MILWAUKEE
MILORGANITE
IDEAL TURF FERTILIZER

BULLETIN No. 3

FAIRWAY IMPROVEMENT

Theory and Practice

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FAIRWAY IMPROVEMENT

Part I

Theory

Dense Turf Suppresses Weeds: Development of a dense mat of grass is the secret of weed control and is the basis of good fairway turf.

Fall Best Time to Start Program: In the North, fall is the best season to renovate neglected fairways and start a systematic program of improvement. This is especially true in the crab grass belt, embracing the region from Philadelphia and Washington to Cincinnati, Louisville, St. Louis, and Kansas City. Only by utilizing favorable growing weather throughout the fall and again in spring is it possible to produce turf which can resist reinfestation the following season.

Farther north, where summer heat is not excessive, improvement programs can begin in spring. By fertilizing then grass starts to thicken immediately; but where supplementary seeding is desirable that part of the program should be deferred until fall.

Turf Grasses Spread Naturally: The fundamental premises in formulating a sound improvement program is the cardinal fact that all turf forming grasses spread by vegetative means to form dense turf - provided environmental factors are favorable. This is either overlooked or ignored. Bent and poa trivialis creep by means of surface runners called stolons, whereas Kentucky blue grass and fescue spread by underground stems called rhizomes. Hence, one or several unfavorable factors prevent development of good turf. Impoverished soil is commonly blamed for poor grass, but other unfavorable soil factors, bad drainage, unsuited grasses, or the ravages of destructive insects and diseases may be even more important.

Determine Cause for Poor Turf Then Devise Program: Improvement from fertilization cannot occur if existing grass is unsuited to soil or climate. In that event, re-seeding to introduce suitable grasses must accompany fertilization. So, before formulating a program, the necessity for determining the cause of poor turf is fundamental. This calls for a careful examination of soil, turf, and all other factors. Since the answer is usually right on the property, it is a simple matter to devise a workable plan which will eliminate all retarding factors and transform poor or mediocre turf into a beautiful, dense sward of grass.

Drainage: Obvious drainage needs are generally provided. Very often damage from seepage and almost imperceptible depressions is not recognized. Poor turf near the base of hillsides generally results from seepage. Damage occurs in spring or fall. Kentucky blue grass and fescue usually disappear, whereas bent and poa trivialis invariably survive. Tile lines to intercept seepage must precede fertilization and re-seeding. The other alternative is to use moisture tolerant bents.

In northern regions knotweed, clover, plantain, etc. take possession in slight depressions following winterkill of blue grass or fescue, but tile is not the answer. Drains never function when ground is frozen. Improved surface drainage or the use of creeping bent is the obvious solution.

Soil: Soils ranging from sandy to silt loams are best for fairway turf because of their capacity to hold and ability to deliver capillary water and plant food.

When grass is sparse on heavy soil, players may advocate top-dressing with sand. This complicates future maintenance and does not solve the problem. Improved "lies" depend upon development of dense turf to form a cushion so the ball sets up.

Sands present the real problem. Their low water-holding capacity makes it impossible to hold turf during summer heat and drought. Furthermore, they are low in plant food, particularly nitrogen, because plentiful aeration speeds oxidation and consequent destruction of organic matter. Here again top-dressing is usually advocated. A thin layer of heavier soil does not solve the problem. Fairway watering, together with fertilization to stimulate grass and curb weeds and clover is more effective, and probably less expensive. Where irrigation is impossible, the only alternative is to encourage fescue. It stands drought better than any other fairway grass.

Lime: Once frowned upon as the principal cause for clover and weeds, lime has been restored to favor. It is recognized that soils can become too acid even for acid tolerant bent and fescue.

Definite need for lime is indicated when soils are moderate to strongly acid. With borderline soils (pH 5.5 to 6.0 for blue grass and pH 5.0 to 5.5 for fescue and bent) no serious harm will result from delay until definite need is established by test strips across one or more fairways, using 50 or 75 pounds (1 ton and 1½ tons per acre, respectively) on plots measuring 10 x 100 feet.

