthworms.

The individual effect of the fertilizer treat-

Table 1. Summary of Conditions on Turf Plots at New Brunswick, N. J. The Soil is a heavy Silt Loam, the Turf Grass is Virginia Creeping Bent, and the Treatments Have Continued for Two and One Half Seasons.

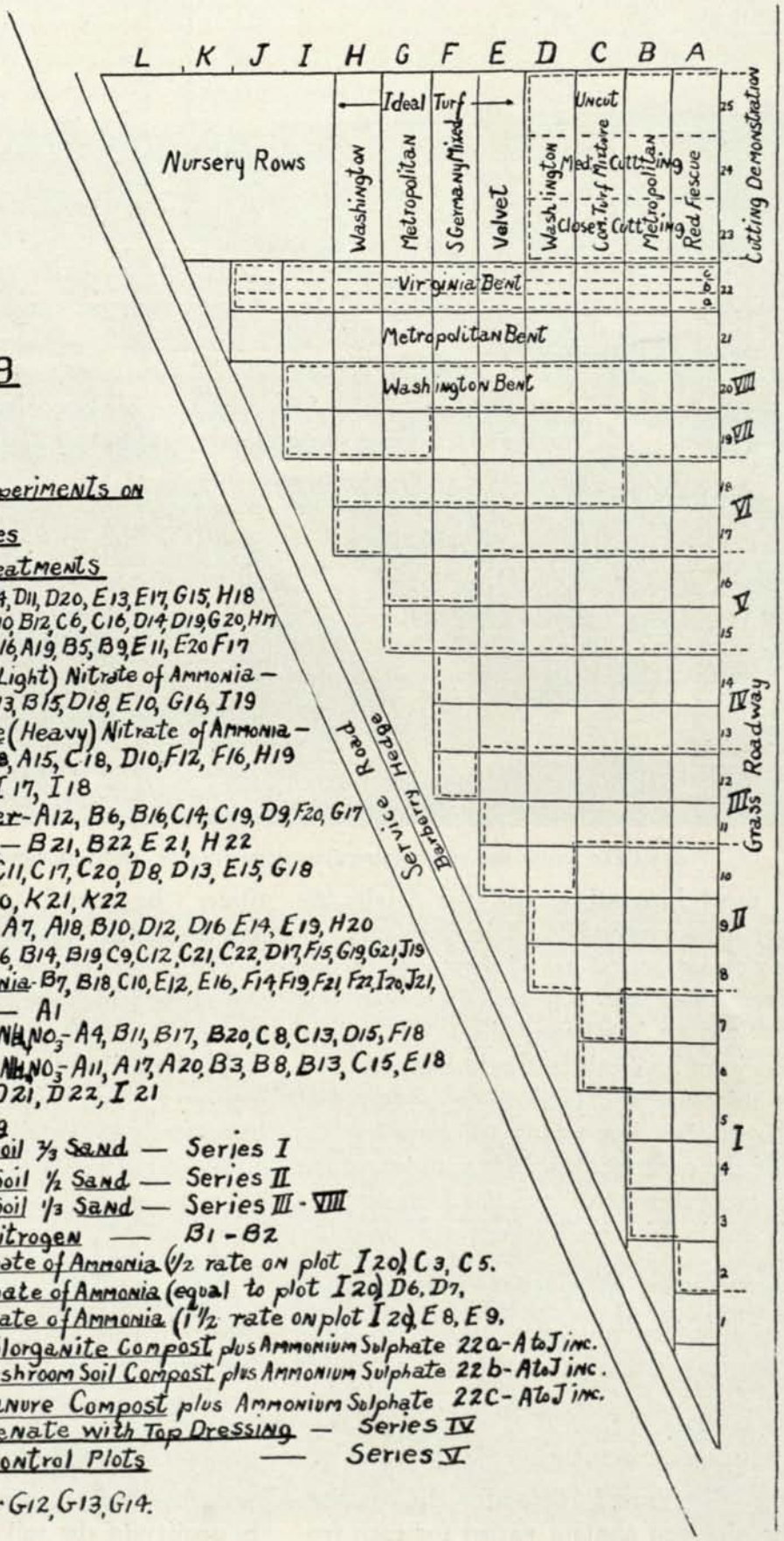
Treatment	Material Applied per 1000 sq. ft. per yr. (lbs.)	Nitrogen Applied per 1000 sq. ft. per yr. (lbs.)	Acidity of Soil (2) (pH.)	Total Dry Wt. of Weeds per plot (%)	Proportion of Turf Composed of: White Clover (%)	Proportion of Turf Composed of: Poa Annua (%)	Notes on Vigor Nov. 10, 1928 (3)	Earthworm Casts per 12 sq. ft.
No Fertilizer	---	---	6.2	100	28	33	m to p	39
Nitrate of Soda	18.7	2.83	6.8	56	11	17	m to g	43
Sulfate of Ammonia	14.1	2.83	5.4	20	6	16	m to p	28
Ammo-Phos	16.9	2.83	5.7	28	8	20	poor	26
Complete Fertilizer (1)	70.2	2.83	6.4	26	3	32	g to m	47
Alfalfa Meal	115.7	2.83	6.5	56	10	25	m to g	91
Manure	688.7	---	6.3	127	16	32	medium	34
Bone Meal	117.1	2.83	6.6	36	10	37	g to m	64
Light Sulfur	6.9	2.83	5.3	46	10	20	medium	28
Nitrate of Ammonia	8.8							
Heavy Sulfur	13.8	2.83	2.5	15	7	6	medium	18
Nitrate of Ammonia	8.8							
Light Hydrated Lime	68.9	2.83	8.0	55	4	12	good	43
Nitrate of Ammonia	8.8							
Heavy Hydrated Lime	137.8	2.83	8.1	22	3	18	good	34
Nitrate of Ammonia	8.8							

