THE PATH TO PERFECT FAIRWAYS

By KENNETH WELTON

Any fall fairway improvement program must be planned NOW. This is the second instalment of Mr. Welton's article; the first appeared in our July issue.

FOR results of an experiment started in the spring of 1934 on some old fairway turf on clay soil, see Table 2. The experiment included 20 plats consisting of a great many variations of fertilizers and rates. The series was laid out in duplicate, one section being watered, the other left unwatered. In this series we may make a direct comparison of cer-

TABLE 2—EFFECT OF LIME ON KENTUCKY BLUEGRASS

	Grass %	Clover %	Other Weeds %	Bare Ground %
Check (no fertilizer or lime)	25	5	24	46
Inorganic fertilizer	30	2	33	37
Inorganic fertilizer and lime	43	7	20	30

tain plots receiving inorganic fertilizers carrying sulphate of ammonia against plots receiving similar fertilizers at similar rates but also receiving sufficient lime to prevent them from becoming acid.

The results given above are the averages of these plots for the first year. They are of value in that they show the advantages of using lime on old turf in conjunction with fertilizer. In this case the pH of the soil ran about 5.8, which is not considered exceedingly acid, yet the results show that the addition of lime accounted for an increase of 13% in bluegrass over the use of combinations of inorganic fertilizers alone. It will be noted that although there is an increase of 2% in clover over the check plots that there is a decrease of 4% in other weeds. In this case the turf has not been improved sufficiently on the average to the point where there is a great enough increase in grass to crowd out clover and weeds. The lack of an appreciable increase in clover and the small decrease in the weed population is all the more convincing. These results add additional proof to the contention that lime will not increase clover and weeds on turf providing nitrogen is supplied to stimulate grass growth.

Heavy Fertilizing for Thin Turf

There are many courses in the country on which the fairways are becoming real problems. Most of these fairways are the result of starvation. When the turf becomes poor from starvation the grass plants do not make enough increase and the turf becomes thinner and thinner. In other words, the number of grass plants in a given area become less and less. Also the number of shoots and grass blades on each plant become fewer and fewer. This decrease in the grass population leaves small bare areas which either become larger until they become noticeable or the bare areas become filled with clover and weeds.

Once a turf becomes this poor it becomes very difficult to get it back into good shape in even several seasons with normal fertilizing. In the fall of 1931 the Green Section started an experiment to determine what could be accomplished on a thin, run-down turf by heavy feeding. This experiment has been written up in the Green Section "Bulletin" of December, 1933, so at this time I am only going to refer to it briefly. A uniform area of one acre or more on clay loam soil on a fairway of a run-down course in the Washington area was chosen for this experiment. Strips 10 feet wide and 100 feet long were run across the fairway and a 6-12-4 fertilizer made up in both the inorganic and organic form was chosen for the experiment. Fertilizers containing 6% nitrogen were chosen partly because there are a number of popular organic nitrogen carriers on the market which contain about 6% nitrogen and hence the rates of application are comparable to rates used with such fertilizers. These fertilizers were applied at rates of 700, 1400, 2800 and 5600 pounds to the

TABLE 3—CONDITION OF TURF BEFORE FERTILIZERS WERE APPLIED (FALL 1931)

Grass Cover %	Clover %	Other Weeds %	Bare Ground %
62	8	12	18

TABLE 4—CONDITION OF TURF (1932) AFTER TWO FALL FERTILIZER APPLICATIONS

	Rate of Application lbs. per acre	Grass Cover %	Clover %	Other Weeds %	Bare Ground %
Average of checks	(unfertilized)	63	8	11	18
Inorganic	700	82	10	3	5
Organic	700	80	5	5	10
Inorganic	1400	94	1	0	5
Organic	1400	80	5	10	5
Inorganic	2800	95	0	0	5
Organic	2800	93	2	3	2
Inorganic	5600	80	0	0	20
Organic	5600	91	1	3	5

acre, and similar areas were left unfertilized as checks.

