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The USGA Green Section Specifications How Have They Done?

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In this age of the "Credibility Gap," no one expects immediate acceptance of new ideas or techniques. People have always resisted change. It is not surprising then that, when the USGA Green Section introduced *Specifications For A Method of Putting Green Construction* in 1960, a crackling controversy soon developed. But the gap has closed during the past 7 years. A review of what has happened to putting green construction is more than interesting, it is vital to anyone concerned with the future in golfing turf management.

The Specifications represented the first major attempt to apply scientific principles to the technique of putting green construction. It was not difficult for the skeptic to say, "They will never work." Perhaps the most often heard comment was (and still is), "How can a laboratory in Texas possibly tell me what soil mixture is best for my greens in California?" From the outset, it was difficult for people to understand or accept the techniques involved even though they are based on widely recognized and proven principles.

A brief description here of the Specifications is in order. Developed over a period of 10 years through research grants made to a number of Universities, the Specifications were authored by Dr. Marvin H. Ferguson, USGA Research Coordinator in 1960. Basically, they call for a 4-inch gravel blanket entirely covering the subsoil of the green with tile lines properly installed. The gravel blanket is overlaid with a coarse sand layer 1-1/2 inches in depth. This in turn is covered with at least 12 inches of a soil mixture (sand, native soil and organic matter) that meets certain physical soil requirements. This is an extremely important point in the Specifications. The exact ratio of sand, native soil and organic matter can only be determined by a physical soil analysis made by a laboratory familiar with the specific techniques. There are a number of other details in carrying out the Specifications, but the cross section shown in Figure 1 generally illustrates the profile of a USGA Green. Since each phase of construction is interdependent on all others, greens must be built exactly as outlined if they are to function properly. "Short cuts" have not proven successful.

Early Resemch Work

As early as 1956, Dr. 0. R. Lunt, University of California at Los Angeles published results of his study of soils for putting greens.[3] He reported that greens comprised of 85% sand, 7.5% clay and 7.5% fibrous peat should resist compaction, maintain highinfiltration rates, have the capacity to retain fertilizers and water and provide an ideal medium for putting green turf. Hillcrest Country Club in Los Angeles (as well as a number of other courses) built several greens to Dr. Lunt's recommendations and they have performed very well over the past 9 years.

It wasn't long after these scientific breakthroughs in putting green construction were introduced in the late 1950's and early 1960's that several "home style" inovators, including some golf course architects, arbitrarily started to add more sand to their soil mixtures when building greens. Many of these greens went under the guise of "USGA Greens," but were a far cry from them in reality. Equally unfortunate, the scientific greens of UCLA and the USGA soon became known in the profession as "sand greens," losing their identity with the principles of soil physics, moisture retention, nutrition, etc.

The Golf Course Architect

The golf course architect was quick to recognize the advantages of using straight sand or sand and organic matter when building greens. Sand is extremely easy to "grade out," it is easier to obtain and usually less expensive than good top soil and there is no problem with rocks, stones or weeds. Furthermore, clients have been reminded that "sand greens" are the very latest in scientific research recommendations.

To the golf course architect, tile line installation is something else. Usually scoffed at, tile lines were (and still are by many architects) considered unnecessary. If a client insists, some perimeter tiling might be done, but not with enthusiasm. Architects have also resisted if not rebelled at off-site mixing so essential in obtaining a uniform soil mixture. Although there are recent signs to the contrary, it is most unfortunate that this influential segment of the golf course construction industry, i.e., the golf course architect, has, in the past, generally failed to demonstrate an appreciation or understanding of fundamental soil knowledge and research results.

Facts That Have Been Overlooked

In today's "soilless greens of the West" (i.e., constructed with pure sand), the fact has been overlooked that the soil must act as a reservoir for plant life: a reservoir not only for moisture, but nutrients as well. Base exchange capacity is important. Frequently called "ionic exchange," base exchange is simply a way of expressing the relative adsorptive power or ability of any soil to hold nutritive elements. C. E. Marshall,[3] a noted agronomist, has said that, next to photosynthesis, base exchange "is the most important chemical reaction in the whole domain of agriculture." Greens constructed from pure sand have little or no base exchange capacity. They must be "spoon fed" constantly and carefully. It is only when clay and/or organic matter are present in a soil mixture that base exchange capacity is also present.