When lime is needed, soils should be tested for available magnesium. If low by a dependable method, a finely ground dolomite limestone should be used to correct acidity. This eliminates any possibility of magnexium deficiency.

On watered fairways, development of localized dry spots in summer is sometimes due to excessive soil acidity. In such cases the use of lime gradually corrects the condition.

Fertilization: After eliminating other factos, fertilization is the clue to increased turf density.

On established fairways, nitrogen is the key to better turf. On nitrogen starved grass, heavy rates are justified spring and fall until turf of desired density is obtained. After that, rates can be reduced to bare maintenance requirements and possibly only one a year. In crab grass regions, major nitrogen feeding should be in fall with smaller doses in spring so as not to encourage crab grass.

True organics, such as Milorganite, should furnish most of the nitrogen because they are longer lasting. Soil processes release the water insoluble nitrogen gradually over long periods. They are certainly superior for fall use, because any nitrogen not taken up and utilized that season does not leach away during winter.

Milorganite can be applied in a single application, even in the large quantities needed on impoverished turf. But with soluble fertilizers, split applications are necessary to avoid serious burning.

Phosphate Overemphasized: Need for phosphate has been overemphasized on established fairway turf. It should be used liberally only where soil is known to be deficient, or where re-seeding is necessary. After one generous application additional phosphate is not needed for three or four years at least, if Milorganite is used to furnish needed nitrogen in the interim. 1,000 pounds of Milorganite per acre supplies as much phosphoric acid as 200 pounds of 16 percent superphosphate.

In this connection, however, it may be well to point out the importance of using superphosphate quite generously before seeding. This applies to re-seeding on established fairways as well as on new seedings.

Potash Seldom Needed: Because clippings are not removed and because most soils contain abundant potassium, fairways seldom need potash fertilizer. Its use may simply aggravate clover.

Grasses: On well drained fairways out in the open, Kentucky blue grass or fescue should predominate. Of the two, blue grass is most certain and apt to survive.

For Kentucky blue grass, soil must not be too acid and must be well supplied with phosphorus. There are sections along the Atlantic seaboard and in the Pacific Northwest where soils are too acid and low in phosphorus for this grass to survive. Contrary to the belief of some, blue grass can be grown in both regions, provided acidity is corrected and phosphorus deficiency eliminated.

Kentucky blue grass does not withstand drought as well as fescue. On the other hand, it survives on watered fairwys, whereas fescue usually disappears. Of itself, blue grass does not make a tight turf, which will keep clover out completely when cut to fairway length. For that reason, there is a tendency to use some colonial bent along with blue grass on watered fairways, especially where clover control is a real problem.

Fescue fairways are prized by most golfers, but clubs find it difficult to maintain pure stands of this grass. On light sandy soil, fescue is usually preferred, but it will grow on heavier soils provided they are well drained. Fescue stands hot dry weather, but disappears during wet humid summers. Hence it is folly to use this grass in the region from Washington across to Kansas City. Fescue is not sufficiently aggressive to survive on watered fairways. So, when golfers demand water and fescue predominates, re-seeding is necessary to introduce grasses which will survive under irrigation. Otherwise clover and weed infestation is sure to follow fescue deterioration.

Creeping bent is not a good fairway grass. The heavy surface mat which develops is objectionable from the standpoint of play and maintenance. Surface matting prevents penetration of water during dry weather, and grass rots during hot wet spells. Where creeping bent predominates, close cutting is imperative to prevent matting, but then blue grass and fescue disappear.

Recently there has been a tendency to use some colonial bent, such as Astoria, particularly on watered fairways. Not more than 10 to 15 percent is needed in the seed mixture. The bent fills the voids in blue grass turf and thus assists in clover control. The colonial bents do not mat like creeping bents. Since the latter are more aggressive, the colonial bent seed must be entirely free from seaside or other creeping bents.

In northern regions, where winterkill occurs in depressions and low spots, drainage must be improved or bent grasses used in these spots to prevent annual loss of grass. The areas can be seeded, or they can be planted with native bent stolons.