Table 3 shows the condition of the turf in October, 1931, when the fertilizers were first applied. Table 4 shows this same turf in December, 1932, after being fertilized in the two falls of 1931 and 1932. You will note that the average of the check plots indicates that the turf had changed little during this period except where fertilized. Two full applications had done wonders to the turf where 700 pounds per acre had been applied but in the 1400 pounds per acre inorganic the best results can be seen when one considers the amount of fertilizer applied. It is true the 2800 pounds inorganic shows a very slight superiority but since twice as much fertilizer was applied than in the 1400-pound area there is no doubt that the 1400-pounds-per-acre inorganic plot is the outstanding one after two applications. The percentage of grass cover is identical in the organic fertilizer at the two lower rates but there is a decided increase at the 2800-pound rate. Inability to account for the apparent failure of the organic fertilizer at the 1400-pound rate to give better results than the 700-pound rate simply serves to emphasize that many more similar experiments are needed to provide convincing proof of the relative value of organic and inorganic fertilizers at different rates. In neither the inorganic nor organic fertilizers did the 5600-pounds-per-acre applications give appreciably better results than the 2800-pounds-per-acre applications, so it seems as if an application of 2800 pounds in one year is about all the food the grass plants can handle, at least under those conditions.

I wish to draw attention also to the remarkable control of clover and other weeds gained in the inorganic applications of 1400 pounds and over and in the organic plots of 2800 pounds and over. Although there was some bad burning on the plots receiving heavier rates of inorganic fertilizer still the great weed and clover control cannot be attributed to it except indirectly. There was no burning with the organic fertilizer at any of the rates used and still there was almost the same weed and clover control in the two heaviest rates of fertilizer plots. Evidently the weed and clover control was due almost entirely to the competition of the grass as it may be seen in table 4 that the weed and clover control is proportionate to the percentage of grass. The one exception is the 5600-pound-per-acre inorganic plot where the burning was sufficiently severe to affect the growth of grass, as well as clover and weeds.

The soil on this area was not deficient in lime as the only application of any kind it had been given in over 10 years was an application of lime several years preceding the experiment. The soil analyzed about neutral. The soil was found to be deficient in phosphorus, running about 50 pounds per acre of available phosphorus. The fertilizers carried twice as much phosphorus as nitrogen, which seemed advisable, since it was known that the soil was deficient in this element and it was felt that plenty of available phosphorus was needed to encourage the bluegrass to its maximum plant increase. Other experiments on the same soil in previous years have shown that no such plant increase could be gained by nitrogen alone. And the results of this experiment seem to corroborate other data that an

TABLE 5—COUNT OF PLANTS AND SHOOTS ON THE BEST PLOTS IN THE EXPERIMENT AT THE END OF TWO YEARS (1933)

Kind of Fertilizer	Rate of Application lbs. per acre	Shoots per Square Foot	Approximate Plants per Square Foot	Shoots per Plant
Inorganic	1400	2160	240	8
Organic	1400	2000	400	5
Average of checks		256	80	3

adequate supply of phosphous stimulates healthy grass growth, root development, and plant increase. Phosphorus must be considered to play an important part in the maintenance of good fairway turf. It should be noted that the results show decided clover control even though plenty of phosphorus was applied.

Turf Thickens 900 Per Cent

Table 5 shows the increase in plants as shown by a count taken two years after the fertilizer was first applied. This represents about 900 per cent increase in Kentucky bluegrass shoots over the unfertilized or check plots.

Those intending to use heavy applications of fertilizer in order to get quick results should beware of the danger of burning the turf with heavy applications of inorganic fertilizers. In these tests as much as 2800 pounds per acre of 6-12-4 inorganic fertilizer were applied at one time and at this rate the burning was sufficiently severe to kill from 10 to 15 per cent of the bluegrass. However such burning as was produced by applications of 1400 pounds of 6-12-4 inorganic at one time was not permanent, under the conditions of this experiment, and did not kill the bluegrass, bents or fescues in the area. But badly browned fairways may be difficult to explain to the players and under certain conditions might not heal as quickly and completely as turf which we have burned in these experiments has.

To prevent such burning inorganic fertilizer applications may be split. For example, we have not had burning from properly applied applications of as high as 700 pounds per acre of 6-12-4 so a club wishing to make a 1400 pound application could apply 700 at one time and follow after the first rain with a second application. Grass should be dry when fertilizers are applied or burning will be increased. In this experiment as much as 2800 pounds per acre of organic 6-12-4 fertilizer was applied at one time without any burning.

I do not have figures here to show what improvement heavy applications gave in just one season but I can report that on the areas receiving as much as 2800 pounds per acre in one fall the turf had improved from an estimated 20 per cent perfect condition to 80 per cent of perfection by the following spring. I do not expect everyone to immediately commence piling fertilizer on their fairways but I do wish to bring out clearly that usually insufficient fertilizer is applied to get outstanding results.