(1) The complete fertilizer contained 5 per cent nitrogen, 10 per cent phosphoric acid, and 5 per cent potash.

(2) The pH. values give a measure of active soil acidity. 7.0 is the figure for the neutral condition. Figures lower than 7.0 indicate acidity, the lower the figure the greater the acidity. Figures above 7.0 indicate alkalinity, the higher the figure the greater the alkalinity.

(3) "g" means good vigor and color. "p" means poor vigor and color. "m" means medium vigor and color.

This Chart Shows Fertilizer Treatments



FIELD B

Field Plan for Experiments on

Turf Grasses

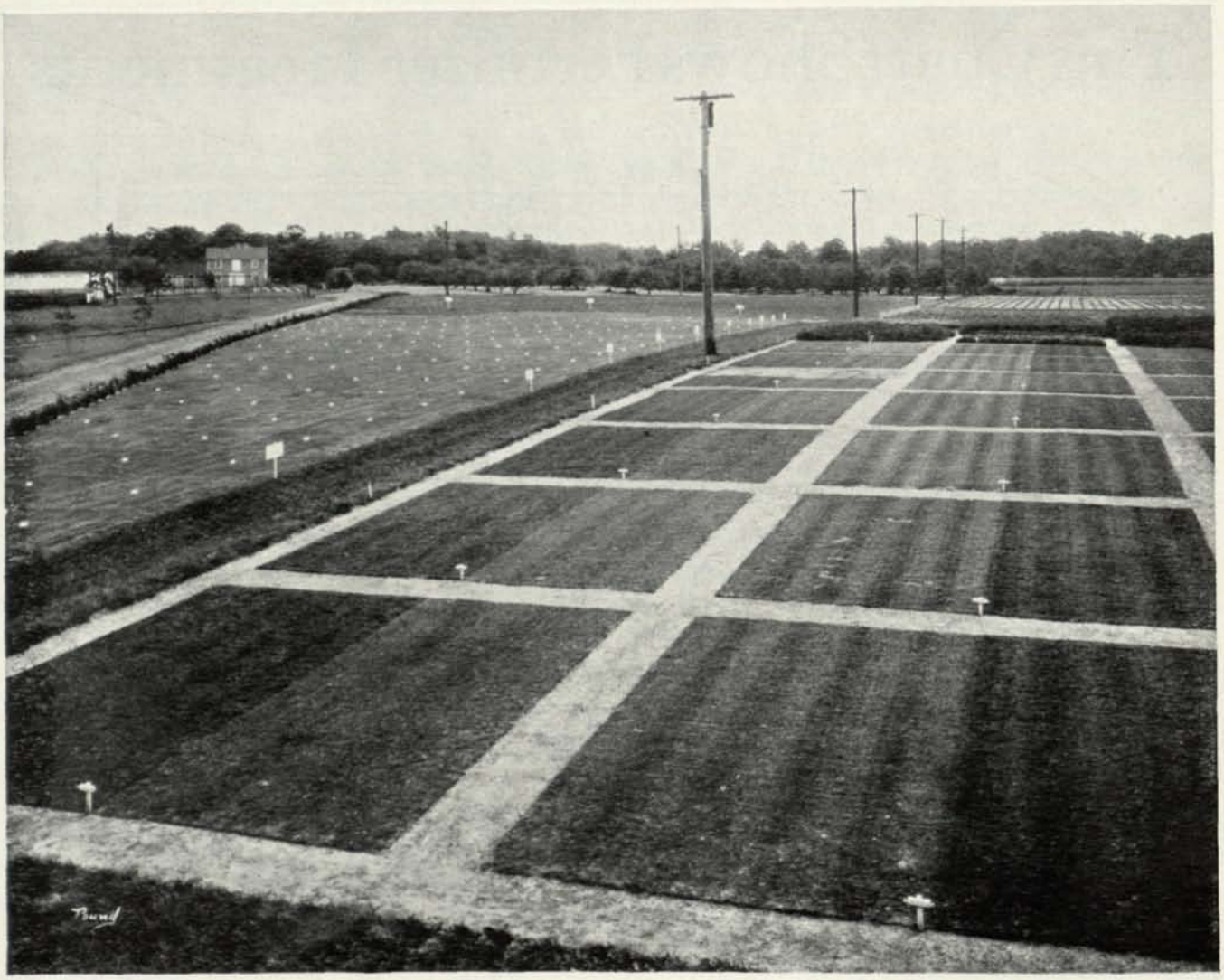
Fertilizer Treatments

Alfalfa Meal – A9, B4, D11, D20, E13, E17, G15, H18
Ammo-Phosphate – A10, B12, C6, C16, D14, D19, G20, H17
Bone Meal – A14, A16, A19, B5, B9, E11, E20, F17
Calcium Hydroxide (Light) Nitrate of Ammonia – A8, A3, A13, B15, D18, E10, G16, I19
Calcium Hydroxide (Heavy) Nitrate of Ammonia – C7, A2, A6, A15, C18, D10, F12, F16, H19
Castor Pomace – I17, I18
Complete Fertilizer – A12, B6, B16, C14, C19, D9, F20, G17
Cotton Seed Meal – B21, B22, E21, H22