Insect Damage and Disease: Grubs are the worst offenders. In regions where Japanese and Asiatic beetles are numerous, grub-proofing with lead arsenate is imperative. In some regions, grubs of the May and June beetles do serious injury in localized spots. These grubs can be controlled with lead arsenate also.

Where infestation is light, the customary rate for applying lead arsenate is 200 pounds per acre, but twice this quantity is used for heavy infestations. Milorganite is the best carrier for applying lead arsenate.

In localized areas chinch bugs have caused serious injury to turf, particularly creeping bent. To date, fine ground tobacco dust of high nicotine content has given best control. The usual rate is 25 to 30 pounds per 1000 square feet.

In wet spells, leaf spot often injures Kentucky blue grass. There is no known cure. Less frequent mowing and higher cutting to preserve as much leaf surface as possible usually proves helpful.

Worm casts are objectionable, particularly when grass is sparse and thin. They usually disappear as turf density is increased by fertilization. However, on some bad areas it is necessary to supplement fertilization with lead arsenate treatment. The customary rate is 200 pounds per acre.

Weeds: Chickweed, clover, plantain, buckhorn, and dandelion are easily the most troublesome fairway weeds. Most of these can be reduced or eliminated by a systematic fertilizer program which increases turf density. That means ample nitrogen. As grass thickens, weeds automatically diminish. However, when weeds or clover are especially numerous, their removal by fertilization is a slow process at best.

In recent years, promising results have been obtained in weed control with chemicals. This work was started by the Green Section of the United States Golf Association. Excellent results have been obtained with Sodium Arsenite and Arsenic Acid. Both have been used quite extensively to clean up roughs.

As a rule, these arsenicals have been dissolved in water and applied as liquid sprays. This necessitates use of special spray equipment. The serious discoloration which occurs and the possibility of consequent thinning of turf has deterred many clubs from extensive treatment of fairways.

By using the dry method of application, the burning hazard is reduced to a minimum. Since it is useless to kill weeds without replacing voids with grass, fertilization must supplement the liquid method of application. By using Milorganite as the carrier for applying Sodium Arsenite (Arsenic Acid is a liquid, hence it can't be used) both results are accomplished in one operation. Furthermore, special equipment is not needed. Any good fertilizer distributor will do.

Two treatments in spring take out most of the clover, so this mixture may be the answer to the clover problem on fairways. One application, or two at the most, kills chickweed. From three to four treatments are needed to eradicate plantain, buckhorn, and dandelion. After that, spot treatment will quickly kill the few remaining large plants.

When re-seeding is not necessary, spring and fall are the best seasons to use Milorganite-Sodium Arsenite mixture. To avoid discoloration, grass leaves should be dry, that is, not covered with dew, but soil should be moist at time of making application. So on unwatered fairways that means waiting for fall rains if soil is dry. On the other hand, heavy rain immediately following an application washes the Sodium Arsenite off the foliage and nullifies its effects.

Where re-seeding of fairways is necessary, treatments should start early so at least one and possibly two applications can be made before seeding. If weather is hot, some discoloration of grass may occur, but that can't be helped. It is important to kill weeds and clover before seeding. The last treatment, second or third, can be made right after sowing seed. Sodium Arsenite may kill young grass seedlings, but it does not prevent or inhibit germination. On established fairways, an alfalfa and grass disc seeder should be used for seeding. This machine cuts the seed into the soil so rains will not wash it away. The operation need not interrupt play.

Sodium Arsenite will kill crab-grass, but is apt to damage grass because of excessive heat when applications are made. However, when infestation is heavy, re-seeding is usually necessary. In that event, Sodium Arsenite can be used to kill the crab grass before it seeds, thus reducing the possibility of infestation during the next year. Within a week the area can be seeded so new grass becomes well established before winter.

Part II.

Practice

A knowledge of the theoretical aspects of turf improvement, covered in Part I, is needed to determine the cause of poor turf and to devise a plan for improvement. However, the practical application of these underlying principles is important. For, unless the necessary operations are performed in the correct sequence, disappointment is sure to follow.

