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TURF SEED QUALITY*

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Since before the beginning of the present century there have been state and federal laws that were designed to regulate the quality of seed that could be offered for sale in the United States. These standards were designed primarily to provide protection to the farmer as he went about his business of producing food, feed and fiber.

In Washington the Seed Division, State Department of Agriculture, headquartered at Yakima, Washington is responsible for enforcing the state seed laws.

Basically, the following information about each seed lot offered for sale must be listed on the label or somewhere on the container:

1. The name of the seller
2. The seed variety
3. A lot number
4. The percent by weight of purity
5. The percent by weight of inert
6. The percent germination
7. The date of the last germination test
8. The percent of crop seed in the lot
9. The percent of weed seed in the 1st
10. The noxious weeds by name and number per pound

Farmers who sell or exchange seed with their neighbors are not responsible to conform to these seed labeling requirements but this is the only exception.

These are all important items to know about a lot of seed but some of them may conceal more than they tell about the important factors of quality. They deal largely with what can be termed the mechanical quality of the seed, an important item to be sure. Let us examine some of the factors in some detail.

Purity seems to be a straightforward term, yet, it is only an indication of the quality of seeds in the lot. Thus, 99% Pure seems to be an indication of good quality but in turf seed we need to know more. How much of the 99%-pure seeds will grow? -Thus, we arrive at a new term, "pure-live seeds," which is simply the % purity x the percent germination. Thus, if there is a 99% purity and 85% germination on the label, we find the L.P.S. = 84% and there is actually 16 pounds of material in each lOO# bag that is only filler. In using the concept L.P.S., do not fall into the trap of replacing the individual purity and germination data with a single L.P.S. enumeration. The L.P.S. provides a handy way to compare quality and value of seed lots but it has certain weaknesses.

	% Pure	% Germ		LPS
Lot A	99	90	=	89.1
Lot B	90	99	=	89

In lot A there is 1% of something other than seed, but in lot B there is 10%. If the 1 or 10 is weed seeds in both cases, you can easily see which is the best buy. But you must know what the non-pure portion consists of; it could be weed seed, other crop or inert. The actual inert material, which by common practice seldom exceeds 2 or 3 percent even in turf seed lots, is usually, chaff, broken stems, broken seeds, etc. Only rarely will you find a so-called "bargain package" with added inert material, such as ground corn cobs or chaff, to increase the volume.

Percent germination as listed on the label is not always a straightforward term. Some grasses have a dormancy characteristic and the laboratory germination technique has been developed to overcome this factor so the reported germination may be higher than you will encounter in the field. Moreover, most legumes have a "hard" seed characteristic, so you may find two items listed on the germination of white Dutch clover-strong sprouts and hard seed. These "hard" seeds are viable but do not absorb water readily and thus may be slow to germinate, so when you see a label that says strong sprouts 37%, hard seed 53%, for a total germination of 90%, you should ask the company to scarify the clover seed before you buy it.

"Other crop" is often the most troublesome part of the grass seed lot. Up to 5% of the lot may be "other crop" without any further identification required. In turfgrass seed other crops can be Timothy, orchardgrass, tall fescue, smooth brome, intermediate wheatgrass and any other pasture or hay grass commonly used in the United States. Other crop in bluegrass could include all of these and also bentgrass, a most undesirable mixture in bluegrass for most turf uses.

It is important to remember that the label gives the percent of other crop or the percent of weed seed in the lot when what you need to know is the actual number of seeds per pound of the contaminating crops or weeds. To arrive at this latter figure (number of seeds per pound), you need to multiply the percent of the contaminant by the number of seeds per pound of the contaminant. The following table gives the approximate number of seeds per pound for a selected list of grass and weed seeds.