There's another reason for including clay and organic matter in a soil mixture. It is known as "buffering." Expessed very simply, the higher the exchange capacity of a soil, the greater will be its buffer capacity. Buffering has far reaching significance. Higher plants as well as microorganisms can suffer seriously from sudden changes in the availability of nutrients. Deficiencies or over-supplies seriously upset the nutritional balance of a soil solution and plants react accordingly. The buff e ring capacity-a result of the presence of clay and/or organic matter in a soil, tends to smooth out abrupt changes in pH and nutrient availability.[4] Putting green management becomes far easier when base exchange and buffering properties ate present in the soil. Pure sand lacks these qualities.

The Variable Soils

For these reasons, the USGA Specifications call for both "native soil" and organic matter in the mixture as well as sand. The native soil furnishes the important clay particle. William Wildman,[3] University of California Soils Specialist has said, "A little clay in a soil can go a long way in improving its water holding capacity, nutritional reserves, and manageability." But research has shown that clay must be used in putting green soils in small quantities and carefully. Native soils vary widely in their percentage and type of clay. They also have varying percentages of fine sand and silt and these latter materials are the components causing compaction. If their quantities are too high in the total mix, problems are sure to develop.

Variable Organic Matter

The Specifications also call for organic matter. But the layman's version of what constitutes "organic matter" has been distorted in recent years. For example, are soil amendment materials such as calcine clays, mica products, cinders, diatomaceous earth, slag, etc. suitable as organic components of a soil? Where do the wood products such as bark, treated chips and sawdust fit into the picture? Can they take the' place of organic materials such as peat moss? We have reason to be confused.

In the laboratory work done for USGA Greens, it is generally agreed that a good, fibrous peat moss is still hard to beat when it comes to providing moisture retention, soil resiliency and a high base exchange capacity. The amendment materials may have advantages over peat in one respect or another, but usually fall short in some other catagory (cost is but one example). Therefore, the value of a good quality peat moss in a soil mixture should not be overlooked. Amendments undoubtedly have their place; but only as amendments, not substitutes for true organic materials.

Variable Sands

Lastly, the major percentage of today's soils for putting greens is made up of pure sand. Unfortunately, sand comes in all sizes, shapes and descriptions. There is no uniformity in particle size or gradation within some sand pits, let alone throughout the country. It is another great variable in the picture of putting green soil mixtures.

Why a Physical Soil Analysis?

With so many variables to contend with; i.e., different types of clays, silt and fine sand percentages, particle size differences within any given sand, variances in organic matter, etc.; a physical soil analysis is essential if proper ratios are to be achieved. It can not be done by feel, guess or intuition any better than it can be done by a laboratory analysis. This is exactly why a "soil laboratory in Texas" *can* tell you what the proper ratio of materials you have on hand should be for proper construction. The results are based on measurable physical facts, and sound judgement should be based on nothing less.

Once the proper ratio of sand, native soil and organic matter has been determined, it can only be mixed accurately and thoroughly through "off-site" mixing. No other way has been found to consistently obtain a complete mixture of ingredients.

Why Not?

Since 1960, over 2000 USGA Greens have been built in this country. Where the work was carefully done and every step carefully followed, the greens have been a total success. There is no question that the method is both practical and successful. Where failures have occurred (and there have been failures), they can usually be traced to "on-site" mixing, poor "off-site" mixing techniques or a failure to closely follow all seven steps of the Specifications. Serious compaction problems have been overcome. Good drainage has resulted and nutritional problems have been easily corrected and managed.

In a number of cases, the comment has been made that such greens are simply too expensive to build. Off-site mixing is frequently cited as prohibitive in cost. But where there's a will, there's a way. With today's modern equipment, off-site mixing can easily be done with minimum time and labor. The same holds true in answer to all other objections. Good planning and proper scheduling are prerequisites for any job well done today.

The Specifications have revolutionized putting green construction. They have been criticized by many, but each year more and more golf clubs and golf course superintendents insist on this method of construction. A number of golf course architects have joined the march. And why not? No other method of putting green construction has yet been present ed that can prove to be scientifically superior or even equal to the Specifications. When the day comes, the Green Section will fall in line and give full support. Until that day comes, we shall continue to strive to close the "Credibility Gap."