Survey Important: A careful field survey, possibly augmented by tests of representative soil samples should precede actual formulation of the improvement program. The field survey should embrace a careful investigation of drainage, soil, and turf, as well as possible damage from insects, disease, etc. Turf density and amount of weeds and clover should be estimated, and grasses constituting turf population should be identified. Soil tests should include reaction and available quantities of the major nutrient elements. A statement of past maintenance practices, particularly with respect to cutting habits, lime, and fertilizer usage, water practice, etc. is most useful. After gathering this information, a program can be devised with full assurance that it will succeed.

Drainage: Needed drainage should be decided upon first and all, or at least the most necessary, tile lines should be installed before winter.

On hilly courses, possible damage from side-hill seepage must be considered. Needed tile lines must cross the direction of slope and be sufficiently deep to intercept flow. Backfill of trench with gravel or cinders to within 8 or 10 inches of the surface is a "must" item to lead water down to the tile. Without this porous trap to collect water, pressure from above drives seepage across the tile and then it breaks out along the base of the hill just as before.

Occasionally water table is near the surface and can't be lowered sufficiently to permit installation of tile. Under these conditions it is foolish to expect Kentucky blue grass or fescue to survive and form turf. Hence, choice is limited to one of the bents. Seaside is best for the damper locations, otherwise Colonial may do.

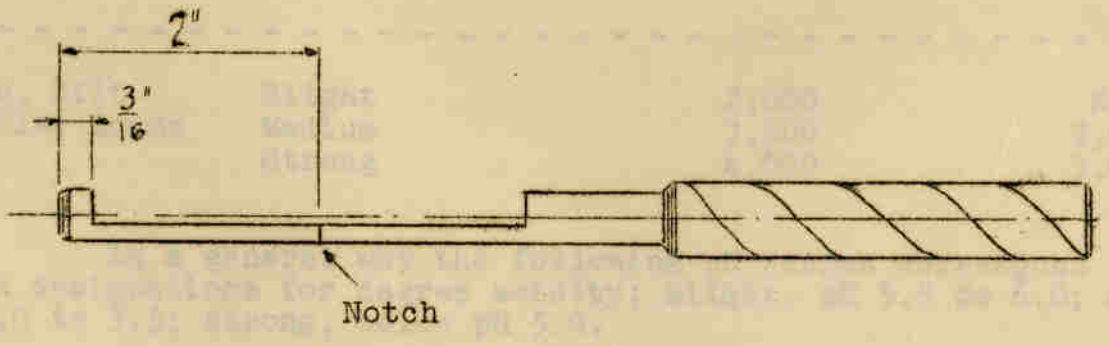
In northern regions where Kentucky blue grass and fescue winterkill in pockets and depressions, surface drainage must be corrected or bent used. The area can be seeded or planted with stolons of native bent, which grow wild along adjoining streams and other wet spots. Stolons can be used on areas where watertable is high also. Customary procedure is to loosen soil by cross-discing, then scatter stolons and disc again to cut them into the soil, and finally to roll. Top-dressing is helpful, but not absolutely necessary. Fertilization with Milorganite at 1000 to 1500 pounds per acre (25 to 40 pounds per 1000 square feet) before scattering stolons speeds turf formation.

Top-Dressing Fairways Not Necessary: Except in very rare cases, extensive top-dressing of fairways is not justified because of the huge expense involved. There is the added danger of introducing clover and objectionable weeds.

At one time top-dressing was customary practice to eliminate the cuppy "lies" which invariably exist where turf is thin and bunchy. Fertilization is the cheaper and quicker method and hence preferable because it encourages grass to spread. "Cuppy" depressions disappear when complete coverage is obtained.

Even on sandy soil, top-dressing is seldom justified, for increased waterholding capacity is not materially increased by several inches of heavier soil. Fairway irrigation is a more satisfactory answer and probably cheaper in the long run. However, supplementary fertilization every year is imperative, otherwise clover and weeds take possession.

Lime and Fertilizer: Chemical soil tests are helpful guides in determining need for lime and phosphate. But, unless samples are carefully collected results are meaningless. Individual plugs should be taken to an exact depth of 2 inches, and each sample should consist of 8 to 10 plugs taken at equidistant points over the area being sampled. An efficient sampler can be made from a discarded steel golf shaft. For details see illustration below.