TABLE 1. Number of Seeds per Pound of Selected Grasses'

Variety	Approx. # of Seeds per lb.
Bentgrasses	
Highland *Agrostis tenuis*	5,740,000
Colonial and Creeping bent	6,200,OOO
Astoria	5,800,000
Penncross ***Agrostiu Spp.***	5,800,000
Velvet *Agrostis canina*	8,200,OOO
Red Top ***Agrostis alba***	4,800,OOO

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Bluegrasses		
Canada blue	*Poa compressa*	2,500,000
Merion blue	*Poa pratensis*	2,177,000
Annual blue	*Poa annua*	1,200,000
Rough blue (shadyland blue)	*Poa trivialis*	2,500,000
Fescues		
Creeping red-chewings	*Fesluca rubra*	545,000
Hard fescue	*Festuca ovina`*	550,000
Tall, Meadow Alta	Festuca *arundinacea*	227,000
Ryegrasses		
Annual, Perennial	*Lolium perenne*	227,000
Orchardgrass	*Dactylis glomerata*	465,000
Smooth brome	*Bromis inermis*	113,000
Timothy	*Phleum pratense*	1,200,000
White Clover	Trifolium repens	680,000
Weeds		
Hairgrass	*Festuca capillata*	1,450,000
Black medic	*Medicago Lupulina*	265,000
Velvetgrass	*Holcus lanatus*	1,520,000

'Adapted from WSU Seed Testing Laboratory and from 0. M. Scott Proturf Professional Seminar 1974

How does this all go together? Look at a recommended mixture for Western Washington lawn turf.

Recommended seeding rate lb/1000 sq ft	Variety	% of mix by weight
2.5	Kentucky blue	62
1.0	Red fescue	25
.5	Bentgrass	12

Rec. Seeding %		NO. Seed per lb				Actual Seed count %
62	X	2,177,000	=	1,349,740	=	52 K.B.
25	X	545,000	=	136,250	=	05 R.F.
12	x	9,000,000	=	1,080,000	+	43 Bent
				2,565,990		

Thus, instead of 12% bent, you are actually planting 43% bentgrass based on number of seeds per pound.

Let us turn our attention from the mechanical purity of seed, i.e., the percent purity % weeds, and % germination — to a somewhat different concept, that of genetic purity. Actually, genetic purity refers to the varietal purity. If you want Merion or Fylking bluegrass, you should be able to be sure that is what you are buying and not an inferior variety turfwise. There is no easy way you can look at the seed and tell if the variety is Merion. You cannot tell the difference between the seed of Colonial and Seaside bentgrass. Seeds of Koket creeping red are indistinguishable from those of Checker or Olds, creeping red fescue. The certification program was developed in the U.S. to provide a pedigree system of record keeping, plus a field and processing plant supervision program that will insure a high level of variety purity. Thus, if it is important to you to have the performance of a known and recommended variety, you should add the requirement of variety certification for genetic purity to that of the mechanical purity required by state and federal seed laws. Most of the superior varieties are now available as certified seed.

In Washington there is a truly elite seed quality now available called "sod quality'! seed. This is seed produced under standards of purity, germination and certification designed to satisfy the sod grower. Amongst important standards for sod-quality bluegrass, red fescue and Chewing fescue is that the seed must be free of ryegrass, orchard, timothy, bentgrass, Canada blue, rough bluegrass, smooth brome, tall fescue, reed caanarygrass and clover. Weed seeds prohibited include annual blue, chickweed, plantain, dock, crabgrass and all noxious weeds. There are several leading seed conipanies who handle sod quality seed.

One additional program you should know about is the annual bluegrass quarantine area whereby all grass seed stocks brought into eastern Washington must be sampled and tested by the Washing State Department of Agriculture Seed Division offic nd found to be free of *Poa annua* prior to planting for seed production. This procedure is important in keeping annual bluegrass out of the seed-producing fields in this area, and it is an essential link in the effort to keep the seed industry producing high quality seed. This, coupled with the expanded *Poa annua* control program of Dr. Goss and Mr. Cook, which can be applied not only to turf on golf courses but also to seed fields of turf grasses, will insure top quality seed from the Washington Seed Industry.

WATER REQUIREMENT INFORMATION NEEDED FOR GOOD PLANNING**

Albert W. Marsh*

Designing Adequate System Capacity

The capacity of the irrigation system must be adequate to meet some level of anticipated peak evaporation if dry-appearing turf is to be avoided during hot, dry weather. The designer is faced with a problem of knowing the peak need he should try to meet. Adequate data on water requirements are scarce and where existent (1) are usually monthly and annual totals.