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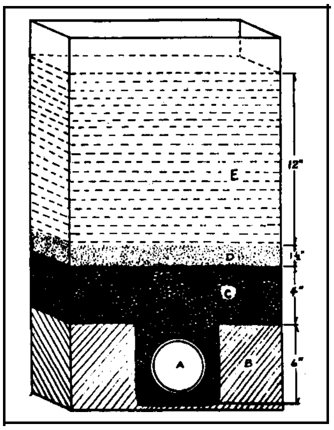
FIGURE 1

PROFILE OF PUTTING GREEN WITH TRENCH AND TILE LINE, IN CROSS-SECTION



A. 4-inch diameter tile.
B.. Subgrade of native soil or All material.
C. Gravel-preferably pea gravel of approximately 1/4" diameter. Minimum thickness 4 inches.
D. Coarse sand-this sand should be of a size of 1 mm. or greater, 11/2 to 2 inches in thickness.
E. Topsoil mixture. Minimum thickness of 12 inches.

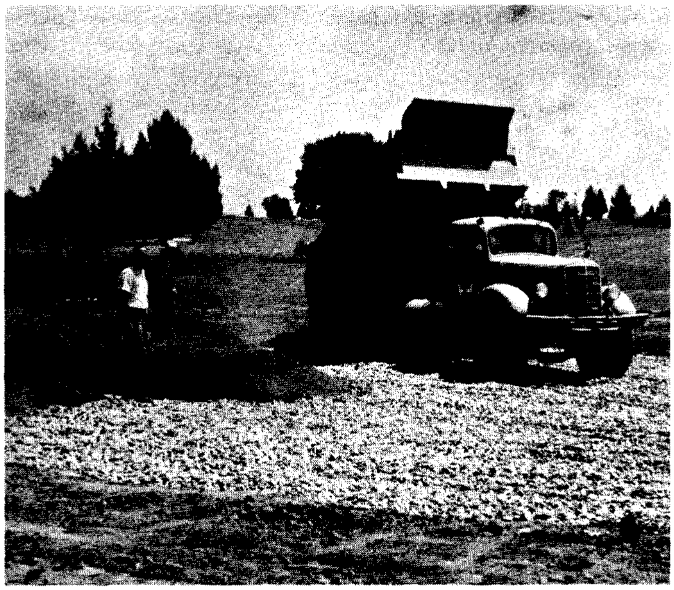


FIGURE 2 A gravel blanket under the green plus tile lines insures good subsurface drainage.

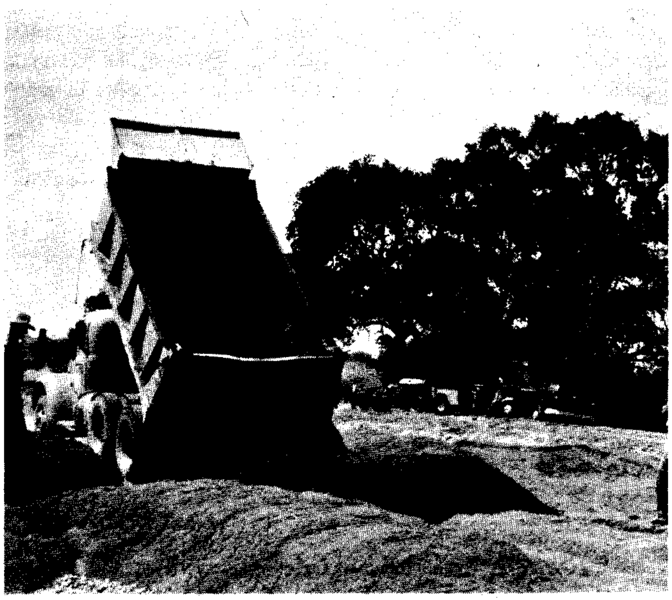


FIGURE 3 Off-site mixing is important. Then transport the soil mixture to the green.

Water Distribution

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Tutf is not a marketable commodity, but is maintained as a useful ground cover pleasing to view and use. While a variety of textural surfaces and appearances can be provided by use of different turf species and varieties, there is always a strong desire to have the particular cover selected appear as a well kept, uniform cover without bare spots, dry spots, or off color spots. Variable water distribution is one of the reasons why these various spots occur in turf. Some ‘of the turf area may receive insufficient water and becomes brown or dies out, while other parts may receive an excessive amount of water and turn yellow or take on a coarse appearance.

The greater the variance in water distribution from sprinklers, the more water will be required to produce a satisfactory appearance in the turf. When enough water is applied to produce a satisfactory appearance on the areas which receive the least amount, the excess may produce an off color or unsatisfactory appearance on the areas receiving a greater amount. In addition to showing off color in turf, the excessive applications may cause other problems such as disposal of the extra amount of water providing the soil is not freely drained. A big effect of poor distribution of water is the increase in the cost of water and power to distribute this water which must be paid month after month and year after year.