Manure – A5, C11, C17, C20, D8, D13, E15, G18
Milorganite – J20, K21, K22
Nitrate of Soda – A7, A18, B10, D12, D16, E14, E19, H20
No Treatment – A6, B14, B19, C9, C12, C21, C22, D17, F15, G19, G21, J19
Sulphate of Ammonia – B7, B18, C10, E12, E16, F14, F19, F21, F22, I20, J21,
Sulphuric Acid – A1
Sulphur (Light) NH_4NO_3 – A4, B11, B17, B20, C8, C13, D15, F18
Sulphur (Heavy) NH_4NO_3 – A11, A17, A20, B3, B8, B13, C15, E18
Urea – D21, D22, I21

Top Dressing

Top Dressing 1/3 Soil 2/3 Sand – Series I
Top Dressing 1/2 Soil 1/2 Sand – Series II
Top Dressing 2/3 Soil 1/3 Sand – Series III - VIII
Pure Sand No Nitrogen – B1 - B2
Pure Sand Sulphate of Ammonia (1/2 rate on plot I20) C3, C5.
Pure Sand Sulphate of Ammonia (equal to plot I20) D6, D7.
Pure Sand Sulphate of Ammonia (1 1/2 rate on plot I20) E8, E9.
Top Dressing Milorganite Compost plus Ammonium Sulphate 22a - A to J inc.
Top Dressing Mushroom Soil Compost plus Ammonium Sulphate 22b - A to J inc.
Top Dressing Manure Compost plus Ammonium Sulphate 22c - A to J inc.
Lead Arsenate with Top Dressing – Series IV
Disease Control Plots – Series V

Nitrophoska – G12, G13, G14.