Designing an irrigation system to protect against hot spells is like building flood protection. The cost of protection from a flood likely to occur once every 10 years is justified, but the cost of protection from a flood likely to occur only once in 50 years may exceed the value of the property protected. It is not economic to design beyond reasonable peak needs but, after explaining this, the designer should ask the buyer what level of protection he is willing to buy. This will require preliminary estimates of the cost for different levels of protection, after which the buyer can make his choice. The designer should identify each level for the buyer. It may be the July average requirement for all years of record: figure 1, the July monthly requirement reached once each 10 or some other number of years; figure 2, the highest weekly requirement in July of record; or, figure 3, the highest weekly requirement reached once each 3, 5, or 10 years. Single-day peak requirements will frequently exceed the chosen levels but can be ignored because of soil capacity to store moisture in a manner to smooth out variable demands of short duration.

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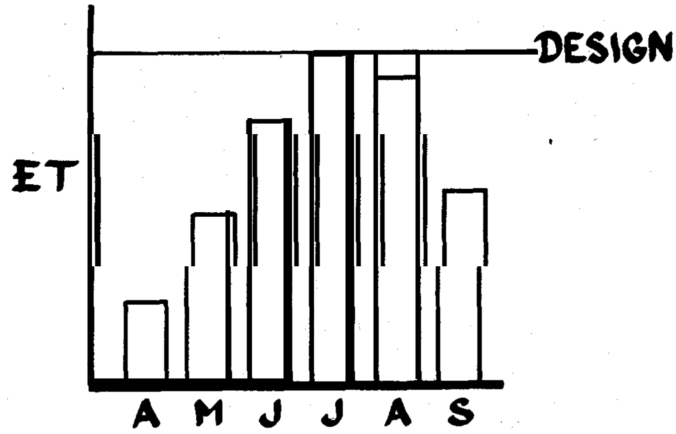
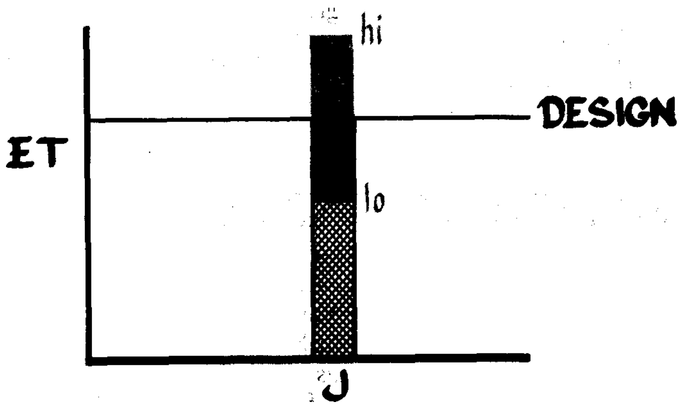
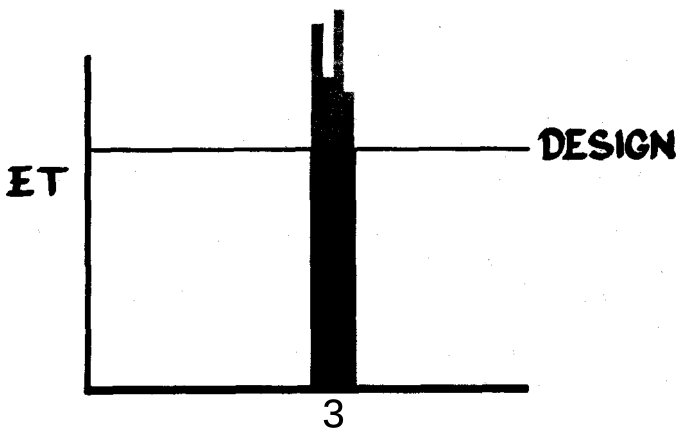
**From: 12th Annual Turfgrass Sprinkler Conference Proceedings, 1974. pp. 37-43.