Turf managers have increasingly exhibited a desire to distribute dissolved materials through the sprinkler system, such as fertilizers and herbicides. The cost of the materials so distributed can be much greater if a sprinkler system has a poor uniformity of distribution. in some cases, the application of two or three times as much material of this type to one area as another can produce adverse effects on the turf, but such variations in distribution must be expected in many irrigation systems. At the present time it is felt that the distribution of such materials should be attempted only through sprinkler systems having a good uniformity of distribution or for materials which produce no problem when applied excessively.

Various methods of assessing uniformity of sprinkler distribution are available for use. All are based on the technique of placing containers on a grid pattern where the sprinkler performance is to be tested. The containers should have a circular opening horizontally oriented with sharp edges. The shape of the container beneath the circular opening is not critical but should be such that the can is stable, is not in danger of tipping, and will not allow water to splash out during the test. The cans should be placed in such a manner that each one represents an area of ground surface equal to all others or equal to the total area of ground covered by the test divided by the number of containers used. Attention should be paid to the geometry of the area represented by the containers since the distribution of water will inevitably vary with distance from sprinklers. The area selected which the containers are to repesent should be a natural area bounded by a pattern of sprinklers which is repeated in similar manner in the design of the sprinkler system. The measurement of water caught in any portion of a natural pattern will supply biased information unless i nf orm a ti on is obtained from the remainder of the same pattern unit.

Evaporation of water from the containers before they are measured will almost always occur to some extent. Some of this occurs during the period of sprinkler operation. Some occurs after the sprinkling has been terminated but before the content of each can is measured. Various techniques have been suggested for eliminating or assessing the amount of evaporation from the containers. A container with a sharply constricted neck similar to a rain gauge will minimize evaporation but such containers are seldom used because they are expensive and cumbersome. A few drops of white or colorless mineral oil placed in each can before the test starts will float on the surface of the water and tend to restrict evaporation during and after the test. Again this method has proved sufficiently cumbersome, particularly when measuring the water at the conclusion of the test, that it has seldom been used.

Another technique is to place a measured amount of water in a few blank cans at the beginning of the test and place them at some point where they are near the test but will not receive any water from the sprinklers. When the water is measured at the end of the test, half of these cans are measured at the beginning of the measurement period and half of them at the close of the measurement period. The average of these measurements is then subtracted from the amount of water initially placed in the cans. The difference is presumed to represent the average evaporation taking place in the test cans. This technique introduces a systematic error of unknown magnitude. The blank cans standing away from the sprinkler pattern where they do not receive water are probably subject to greater evaporation during the water application period than are those cans receiving water from the sprinklers. They will probably have a different temperature and humidity.

Because of these several uncertainties and extra effort involved, most people making sprinkler evaluation tests in the field have ignored the evaporation problem. To do so probably has little effect on the calculation for distribution uniformity of the sprinkler system. It does affect the calculation for absolute efficiency when compared to the amount of water applied. This latter is seldom done with turf sprinkler tests because of the difficulty of measuring the direct output from individual sprinklers.

The contents of the containers are most easily measured in laboratory cylinders graduated in milliliters (ml.). A number 2-1/2 can, a size easily available and closely approximated by 2 lb. coffee cans, will generally catch about 200 ml. for each 1 inch depth of water. The volume of water in 250 ml. graduate cylinders can generally be read to the nearest ml. so that a fair degree of precision is possible. If the inside diameter (D) of the lip or top of the container is measured in millimeters (mm.), the conversion to inches depth is easily made by the formula $\frac{D2}{50}$ = ml./in.

When all of the can contents have been measured, arrange the figures in a column by descending order as in Table 1. The ratio of high to low catchments can be obtained by comparing the first and last entries in the column. Add all the values in the column and divide by the number of entries to obtain the mean or averaee amount. In a parallel column, insert the difference between each measured figure and the average amount. Use a positive sign for all differences. Obtain the sum of all of these differences. The individual differences are labelled "y" and the sum of all the differences labelled (Ey).

A long time standard for assessing uniformity of distribution has been the coefficient of uniformity developed by J. E. Christensen. It is represented by the formula

$$Cu = 100\left(1 - \frac{Ey}{mn}\right)$$

m is the mean or average of all measurements and n is the number of individual measurements. The coefficient of uniformity provides a relative rating for comparing different sprinklers and sprinkler combinations but tells little else about the affect of the uniformity or lack of it on performance.