Soil Sampling Tool
Made from Discarded Steel Golf Club Shaft

The simple, practical soil sampler illustrated above is made on an emery wheel from a golf shaft with a heavy sidewall. Those of light stock break easily.

The cutting edge is only 3/16 inch to facilitate removal of plugs, and is sharpened. The slot is ground just below center so plugs slip out easily and the mark for measuring plugs is EXACTLY 2 INCHES.

Enough samples should be collected to truly represent soil conditions on the course. That means collecting two or more composites for each kind of soil and for each different elevation, if the course is hilly. Never put plugs of different color, texture, or from different elevations in the same composite sample. When sampling a poor spot, another sample should be taken from a nearby good area. A dependable method should be used, and tests should be made by an experienced person. If that necessitates sending samples away, they should be air-dried first and put in clean containers. New one-half or one-pound paper bags, obtainable at any store, are excellent for this purpose.

Need for lime should be based on reaction, usually expressed in terms of pH. By this method the figure 7 represents a neutral soil and lower ones increasing acidity. Rate of application depends upon kind of grass, type of soil, and degree of acidity. Kentucky blue grass needs lime before fescue or bent. More lime is needed on heavy soil than on sandy soil to produce the same degree of change. All these factors are taken into account in the following table. Suggested rates are based on using a finely ground limestone.

Suggested Rates for Applying Ground Limestone on Fairways

Soil Texture	Degree Acidity	Pounds per Acre	
		Kentucky Blue Grass	Fescue and Bent
Sands and Sandy Loams	Slight	1,000	None
	Medium	2,000	1,000
	Strong	3,000	2,000
Loams, Silt and Clay Loams	Slight	2,000	None
	Medium	3,000	2,000
	Strong	4,000	3,000

In a general way the following pH ranges correspond to above designations for degree acidity; slight, pH 5.5 to 6.0; medium, pH 5.0 to 5.5; strong, below pH 5.0.

Sometimes acid soils are low in magnesium. Then the limestone used to correct acidity should contain magnesium as well as calcium. They are commonly called dolomites or dolomitic limestones. The material used should contain not less than 20 to 30 percent magnesium reported as magnesium oxide. If analysis is not printed on the bag, it can be obtained from the manufacturer.

Ground limestone can be applied at any time. However, if soils is strongly acid, it should be used as long before fertilization as possible, particularly if phosphate is to be used.

Nitrogen is the main necessity on established fairways, but phosphate is important on new seedings. Potash is seldom needed because clippings are not removed. Furthermore, most soils contain an abundance of potash. Its use may only encourage clover.

Most of the nitrogen should be supplied from organic fertilizer, such as Milorganite. It can be applied all at once in the amounts needed on thin grass without danger of burning, but with soluble fertilizer split applications are necessary. Milorganite also furnishes vital growth promoting nitrogen over longer periods than ordinary fertilizers. This is why it produces much longer lasting results.

The rate for Milorganite in the fall should range from 1,000 to 1,800 pounds per acre. The smaller quantity is ample where grass is fair to good, but on fairways where turf is thin, the heavier rate should be approached. Another application should be made in early spring, but at a somewhat lighter rate.

On weedy fairways it is sometimes advisable to use 100 to 200 pounds per acre of ammonium sulphate with the Milorganite. If tests show need for more phosphorus than is supplied by Milorganite, 16-20 or 11-48 grade ammophos can be substituted for the sulphate.

Soil tests are helpful guides in determining need for phosphate if a dependable method is used. Some show need for phosphate which is not substantiated by results in the field. Past tendency has been to over-emphasize need for phosphate on established fairways.

Milorganite alone supplies enough phosphorus when soil contains 75 to 100 pounds per acre of available phosphorus by the Hellige-Truog Method. In the range from 40 to 75 pounds superphosphate should be used also at 200 pounds per acre for the 20 percent grade. When available phosphorus is below 40, the rate for superphosphate should be doubled, that is, 400 pounds per acre. One application of phosphate is ample for 2 to 4 years at least, if Milorganite is used in the interim to supply needed nitrogen.