1. Historic July average water use sometimes used for design capacity of turf irrigation systems.



2. July records reached once in 10 years provide a safer design capacity.



3. The highest weekly record may be too high for practical design.

In addition to meeting peak evapotranspiration, design capacity must also be adjusted to application efficiency. If an irrigation system is able to provide a good uniform distribution, the design capacity can be close to expected peak demands. If an irrigation system is unable to provide uniform distribution, it will need a greater design capacity because it must meet demands of part of the area that receives less than the average water applied to the whole area. The extra capacity needed to perform an acceptable irrigation in hot wather may cost as much or more than a system of smaller capacity but capable of more uniform distribution.

We have used the term "water factor" to denote the ratio of water needed by any irrigation system compared to that needed by a system having perfect distribution. To allow for random vagaries that might occur during repeated measurements of any system, even a perfect one, the water factor, WF, is defined as the volume of water in acre-inches needed to apply a minimum depth of 1 inch to a selected fraction of the area, usually 90% divided by the acreage covered by the irrigation system. It can be determined from a can test for water distribution (2,3) and calculated by the formula:

$$WF = \frac{1}{1 - (t\ a/r)}$$

where:

t = probability value from a statistical table (4) related to the number of can in the test and the percentage of the area that must receive a unit amount of water*

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n}}$$

x = each individual can value

$\bar{x}$ = the mean of all values

n = the number of cans

***"t" Values for Calculation**

Coverage	Cans Used in Test			
Percent	**50**	**100**	**150**	200
95	1.67	1.66	1.65	1.64
90	1.30	1.29	1.29	1.28
85	1.05	1.04	1.04	1.04
80	0.85	0.85	0.84	0.84

A WF_{90} of 1.0 is excellent, 1.2 is better than most, 1: 5 is common, 2.0 can be found in many systems. The capacity needed for any system would be the water requirement multiplied by the water factor. It is important to keep the water factor low by good design.

Sometimes the total water available is limited and the designer must utilize it to the best effect. To do this, he needs to know the water requirement as accurately as possible, particularly the peak rate. Designing a system with a low water factor is the first step. Possibly the capacity for meeting the peak rate can be reduced by using a shorter term peak rate, such as once every three years versus every 10 years, and also by using the peak month rather than the peak week unless the soil is very sandy. He might also limit the area irrigated to an amount that can be serviced adequately at all times.

Where Does the Designer Obtain Water Requirement Data of Reasonable Reliability?

In the corridors one may hear the figure 1.5 inches per week suggested for peak use. In recent years, evaporation data and calculations using the Blaney-Criddle formula based on temperature and day length have been used (1) . Data for Blaney-Criddle calculations are generally available from standard weather stations, but coefficients are uncertain for many areas and types of grass. Evaporation data are more difficult to obtain and coefficients are generally lacking or uncertain.

Experimental results are helpful where available but are more scarce than evaporation data. As experimental results become available, they will provide coefficients for both evaporation and Blaney-Criddle formula that will extend the use of these indirect measurements. Answers to specifice inquiries have been supplied in a few cases by this method. A summary for more general use is planned.

In summary, the irrigation system designer needs water requirement data particularly peak use values to properly design a system. These data are not plentiful but are gradually accumulating. Annual water requirements are not helpful to a designer unless the entire water supply is a system of lakes or limited capacity. They are useful for determining water allocations, usually the responsibility of water districts. Irrigation systems should be designed but not managed for day-to-day operation by historic data and calculations. Such management requires current measurements either with soil moisture sensors or an evaporation pan.

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"EYEBALLING" TURFGRASS FERTILITY NEEDS**

John H. Madison*

Approved ways of estimating turfgrass fertility are by analysis of soils or of leaves. Soils analysis gives results having good diagnostic value for the minerals: phosphorous, potassium, calcium, magnesium, zinc, and boron. Tests on grass clipping give good estimations for phosphorus and potassium. These for calcium, magnesium, sulfur, manganese, and boron may be helpful.

We can make accurate measurements of nitrogen, molybdenum, sulfur, copper and iron and other elements: but these measurements usually fail to provide usable information. Iron for example, can be plentiful both in the soil and inside the plant; but iron can still be unavailable to the new tissues and therefore deficient.