Since a turf manager looks at all parts of the turf, he will be conscious of differences oc cur ri ng if water distribution is the cause. His effort as a turf manager will generally be to irrigate enough to provide sufficient water to the areas within the sprinkled system which naturally receive the least amount of water. Those which receive the average amount of water or greater will obtain more water than necessary but this is generally disregarded unless drainage is limited or the grass tends to turn yellow because of leaching. In making an evaluation, it seems desirable to quantitately assess the differences in amount of water received by various areas under the sprinkler system. This can be done by plotting a cumulative distribution curve of water received on different percent ages of the total area or by mathematically obtaining percentage distribution figures from an organized column of data in descending order.

It would be desirable if all or most of the area irrigated were to receive the average amount of water applied or close to the average amount. To determine how well this has been done, it seems appropriate to calculate the percentage of the total area which receives within 10% of the average amount. Since few sprinkler systems provide for coverage of a sizable fraction of the total area within this narrow range, it is also useful to determine the percentage of the area covered within 20 or 25 percent of the average application.

Since a turf manager can generally tolerate a very small amount of turf receiving insufficient water to maintain healthy vigorous growth, it seems appropriate to ask "What per cent of the total area can you tolerate or permit to receive less than the minimum necessary water requirement?" The answer might be none in many cases, maybe 5% or 10% in others. For agricultural purposes, a larger per cent receiving less than the desired amount can be tolerated since the area will not have a total crop failure but will merely produce somewhat less than the better watered areas. For a turf manager, however, a partial crop failure is sometimes equal to a total crop failure and cannot be tolerated.

Since the extreme low values measured in a catchment test are subject to random variation for various reasons and may not be indicative of a minimum amount that will always be received by that particular portion of the turf area, it seems necessary and desirable to base our computations even for turf on the basis that maybe 95 or even 90 per cent of the total area receiving a sufficient amount of water will be satisfactory. Either of these points can be selected from the distribution curve or the columnar tables and the minimum amount of water which will be received by 90 or 95 per cent of the total area determined. If this area must receive, for example, one inch of water per unit of time, the average amount of water which must be applied through the sprinkler system is obtained by multiplying the 1 inch requirement by the fraction equal to the mean amount of water applied through the system divided by the minimum amount of water received by 90 or 95 per cent of the total area. The inverse of this figure or the minimum amount caught at the 90 or 95 per cent point divided by the average application provides a figure which we can call the application efficiency.

If 1 inch of water is the requirement for a unit of time, it is possible that 1.5 inches or more applied during that same period will produce certain adverse effects such as creating drainage problems, turning turf yellow, or causing runoff. It is possible from these same figures to calculate the percentage of the area receiving more than 1.5 inches when a minimum of 1 inch has been applied to 90 or 95 per cent of the total area. These figures will provide some indication of the proportion of the area which may be subject to problems of excess water. Table 2 shows these various statistics computed for three random sprinkler systems which have been tested. In general, these are all fairly good sprinkler systems and far worse data could be obtained if some of the poorer systems tested were to be included.

TABLE 1

CALCULATIONS FOR SPRINKLER #1 - 3 HOUR TEST

Rank	% of Area	Departure from Mean. %	x	y	Rank	% of Area	Departure from Mean. %	x	y
1			235	84	41			148	3
2			207	56	42			148	3
3			207	56	43			147	4
4			193	42	44			147	4
5			192	41	45			146	5
6			188	37	46			145	6
7			186	35	47			144	7
8			183	32	48			144	7
9	11	+ 20	182	31	49			143	8
10			180	29	50			141	10
11			175	24	51			141	10
12			172	21	52			140	11
13			170	19	53			140	11
14			170	19	54			139	12
15			170	19	55			138	13
16			168	1	56	70	- 10	138	1
17	21	+ 10	167	16	57				16
18			166	15	58			135	16
19			164	13	59			133	18
26			164	13	60			132	19
21			163	12	61			132	19
22			162	11	62			131	20
23			160	9	63			131	20
24			158	7	64			131	20
25			158	7	65			131	20
26			158	7	66			131	20
27			157	6	67			130	21
28			157	6	68			127	24
29			155	4	69			127	24
30			154	3	70			126	25
31			154	3	71			126	25
32			154	3	72	90		125	26
33			153	2	73			125	26
34			153	2	74			123	28
35			152	1	75			123	28
36			152	1	76	95	- 20	121	30
37			152	1	77			116	35
38	47	0	151	0	78			115	36
39			150	1	79			114	37
40			150	1	80			113	38
							Σ	12058	1424

m = 151

$$Cu = 100\left(1 - \frac{1424}{12058}\right)$$

88.2%

TABLE 1 (contd.)