GENERAL VIEW OF TURF EXPERIMENTAL PLOTS, NEW BRUNSWICK, N. J.

ment is most interesting, and the details are given for the season of 1928 in Table 1. In the study and practical use of these results, one should remember that the soil on which this grass was grown is a heavy silt loam, mildly acid, medium in fertility, well drained, but poor in structure and inclined to puddle and bake. It is also important to consider the nature of the climatic conditions under which the tests were conducted and the fact that the Virginia strain of creeping bent was used.

Comparison of Nitrogenous Fertilizers

THE soluble fertilizers were applied in solution form; the total quantity being divided into 5 or 6 parts so that an application of fertilizer was made every 4 or 6 weeks. The solid fertilizers were applied in four equal applications distributed through the season. Since the nitrogen content varied for each fertilizer, the quantity required to give equivalent amounts of nitrogen differed.

The plots treated with sulfur to make the soil more acid were given a single application in 1926, but the plots which were limed to make the soil more alkaline have been treated regularly. Both the limed and sulfured plots have received equal amounts of ammonium nitrate fertilizer, and therefore any differences noted between these treatments are due to the use of sulfur or lime and not to the fertilizer applied.

Soil Acidity. It has been believed by many that if the soil were made strongly acid by some treatment or other, the bent grass would be able to thrive and at the same time the weeds would be discouraged and largely controlled. The fertilizer treatments in these experiments have been very effective in changing the acidity of the soil, thus making it possible

to test the value of the theory.

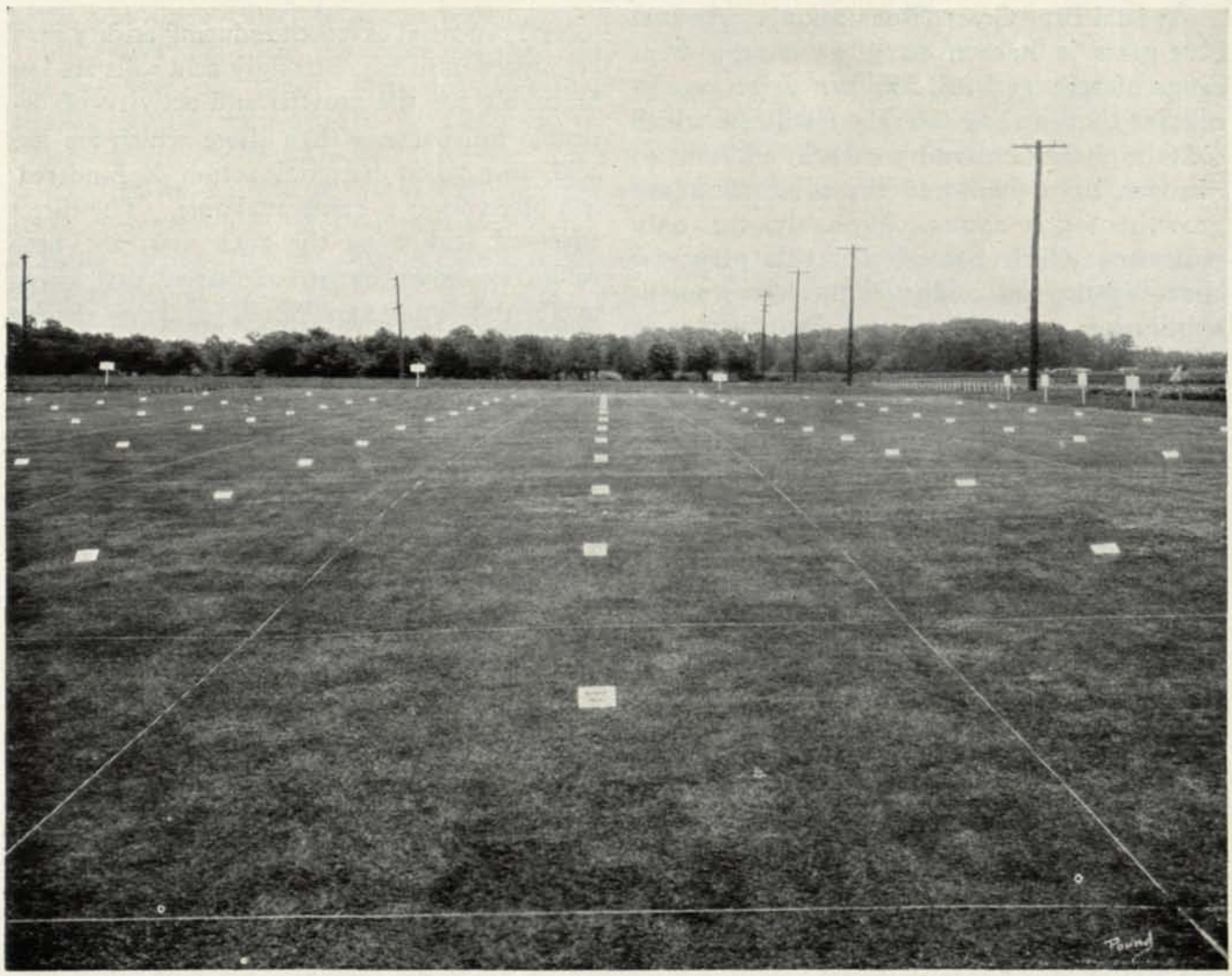
Acidity is conveniently measured in terms of a unit called the **pH.** When a soil has a pH. of 7.0 it is neutral. Figures lower than 7.0 indicate acidity, the lower the figure the greater the acidity. Figures above 7.0 indicate alkalinity, the higher the figure the greater the alkalinity. The soil on which these tests were conducted was naturally mildly acid as shown by a pH. of 6.2 on the untreated plot.