Nitrogen, which we use most and which we need most can be analyzed for in the soil or in the leaf as nitrate, ammonium, or as total nitrogen. Some of these have good predictive value of turf requirements.

Grass is a good forager for nitrogen. It can't compete with some of the bacteria. It competes aggressively, however, with tree, shrubs, flowers — with other landscape plants. Grass will rapidly take up available nitrogen. Also, the nitrogen status of a turf can vary rapidly. Today it can have an excess, next week a lack.

A soil analysis showing abundant soil nitrogen under turf would tend to indicate one of three things:

l-fertilizer has just been applied;

2-the turf is sick;

3-the turf is experiencing climatic adversity such as drought or heavy overcast.

A healthy well irrigated turf growing with adequate sunshine will generally take up N so rapidly that N will drop to low levels in the rootzone within a few days of its appication.

An analysis of clippings for N may show a good level of N. That is without predictive value, however. In a season of vigorous growth the same turf may be undersupplied with N a few days after collecting the sample.

A low value of N in clippings has excellent predictive value of a deficiency. However, we could already see the paler color of the grass when we took the sample so the analysis tells us nothing new.

Because we use nitrogen frequenty;

Because nitrogen tests give little usable information; and

Because we can see color changes associated with nitrogen levels in the plant, we do the obvious. We "eyeball" our turf and judge nitrogen need according to what we see.

It makes good sense to judge by appearance. If we are going to make good visual judgments we need to review in our minds from time to time, the limitations. That is what I am going to do here.

First, let's look at some possible confusions that could make our diagnosis invalid.

These confusions might be chemical:

l-We might have a deficiency of another element; or

2-We might have an imbalance among the nutrients.

The confusions might be mechanical:

3-dull mowers affect growth and color;

They might be organic:

4-toxins interfere with plant growth.

Let's look first at the balance of nutrients.

The plant can grow and function in a wide range of soils with widely variable contents of nutrient elements. It grows most favorably, however, when nutrients occur

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in certain proportions or balances.* Our use of nitrogen fertilizers can affect such grow in two ways:

1-by the kind of N we use;

2-by the amount of N we use.

Suppose we have clay particles in the soil with negative charges to which Ca++, Mg++, and K+, ions are adhering electrically. We apply ammonium sulfate fertilizer. The NH,+ ions will displace the ions of Ca, Mg and K, and take their place on the soil charges.

The soil solution is filled in the process, with many ions of calcium, magnesium and potassium and the turf can take up a rich diet of these minerals. The net effect may be a beautiful, healthy turf. Any excess of Ca, Mg, or K is apt to be leached down and out of the soil rootzone. As ammonium is taken up by the grass it is replaced on the charged clay particle by H+ hydrogen ions. With repeated use of ammonium fertilizer the soil becomes acid and the balance between the NH, and the Ca, Mg, and K is destroyed.

So, the first application may result in healthy growth -the 10th application in sick grass with imbalanced nutrition.

Here our visual evaluation leads us astray for color has shown the nitrogen status but has not exposed the imbalance resulting from our fertilizer practices.

The amount of N we use may affect our judgment differently. The soil is a huge chemical factory in which hydration, oxidation, reduction, solution, and precipitation are continually taking place. In the process minerals are brought into solution. This is called mineralization.

We mav have a soil that tests 16 nounds of available phosphorous to the acre. Our grass may remove 80 nounds in a year. Yet we mav have plenty if the rate of mineralization is sufficient to replace what we use. Suppose we decide we want a deeper green turf and so we increase the amount of N we apply. As a result we increase growth to where we remove not 80 but 150 pounds of P in a year. This rate of removal may exceed the capacity of the soil factory to mineralize phosphorous. In a year or two our soil balance is deformed and grass health decreased.

We can create imbalances and deficiencies of one or many of several minerals by increasing nitrogen fertilization. It depends on soil and other factors. Again, visual analysis provides inadequate information and leads to poor nutrition.