I also wish to present the idea that it may be of decided advantage to some clubs to accomplish the desired results on their fairways in one or two seasons rather than to use an equal amount of fertilizer over a number of years and still be short of having desired conditions. From the growth on these heavily fertilized plots over a year and a half after the last application was made it appears that once fairways are brought to perfection by fertilizing that the soil is sufficiently fertile to carry the grass without appreciable loss for two years at least without further applications.

Crabgrass Still Serious Problem

At this point it is necessary to describe the sad fate of part of the experiment just described. Not to stop at the excellent results obtained with applications of fertilizers for two succeeding falls we applied the same amounts of fertilizers to the plots the following spring for the purpose of discovering where the limit lay. And this spring application brought home very forcibly a fact which we long had suspected but of which we lacked much convincing proof, which is that spring fertilizing encourages crabgrass.

For the benefit of many here I must explain that Washington is the belt where crabgrass (Digitaria sp.) is a serious fairway problem. Crabgrass is found in many northern and southern sections of the United States but one must have turf maintenance experience in such golfing centers as Washington, Cincinnati, Louisville and St. Louis to appreciate how serious a problem it is. Crabgrass is purely a

TABLE 6—CONDITION OF TURF THE SUMMER FOLLOWING FALL AND SPRING FERTILIZING

	Grass Cover %	Clover %	Other Weeds %	Bare Ground %	Crab-Grass %
Average of checks (Unfertilized)	52	17	11	10	10
Fall application, Inorganic	82	2	1	0	15
Fall application, Organic	60	10	15	0	15
Spring application, Inorganic	10	0	0	0	90
Spring application, Organic	20	20	10	0	50

summer annual and a prolific seeder. It germinates in the Washington district during May and matures in October. The first frost usually kills the plants. It likes warm weather and plenty of moisture for maximum growth. It is always worst in seasons with warm wet weather in the late spring.

The spring of 1933 was a warm wet spring and there was such a profuse growth of crabgrass on the heavy spring fertilizer plots that the 2800 and 5600 pounds per acre plots were completely ruined. The crabgrass grew so profusely on these plots that all the bluegrass was completely smothered. The bluegrass on the 1400 and 700 pound per acre plots was badly thinned but came along quickly in the fall and made a fair recovery but even in these much of the good results of the preceding fall applications was lost.

A new series was started in the fall of 1933 under similar conditions with the intention of discovering the differences to be expected from spring and fall applications.

Table 6 shows the results of an application of 2800 pounds per acre in the fall compared with a similar application the following spring. You will note on July 3rd the fall plots ran 82% and 60% Kentucky bluegrass, respectively, and only 15% of crabgrass apiece. Whereas the spring plots which were fertilized May 1st and which were beside the others under identical conditions had only 10% Kentucky bluegrass in inorganic and 20% in organic but contained 90% and 50% of crabgrass, respectively. This experiment is only a year old but since it is supported by results in other experiments and by numerous observations it merits serious consideration and I would advise those in districts where crabgrass is a serious problem to do no spring fertilizing of fairways at least until you have checked on this angle to your own satisfaction.

In Table 6 I wish to draw attention to the remarkable clover and weed control gained by the fall application of inorganic fertilizers. This also illustrates how much burning old bluegrass can stand, since the application of 2800 pounds per acre was applied at one time to save labor. Although it was applied mixed with sand when the grass was dry there was a bad burn, yet the bluegrass came along strong after the first rain, but the clover and weeds (mostly narrow leaf plantain) seemed unable to recover. The spring applications also showed clover and weed control due to the smothering effect of the crabgrass. This heavy growth of crabgrass died the latter part of October and left the area much worse than the check area.

Before leaving the crabgrass subject I would like to call to your attention the crabgrass control work which the Green Sections has been doing with sodium chlorate; the preliminary results of this work are published in the December, 1933, Bulletin, which I mentioned before.

From the results of these experiments with sodium chlorate and the experiment referred to in Table 6 it appears that it will be possible to keep crabgrass under control in the fairways by spring and summer applications of sodium chlorate and adequate fall fertilizing. There are other factors, particularly height of cut and watering which also should be considered, but we have no time to discuss them at this time.

You may have received the impression that there is still a great deal to be learned about fairway fertilizing. I hope you do feel that way about the subject. I have pointed out that there are certain things experiments have shown us and certain scientific facts which we may believe, but there are also many phases of fairway fertilizing which are still puzzling to us. It is a big interesting subject with many angles to it and in time there will no doubt be many new facts learned. In the meantime however I feel that there is much more known about fairway fertilizing than is being practiced and we should not be discouraged until we have at least given the golf clubs the advantage of our present information.