The single sulfur application in 1926 proved an effective means of increasing soil acidity but it was found that much care is needed to prevent burning when the material is applied. Sulfate of ammonia has been very effective in gradually making the soil more acid, and ammo-phos proved nearly as good. Manure and the complete fertilizer (nitrogen furnished by equal parts of nitrate of soda, sulfate of ammonia, and tankage) caused no change in acidity.

Nitrate of soda, bone meal, and alfalfa meal have all reduced acidity. However, the most effective means of reducing acidity has been by the use of lime. The limed plots have become strongly alkaline, a condition that practically never occurs in nature in this region.

Weeds. Irrespective of the changes in soil acidity caused by the treatments, weed growth has, in general, been reduced by fertilization. The only treatment which permitted appreciable weed growth was manuring, and in this case the weeds present undoubtedly came largely from seed contained in the manure.

The most striking point regarding abundance of weeds is the fact that the development of strong acidity has not resulted in any more effective weed control on putting greens than



VIEW OF THE EXPERIMENTS WITH BENT GRASS, NEW BRUNSWICK, N. J.

mild acidity or alkalinity. Apparently the native weeds in this area are as tolerant of acid soils as the grass itself, and therefore strong soil acidity is not a means of eliminating them. Fertilizing to promote the greatest vigor of grass seems to be more effective in weed control than developing strong acidity of the soil.

Clover. Another theory which has long persisted is that lime stimulates clover on closely cut turf. In these investigations, clover was no more plentiful on the limed plots than on acid plots. The application of nitrogen fertilizers in adequate quantities for vigorous growth of grass combined with regular close mowing has successfully controlled clover, no matter whether lime was added or not. It is quite possible that applications of lime without the addition of nitrogenous fertilizer would stimulate clover, but when fertilizer is also applied, clover is not increased.

Annual Blue Grass (Poa annua). Annual blue grass is known to grow over a wide range of soils and soil acidity. It seems significant that in these tests the fertilizers which contain phosphates and potash in addition to nitrogen have permitted the most abundant growth of poa annua. Probably the only treatment which has affected this plant by changing the soil acidity is the heavy sulfur application. Apparently the acidity has been strong enough in this case to hinder growth.

Opinion is divided as to the value of poa annua for greens, but those who dislike the plant may discourage it by making the soil strongly acid and by withholding fertilizers containing phosphates and potash. However, the advisability of this procedure is doubtful since the bent grass becomes less vigorous under such treatment and, in some cases at least, has proved to be less capable of withstanding hot, dry weather, disease attacks, and the competition with such weeds as crab grass. A more sensible procedure would be to make conditions as favorable as possible for the bent grass or other grass occupying the greens, and allow the poa annua to remain if it is aggressive enough to come in under such treatment.