Another chemical way in which we can go astray is to misread the cause of a pale green turf. Nitrogen, magnesium, and iron all affect chlorophyll synthesis, and effect the same yellow to green color changes. Other minerals, sulfur in particular, also affect the green color of turfgrasses.

If we make a mistake and apply nitrogen when another mineral is what is lacking, we quickly discover our error. We apply the nitrogen fertilizer, but the turf doesn't green up. So we look for another cause. On putting greens the problem is often an iron deficiency. This is easy to tell. First, if the green begins to lose color due to decreased N, the amount of clippings in the box goes down. If the green begins to lose color from iron lack, the amount of clipping stays nearly the same.

If we pull up a few shoots of grass, iron deficient plants will have more green in the old leaves; new leaves will be pale. Nitrogen deficient plants will have new leaves that are greener 'than the old ones. This is because N is moved in the plant to where it is needed most, whereas iron is fixed. If the problem is one of low magnesium, there will be a tendency for the blades of grass to be greenest next to the veins, paler in between.

Sulfur is difficult to diagnose, but is infrequently seen since many of our fertilizers are sulfates. Sulfur defficiency results in a smaller blade of uniform pale green. If you suspect sulfur just put down some ammonium sulfate along side of some urea, calcium nitrate or ammonium nitrate, and you will have your answer written in the grass in the morning.

Deficiencies of molybdenum, manganese and boron will also cause chlorosis and attempts to cure them with N will make sick grass sicker.

There are other reasons a green will go off color and not respond to nitrogen fertilizer. A dull mower can cause this result. When the cause is a dull mower, the green wil be off color on the brownish side of green since the cut ends of the blades will turn brown.

Another cause may be the inhibition of plant functions due to toxins. Nematode toxins can result in a turf that cannot respond to nitrogen fertilizers. In bermudagrass country, toxin injury results from mites under the leaf sheath. Scale insects and leafhoppers inject toxins. Chinch bug appears to have a toxin in its saliva. Any of these may cause an unthrifty appearance of the turf and a failure to respond to N.

Some fly and beetle larvae may injure the root system to an extent that nitrogen uptake is limited and response to fertilizer is less than expected.

There is yet another component to our skill in "eyeballing" nitrogen needs. When we fertilize for high color, we may use more N than is desired for good health.

Too much N in summer may favor Pythium disease-in winter Fusarium and Typhula snowmolds. Ability to resist cold, heat, drought, and disease is impaired at high nitrogen levels.

How can we judge adequate nitrogen as opposed to high nitrogen? As background to discussing this, I would like you to imagine starting a new turf from seed. The soil has little nitrogen. Seed is lightly sown. Seedlings are about 3" apart. We add I pound of nitrogen per 1000 square feet in the seedbed. Most of the seedbed nitrogen will be lost by leaching, and 10-20 days after germination we have little plantlets showing the fourth leaf; but they are pale and running out of nitrogen.

We add a second pound of N and the grass grows (and so do the weeds). Nitrogen is low again in about three weeks. The turf looks pretty fair from the side, but looking down you see about as much soil as grass. Add a third pound. This may be used in two weeks in a great spurt of growth. Looking down from the top we see the leaves are now touching.

A fourth pound and growth is vigorous for 2-3 weeks. The ground is now covered but if we part the leaves, we see not a solid turf, but spaced plants with soil in between.

*Optimum growth occurs when the exchange capacity of the soil is Ca, 75% saturated by Ca++, Ca 10% by Mg++, Ca 3% by K and with some of remaining capacity satisfied by H+ ions.

We are now reaching a critical point. We add our fifth pound of nitrogen. The result is a strong stand of grass, more tillers, more rooting-a good healthy response. We are at that point where the turf is making full use of the environment. Up to this point each addition of N has caused individual plants to grow bigger and occupy more room. Now there is no more room.

If we continue our fertilization and add a sixth and seventh pound of nitrogen we will stimulate the plants to produce more shoots in an area that is already fully occupied. The result will be a denser carpet that before. But shoots from the same plant will be competing with each other for nutrients, water, and sunshine. More N will result in more plants, more competition, shallower roots, and plants that are less able to stand the rigors of climate and water. We are starting the downhill trip towards soft, shallow rooted, disease and insect prone turf that will look beautiful until it gets those big brown spots in it.