CALCULATIONS FOR SPRINKLER #1 - 3 HOUR TEST

95% of area received 121 + ml

90% of area received 125 + ml

1 inch irrigation to 95% requires $1 \times \frac{151}{121} = 1.25$" average application

1 inch irrigation to 90% requires $1 \times \frac{151}{125} = 1.20$" average application

High to low 235:113 = 2.1:1

Application efficiency = $\frac{121}{151} = .80$ for 95% of area

Application efficiency = $\frac{125}{151} = .83$ for 90% of area

70 - 21 = 49% of area receives ± 10% of mean application

95 - 11 = 84% of area receives ± 20% of mean application

11% of area (121 x 1.5) receives >1.5" for 95% min. coverage

7.5% of area (125 x 1.5) receives > 1.5" for 90% min. coverage

Average application rate

$$\frac{151}{x\ 3} = 0.26 \text{ in./hr.}$$

194 ml = 1 inch

TABLE 2

SUMMARY OF UNIFORMITY TESTS FOR THREE SPRINKLERS

		Sprinklers 1	2	3
1.	Average application rate caught, inches/hour	0.26	0.12	0.78
2.	Coefficient of uniformity, per cent	88.2	82.1	77.3
3.	Ratio of high to low catchment	2.1	2.42	3
	Per cent of total area receiving within			
4.	± 10% of average application	49	29	26
5.	± 20% of average application	84	63	49
6.	95% of total area received at least, in./hr.	0.21	.089	0.50
7.	90% of total area received at least, in./hr.	0.22	.092	0.54
8.	To apply 1 inch to 95% of area requires avg. application, in.	1.25	1.35	1.56
9.	To apply 1 inch to 90% of area requires avg. application, in.	1.20	1.30	1.45
10.	Application efficiency for #8, per cent	80	74	64
11.	Application efficiency for #9, per cent	83	76	69
12.	Per cent of area receiving >1.5 inch for $8	11	28	47
13.	Per cent of area receiving >1.5 inch for #9	7.5	23	37
	A test should also include:			
14.	Sprinkler identification			
15.	Sprinkler spacings			
16.	water pressure			
17.	Discharge per sprinkler			
18.	Ratio of average discharge:catchment			

Vertical Mowing – Aerification – and Poa Annua Invasion*

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Effects of vertical mowing of bermuda turf in the fall in Southern California on Poa annua establishment Photographed in Januor Area next to street with dense stand of Poa annua was partialy dethatched with a vertical mower in November. Area next to fence containing a few scattered clumps was not dethatched.

Turf weed problems can be related frequently to specific management practices. Slight errors in timing of a maintenance operation or improper use of equipment may result in a weed population explosion. This is certainly true for annual bluegrass, Poa annua, a weedy grass that thrives under many conditions that may weaken or destroy the desirable turf grasses. Elimination of annual bluegrass from golf greens seldom may be possible, but attention to a few practices can reduce the problem greatly.

Often faulty methods are used because of an inadequate knowledge of the life history and ecology of the weed plants. *Poa annua* populations in golf greens increase and control methods fail when certain characteristics of the plant are not considered. In much of the United States, heaviest germination of annual bluegrass seeds takes place in the fall. While germination may continue through the winter in regions of mild winter climate such as California, it will be at a much lower rate.

However, in cold-winter regions heavy germination may occur also in the spring. Very little seed germinates during the warm weather from late spring to early fall. Time of germination and length of the germination period can be determined for any area by a little observation.

Poa annua seeds require moisture, moderate temperature (optimum about 70 F.), light and air for germination. Seedlings are poor competitors in a dense turf of perennial grasses.

Flowering begins a few weeks after seed germination, when plants may consist of only four or five tillers, and continues thereafter within a wide range of temperatures and photoperiods. A single plant, therefore, can produce continuously for many months. This seed does not germinate immediately but lies dormant in the soil and thatch for several months, usually until fall. Thus, large quantities of seed, which may be produced by only a few plants, will be ready to germinate as soon as favorable conditions are provided.

VERTICAL MOWING AND AERIFICATION

Vertical mowing and aerification are necessary management practices for high quality golf greens. Moreover, they are effective means to keep Poa annua in check by maintaining a vigorous bentgrass turf. However, performing these operations during the wrong time of the year can have the opposite effect. Disturbing the turf by any means, so as to expose the seed that is almost certain to be in the thatch or soil to light and air, at a time when temperature and moisture conditions are favorable for germination will increase the Poa annua population.