On new seedings, or when re-seeding established fairways, superphosphate should be used with Milorganite even though available soil phosphorus exceeds 75 to 100 pounds per acre. From 300 to 400 pounds per acre should be used along with 1,000 to 1,500 pounds Milorganite. First apply lime, if needed, then the fertilizer and sow seed after that. One advantage possessed by the Milorganite-superphosphate combination is the fact that seeding can proceed immediately after fertilizer is applied. This is not the case with soluble fertilizers. They are apt to inhibit germination or burn the young seedlings. Then use Milorganite only for the next 3 to 4 years at least.

Seeding: Where existing grass is uniform but thin, and consists of suitable varieties, re-seeding is not necessary. Fertilization alone will produce good turf.

Re-seeding is justified to introduce a different grass which will produce better turf, or to speed turf development after killing weeds on badly infested areas. The necessity for re-seeding before

starting to water fescue fairways has been mentioned. A mixture of Kentucky blue grass and Astoria bent is excellent. The usual proportion is 80 to 90 percent blue grass, with 10 to 20 percent bent and rate of seeding 50 to 60 pounds per acre. Red top can be omitted because bent seed germinates just as quickly.

Where re-seeding is necessary, an alfalfa and grass disc seeder should be used for sowing seed. Cross-seeding is advised because discs are spaced 4 inches apart. By using this machine, play can continue without interruption. As stated before, needed fertilizer should be applied first.

Weed Control: If weeds are scattered and not too numerous, they disappear automatically as turf density increases by systematic fertilization. The few remaining large dandelions and plantain can be taken out by hand, or by spot treatment with sodium arsenite or gasoline.

Where broad leaved weeds are numerous, Milorganite-Sodium Arsenite mixture speeds weed elimination and causes grass to fill the voids. Such a mixture is now available. For further particulars, see your Milorganite distributor, or write direct to the Milwaukee Sewerage Commission.

This mixture should be applied at 400 pounds per acre each time. Uniform distribution is important so all weeds receive a lethal dose of arsenite.

Although not absolutely essential, it is well to set the spreader to apply 200 pounds per acre and go over the fairway twice. There are machines available which will apply this light rate.

Treatments should start in early fall, after hot weather is over, or in early spring. Soil should be moist at time of application to avoid discoloration of grass. Hence on watered fairways it is best to water turf the day before applying the mixture. Then after four days irrigate again to encourage growth of grass. On unwatered fairways wait for fall rains to moisten dry fairways before starting treatments.

Grass should be dry at time of making each application as a further precaution to prevent severe discoloration. Furthermore, do not apply immediately before heavy rains; because rain washes the arsenite off the weed leaves.

Two successive treatments kill chickweed and take most of the clover. But for plantain, buckhorn, and dandelion from three to four are required. Success depends upon making successive applications when new formed leaves attain a length of 1½ inches.

Treated areas may look brown from a distance if weed infestation is heavy. This is caused by effect of arsenite on leaves of weeds. Where chickweed is heavy, or other close-growing weeds are numerous, treated areas turn brown and may be quite bare after weeds are killed.

If re-seeding is necessary, start treatments in August, despite the fact that grass may be discolored. In deciding on starting time, allow two weeks between treatments and make the last one immediately after sowing seed. Arsenite kills young seedlings, but does not stop seed germination. So, if chickweed is the sole pest, begin treatments two weeks before seeding, but for plantain, etc. where three are needed, the first treatment must start one month before seeding.

Follow-up treatments should be made in spring to kill new weeds starting from seed. One or two treatments suffice because weed seedlings are easily killed.

When used to kill crab grass, one application at 600 to 800 pounds per acre is sufficient. Be sure to apply before seed heads form. This reduces infestation the next year. After crab grass is dead, it should be raked out, or area should be cross-mowed with bed knife set low to remove trash and prepare a seed bed. Then sow seed. Since weather is apt to be hot when using Milorganite-Sodium Arsenite Mixture on crab grass, some damage to grass is apt to occur. This can't be avoided, and does not matter if re-seeding is necessary.