How do we know where to stop?

I am suggesting that we not use color alone as a guide when evaluating turf visually. A grass that has a high green throughout the growing season is over the hump on N and leaves on the same plant are competing with each other for limited resources.

Densitv should be part of our judgment. If the soil is covered with turf then I would withhold fertilizer N and watch for other signs. Some of the other signs could be these:

l-rust infection becoming serious;
2-dollar spot infestation;
3-weeds germinating and becoming established;
4-worn spots showing up or failing to heal;
5-clipping production low-not enough growth for replacement of wear (but there is no need to fill the basket with every pass);
6-bare soil visible from above.

Such observations must be tempered with judgment. There are often other causes than fertility for the above. But once fertility has been established on fairway, or park, or school turf where clipping are recycled, need for fertilizer should be low. Without fertilizing more than once every vear or two the turf should be able to maintain good density, compete well with weeds, and show adequate color most of the year.

With clipping continually removed, putting green turf requires close and frequent observation, and nothing can be said that will substitute for experience. However, we can deemphasize color. Instead we can watch the amount of clippings and whether mowing restores the surface quality. If we watch replacement growth instead of color, we may go one of two wavs.

l-We may find that we make fewer N applications in a year.
2-If we cut the amount of N per application to 1/2 or 2/3 we may make as many applications as before, but use less fertilizer.

I can summarize with the following generalizations:

l-Test the soil for good calcium, magnesium, and potassium balance and for the presence of adequate phosphorous.
2-Apply N by visually judging the turf quality.
3-Avoid excessive use of ammonium sources.
4-Where clippings are removed, be vigilant for deficiencies and imbalances of nutrients other than nitrogen.
5-When clippings are recycled, build up the basic nutrient level, then use N only as needed to keep a full cover; a cover that is not overly dense. We want to use the enviromnent fully, but we don't want a plant competing desperately with itself.
6-We can judge our nitrogen needs visually, but are apt to form better judgments when we observe several factors-not just color alone.
7-Color judgments alone tend to lead to overuse of N.

UC TURF CORNER

Victor A. Gibeault, Forrest Cress*

Controlling Moss, Algae in Turf

A handy guide for preventing or controlling moss and algae in turf appears in the June 1975 issue of Grounds Maintenance.

Briefly, here's some of what Dr. James B. Beard, formerly of Michigan State Univ. and now at Texas A&M, author of the guide, has to say about mosses and algae:

Mosses produce a branched, filamentous growth of two types. One contains chlorophyll and creeps along the surface of the ground. The second type is a non-green, underground filament or rhizoid. Both are one cell in thickness.

Mosses are associated with neglected turfs. Their occurrence is most commonly attributed to poor drainage and high soil acidity. However, several other conditions also combine to favor moss growth: poor soil aeration; wet conditions due to imperfect soil drainage or to ground water seepage; low soil fertility; high acidity; shading; high humidity. Mosses also have been known to occur in highly alkaline or relatively droughty soils if the other previously described conditions exist. Closely mowed, thatched turfs are prone to moss invasions, particularly if composed of relatively noncompetitive grass species.

To control moss, the conditions favoring its development must be corrected. Corrective measures may include: soil cultivation by coring or slicing to enhance drainage and aeration; improvement of soil drainage by installation of drain tile, dry wells, or French drains, or by raising depressions; increasing the fertility level into the favorable range for turfgrass growth; adjusting the pH to between 6 and 7; and/or controlling an excessive thatch accumulation.

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Routine turfgrass cultural practices that may need to be adjusted include raising the cutting height or adjusting the irrigation practices to avoid excessive water applications. Finally, planting a vigorous turfgrass that is well adapted to its soil and environmental conditions can be quite important in minimizing moss invasion.