There are perhaps few times in the year when these operations will not have some effect on germination, but it is obvious that they should be avoided if possible during the normal time of highest germination rate.

A few years ago a simple experiment on the UCLA campus demonstrated clearly the effects of fall vertical mowing on the subsequent Poa auunua population. A long narrow plot of U-3 bermudagrass turf which had contained some Poa annua in past seasons was divided in half longitudinally. The thatch was partially removed from one half in the fall, using a vertical mower, while the other half was left untouched. Following vertical mowing the entire area was watered as necessary to keep the soil constantly moist. No seed was planted.

Within 10 days after vertical mowing, numerous annual bluegrass seedlings were observed in the dethatched area. A month later this entire area was covered with a solid stand of Poa annua, but there was only a few scattered plants in the untreated part.

The following autumn the experiment was repeated, reversing the two treatments. As in the previous year, the area on which the vertical mower was used contained a dense stand of Poa annua in contrast to the untreated area, which had a thin, scattered population. Thus, the dense population always developed on the disturbed area regardless of the condition the previous year.

TIMING IS IMPORTANT

The lesson should be obvious. While this study was conducted on bermuda turf, the principle illustrated would apply to any turf including bentgrass greens. The same result, although perhaps to a lesser degree, could be expected from fall aerification which would promote Poa annua germination in the aerifier holes. This has been observed in one instance where the annual bluegrass plants were evenly spaced in the turf, corresponding to the former location of aerifier holes,

What should you do if the turf condition necessitates vertical mowing, aerification or spiking at an unfavorable time in respect to annual bluegrass? A logical suggestion seems to be to follow immediately with an application of a preemergence herbicide for Poa annna such as Bensulide (brand names are Betasan and Presan) or standard lead arsenate. By so doing, many seedlings will be killed shortly after germination.

Germinating seeds are highly vulnerable to drying. Therefore, permitting the soil to dry as much as possible at the surface between irrigations will assist also in reducing the stand. In fact, this is a good practice to follow throughout the year to reduce weed infestation.

Chemical control of Poa annua in bentgrass greens is seldom as successful as desired. Often this is the result of poor timing of herbicide applications. If heavy seed germination occurs in the fall, it is illogical to expect control from a late fall or spring treatment. The weed killer must be in the soil at a toxic level prior to seed germination. Where germination may extend over a long period, supplimentary herbicide applications may be required to maintain this toxic level throughout the germination period.

There are, as yet, no effective post-emergence annual bluegrass herbicides that are safe for bentgrass greens. As many Poa annua variants ate perennial rather than annual, spreading vegetatively year after year, the necessity for preventative management becomes more apparent. Once perennial types have become established in a green, the choice must be between living with them or complete renovation.

*Reprinted from USGA Green Section Record

Is Crabgrass Here To Stay?*

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Of course crabgrass is here to stay! This answer comes automatically for those who know this weed. However, this question and its quick simple answer does serve as an excellent subject.

The widespread distribution of crabgrass on turf and non-turf areas is most assuring of its persistence. Nearly all crops and soils contain this weed or its seed. Crabgrass always challenges the new turf area to show if it can withstand its attack.

Crabgrass can grow an abundance of seed. We have made some counts that have shown 100 seedheads per square foot. If crabgrass seedheads average 4 recemes and they have 60 seeds per raceme, each seedhead could produce approximately 250 seeds. Thus one square foot of crabgrass could easily produce 20-30,000 seeds. Of course, crabgrass is better known for irs ability to spread rapidly by rooting at the nodes in warm, moist weather. With little impedance from the turf one seed can grow more than one square foot of crabgrass per season. According to this, the seed from one big crabgrass plant can seed l/2 acre *or* a putting green. Surely, the universal distribution of crabgrass, its great seed producing potential and its ability to spread rapidly assures that it will occur in turf on many future occasions.

While crabgrass is here to stay, it can be said just as firmly that it is no longer the threat it was 20 years ago. This weed is down, and its threats will become less frequent.

How has crabgrass been dealt this blow which developed during the past twenty years? Part of this has been through the growing of better turf which gives less room for this weed. A good grass cover will always be an important tool for checking crabgrass. This is often the only recourse on large acreages or on turf areas that are too sensitive for chemicals. If any one doubts good management consider what restricted watering can do in crabgrass periods. The role of water in crabgrass development has been demonstrated in the Northeast by the current drought series which has greatly reduced the crabgrass problem.