Vigor of Grass as Affected by Fertilizers. In general, it may be stated that the turf in the experiments made good growth on all plots during the warm season, except those receiving no fertilizer. It is particularly noteworthy that the limed plots produced as vigorous a growth as any other treatment.

The indirect effect of the various treatments is most striking in the late fall and early spring. Treatments which caused the soil to become more acid were much less capable of maintaining good growth of grass in these seasons than those which reduced acidity. The limed plots produced the most vigorous growth of any treatment, a fact which is contrary to the opinion that creeping bent must have an acid soil. The quantities of lime used on these plots is much heavier than would be recommended for golf greens, but the results expose an old fallacy and indicate that liming may be a very desirable treatment if practiced in moderation.

The beneficial effects of reducing acidity may be largely indirect. Strongly acid soils are less favorable for the growth and activity of desirable soil bacteria than those which are less acid, and when bacterial action is hindered, less plant food is made available. The direct effect of acidity on the grass has not been definitely shown but it is apparent that creeping bent is quite capable of making thrifty growth on soils which are not acid.

Abundance of Earthworms. Earthworms can be controlled by treating with worm eradicators but the soil conditions which are preferred by them are of some interest. The effect of the various fertilizer treatments on earthworms was determined by counting the number of casts on each plot just after a rain. Apparently the organic materials such as bone meal, alfalfa meal, and the tankage in the complete fertilizer are very attractive to these worms. The casts were much less abundant where no organic matter was applied.

On plots receiving only the liquid fertilizers, the worms were most abundant on those made alkaline by treatment and least abundant on plots made more acid. Plots treated with sulfate of ammonia, ammo-phos, and sulfur had the fewest earthworms.

Lead Arsenate Treatments

ONE of the most effective methods of controlling earthworms is the application of lead arsenate in the top dressing. Although the method was originally designed to protect turf from infestations of Japanese beetles and white grubs, it has proved to have other beneficial effects, among which is the control of earthworms. A total of 15 pounds of lead arsenate per 1000 square feet was applied to one series of fertilizer plots in 1928, the material being added with the top dressing in three separate dressings.

No harmful effects were noted from the use of lead arsenate, irrespective of the fertilizer being applied to the grass, and the earthworms were entirely eradicated by the treatment. In addition, the weeds were reduced over 50%, clover nearly 20%, and poa annua about 30% in the first year as a result of the lead arsenate. The treated turf maintained its color and vigor throughout the season.

Since this treatment has been observed for but one year, one cannot state definitely that similar results will always be obtained on weeds, clover, and poa annua. However, there is every reason to believe that it will continue to be a simple and effective means of controlling earthworms on turf as well as the larva of beetles.

The Fertilizing Value of Urea and Cottonseed Meal. In the original plan of the experiments with fertilizers, cottonseed meal and urea were not included. Because of their increasing importance, it seemed advisable to study the value of these fertilizers, and accordingly a strip of Metropolitan bent grass was divided into plots for these tests. The results are given in detail in Table 2.

Urea proved to be nearly as effective as sulfate of ammonia in making the soil more acid, whereas cottonseed meal had no effect. Neither of the new fertilizers was as effective in controlling weeds, clover and poa annua as sulfate of ammonia. In fact, Urea seemed to stimulate poa annua, a result which was entirely unexpected and not accounted for at the present time.

Cottonseed meal caused the grass to remain green later in the fall than either Urea or sulfate of ammonia, but like other organic fertilizers it proved very inviting to earthworms.

Tests of Other Fertilizer Materials

THERE are many new kinds of fertilizer and fertilizer mixtures being offered for sale each year and it would be impossible to test them all without tremendous expansion of facilities. However, space was found along the edge of Field B, for testing three of these materials, Nitrophoska, Castor pomace, and activated sewage sludge.

Nitrophoska is a concentrated fertilizer containing 15% nitrogen, 30% phosphoric acid, and 15% potash. When this material was applied so that the same quantity of nitrogen was added as on the sulfate of ammonia plots, the two fertilizers seemed about equal in value. Since the test was begun in 1928, more time is needed to determine the long-time effect of this fertilizer.