No discussion on the decline of crabgrass can go far without giving major credit to the preemergence herbicides. The discovery and development of the newer crabgrass herbicides is the big news of the decade for turf.

A large number of preemergence chemicals have been found that prevent crabgrass from developing in turf. Several of these are used by some, with little hesitation, on Kentucky bluegrass turf. Crabgrass, the old nemesis of Kentucky bluegrass turf, is no longer a lasting threat to this grass. All of the materials give some risk of turf injury, bur many have adequate safety on mature healthy Kentucky bluegrass. While the use and safety of preemergence chemicals is far more questionable on bentgrass, several of these have been a great help in suppressing crabgrass.

On some turf areas, the danger from crabgrass may be less than the risk of turf injury and other weaknesses of preemergence crabgrass herbicides. Yet, these chemicals have not been used enough.

Some turfmen have been frightened away from their use by an unsuccessful experience. Some of these problems need not occur now, because research and observation has taught some of the factors that insure better perfomance as follows:

1. Choosing the correct chemical. Some chemicals give better control than others. Some are sold before they have been proven. Others have a narrow safety margin. The user must learn the performances of the various chemicals to choose the one that works best.

2. Most of the chemicals are less effective on turf when applied with water rather than a dry carrier. Unfortunately, golf course superintendents who are good experts with spray application, have applied preemergence herbicides too frequently with a water carrier. With many turf chemicals this is good procedure, but it fails with most preemergence crabgrass herbicides. It should not be done unless the chemical is known to perform satisfactorily with this method.

3. Timing of the preemergence application is very important. Most of the chemicals must be applied during a definite period of weeks prior to crabgrass germination. If the correct time of application has not been respected this can easily explain a poor result. Correct timing of preemergence applications is difficult to determine, especially for those chemicals that work only when applied shortly before crabgrass germinacion. Of course, some adjustment must be made for earliness and lateness of ‘the season.

4. At times in the past, respect has not been shown for a grasses intolerance to a given chemical. It is folly to expect a chemical to work the same on annual bluegrass and bentgrass as Kentucky bluegrass or bermudagrass.

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5. Those who supply the herbicides say that the wrong rate of application and uneven application are still major causes of failure.

Mistakes with preemergence herbicides are becoming fewer and crabgrass control through this technique will become a much better method for limiting crabgrass. This develops through improved use and understanding of the chemicals. Also, we are certain to find new chemicals that give better control and greater safety. Possibly they will even be less costly.

Names of chemicals that might be used for preemergence crabgrass control have been avoided to this point, but these must receive mention. On the basis of my research and experiences, I would single-out DCPA, DMPA, and siduron. DCPA has given consistent performance and it has one of the better safety records, DMPA can be applied over a somewhat longer spring period and it has a good safety record. Siduron can give adequate crabgrass control and its safety margin is very good. Its safety to new turf seedings is far superior.

Some have heard me urge the grower to keep a card file on herbicides. This becomes more urgent each year. Mistakes will become more frequent unless the large amount of information is handled systematically. List the chemicals that are considered best for each weed. Under each chemical include such things as the common name, chemical name, trade names, the rates a given grass will tolerate, the minimum rate required for the weed, duration of the chemical after application, the hazards of overdosage, hazards to the user, if they exist, the experience of others, and your experiences with this chemical.

Yes, crabgrass faces a gradual decline because of today's better management and the development of preemergence herbicides. Also, turf is grateful to the phenyl mercury acetate and methylarsonate preparations that have served as postemergence crabgrass herbicides However, it seems we are due for some new postemergence chemicals.

Some may include "hard or silver crabgrass" in the crabgrass category. Unfortunately, the prospects are not bright, at the moment, for controlling this weed. This troublesome plant has not reached its maximum distribution, especially on the newer turf areas. Also, the increase in traffic favors this weed. It seems we should have a good preemergence chemical for gooosegrass, but the current chemicals are not as good for control of this weed as they are for crabgrass. Also, they are often highly injurous where goosegrass grows. Possibly, it should be noted that bermudagrass has better tolerance of preemergence chemicals than most grasses. Yet the goosegrass struggle continues on some bermudagrass turf in southern United States. It appears we have not found the right chemical for this weed.

Dropping crabgrass from the classification of the worst turf weed, does not mean that it cannot become the number one weed on a given turf area. When it does, remember the fundamental to successful crabgrass control is stubborn and persistent prevention of seed production. This is accomplished by growing a good turf cover, minimal watering during crabgrass establishment, wise use of herbicides, and meticulous clean-up of scattered plants.

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