As a fertilizer, Castor pomace compared favorably with other organic materials such as cottonseed meal, but it has not been of any value in controlling earthworms. Although the pomace of castor oil beans is poisonous to man when eaten, it apparently has had no harmful effect on earthworms.

The third material tested was activated

Table 2. Summary of Some Fertilizer Tests at New Brunswick, N. J. The Grass on the Test Plots was Metropolitan Bent and the Treatments had Continued for Two Seasons.

Treatment	Material Applied per 1000 sq. ft. per yr. (lbs.)	Nitrogen Applied per 1000 sq. ft. per yr. (lbs.)	Acidity of Soil (1) (pH.)	Weeds (%)	Proportion of Turf Composed of: White Clover (%)	Proportion of Turf Composed of: Poa Annua (%)	Notes on Vigor Nov. 10, 1928 (2)	Earthworm Casts per 12 sq. ft.
No Fertilizer	---	---	6.2	100	15	13	poor	33
Sulfate of Ammonia	14.1	2.83	5.8	15	2	6	m to g	36
Urea	6.3	2.83	5.9	71	6	18	medium	32
Cottonseed Meal	44.5	2.83	6.2	56	7	9	good	81

(1) The pH. values give a measure of active soil acidity. 7.0 is the figure for the neutral condition. Figures lower than 7.0 indicate acidity, the lower the figure the greater the acidity

(2) "g" means good vigor and color. "p" means poor vigor and color. "m" means medium vigor and color.

sewage sludge. The sludge produced at Milwaukee is called "Milorganite" and this brand was used in the tests at New Jersey. Like other organic fertilizers, the nutrients contained are made available to plants upon decomposition and therefore its effect on grass is slow and extended. The test conducted in 1928 indicates that the fertilizer may be the equal of other organic materials, providing the nitrogen may be purchased at the same price.

Use of the Experimental Data

THE value of these experiments does not lie in the fact that one treatment has been found better than others, but rather in the fact that some of the various factors which go to make up good or poor systems of fertilization are isolated and may be studied independently. It is hardly possible to lay down rules for maintenance of golf greens that will apply over a large area having diverse soils and climate; but if the reasons underlying this or that treatment are understood, the systems of management may be varied rationally to suit the conditions at hand.

There are many other soil and plant problems to be solved before turf management advances from the empirical stage to one of reasoned practice. New experiments designed to solve some of these problems have been recently established at the New Jersey Agricultural Experiment Station, and results should be available in the near future. In the meantime, visitors are always welcome on the turf plots and the exchange of ideas will no doubt benefit everybody concerned.

Seed And Seed Markets

What the probable prices will be in the spring of 1930

BY E. E. PATTISON, *Director*
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NOW that the greenkeeper has finished his fall work, he has ample time to consider his spring needs and as most everyone will require some seed, it seems wise at this time to give information not only in regard to the source of supply, but to the trend of future markets.

The wise greenkeeper will see to it that his seed supplies are ordered from reliable sources and delivered in time for inspection and testing before seeding. He will also see to it that his orders are placed when the markets are favorable. In nine cases out of ten, early buying saves money.

The Bents

EVEN though the fall planting was not so large as originally estimated, due to adverse weather conditions, the carryover of bent seed of all origins is extremely small. One or two importers have some of the badly adulterated bent which came out of Germany and Holland last spring and it will undoubtedly be sold during the coming spring.

South German Mixed Bent

The 1929 crop of European Bent is not so large as the 1928 crop. It is slightly more weedy and will therefore take more reconditioning before shipment to America. From September 1 when the markets opened, until November 1, there has been an advance of 20c per pound. On the present market, today's price to the golf course for spring delivery should be approximately as follows:

70% pure	$70.00
80% pure	80.00
90% pure	90.00

New Zealand Colonial Bent or Brown Top

The 1929 crop of New Zealand Bent was slightly larger and of better quality than the 1928 crop. New Zealand being six months ahead of us in the Northern hemisphere, a great deal of the 1929 crop was used this fall.

In previous years there was some hesitancy on the part of a great many people in using seed of this origin, but from the results of some of the more adventuresome persons, it has been found that seed of this origin (especially that from the Southern Island) is adaptable to our conditions. In many ways, Colonial Bent is the most economical to buy. The seed is usually of higher purity and of lower weed seed content. Whether or not