Existing moss problems may require chemical control. Effective methods include: (1) iron sulfate or ferrous ammonium sulfate applied at 1 to 3 ounces per 1,000 square feet; (2) copper sulfate applied in a dilute solution at 2 to 3 ounces per 1,000 square feet; (3) superphosphate applied at 2 to 3 pounds per 1,000 square feet. The preferred method is use of iron sulfate or ferrous ammonium sulfate.

After moss has been killed by one of the chemical applications described above, rake out the moss to avoid formation of a tight, impervious layer of moss over the soil surface.

Algae are minute, singled-celled, filamentous, green plants that contain, chlorophyll. Under favorable conditions they form a dense, thin, green scum over soil surface that can impair aeration, water movement and turfgrass shoot growth.

Several environmental factors favor growth of algae: a wet waterlogged soil surface; a high soil fertility; a high level of sunlight. Algae development also is associated with flooding.

Corrective measures include: improving soil drainage through surface contouring and installation of drain tile, dry wells, or French drains. Soil cultivation by coring or slicing also will reduce an excessively wet soil condition. Air movement to speed up surface drying can be enhanced by selectively removing trees and shrubs. Introduction of adapted, vigorously growing turfgrass species will reduce light to the soil surface.

The most common method of chemical control of algae is use of copper sulfate, applied as a dilute solution, at 1 to 2 ounces per 1,000 square feet. After the algae is killed, rake out the dead scum or crust. Then apply hydrated lime at 2 or 3 pounds per 1,000 square feet to neutralize any toxic gases or organic compounds that have accumulated in the soil under the anaerobic conditions. This treatment also discourages further algae development. Re-establish bare areas larger than the palm of your hand by seeding, plugging, or sodding.

("Controlling Moss, Algae in Your Turf," by Dr. James B. Beard, Grounds Maintenance, June 1975.)

St. Augustinegrass Susceptible to Phosphorous Deficiency

St. Augustinegrass is very susceptible to phosphorus deficiency.

A good example of this fact occurred recently in Florida. Inspection of two sod farms on organic soils showed wide strips of green turf alternating with purplish-brown colored St. Augustinegrass. Sod had been lifted the previous fall, and the fields had been refertilized using a truck turn-table type spreader. Soil samples were taken and analyzed. Results suggested unequal fertilizer distribution since surface phosphorous (P) and potassium (K) were 57% and 93% greater, respectively, in soil taken from the green turf areas.

University of Florida researchers then set up four demonstration areas, each consisting of strips of P alone, P plus K, and K alone, laid out approximately 100 feet long across the wide discolored strips. The P was applied as superphosphate (0-20-O) at 250 lb/acre. The K was applied as muriate of potash (O-0-60) at 167 lb/acre. These rates are equivalent to the P and K applied in 500 lb/acre of 0-10-20.

Within four weeks after treatment, plots that had received P were growing well with good green color, and the top 1 inch soil samples showed a marked increase in P content. The plots receiving K alone showed no change in growth or color even though the K content in the top 1 inch of soil was increased.

Prior research has demonstrated that seyeral southern forage grasses show P deficiency below 0.14% P, and data reported by numerous workers suggest that no K deficiency is likely at tissue levels above 1.5%. In the pretreatment samples, the P content of the discolored grass was only half that in the green areas and was well below the stated deficiency level, whereas the K content was within normal limits in both areas. In the demonstration plots the P content of the grass which remained discolored on the potash alone plots was less than half that in the plots which had received P, and was also well below the deficiency level. The K content was adequate for good growth in all plots, even though somewhat lower where no K had been applied.

("Phosphorous Deficiency of St. Augustinegrass Resulting from Unequal Fertilizer Distribution," by R. J. Allen, Jr., and G. H. Snyder, Florida Turf, Vol. 8, No. 5, March 1975.)

Carbohydrate Response of Bermudagrass, Dallisgrass, Smutgrass to Herbicides

Even when a perennial grass is not killed by herbicide treatment, its energy balance may be changed. Prior research has shown that the rate of growth and level of reserve carbohydrates of perennial grasses reflect the metabolic energy balance within the plant. Carbohydrates are the primary source of reserve energy stored in the vegetative organs of perennial plants and are essential to survival during periods when photosynthesis is minimized.

In a recent Mississippi State University study, the carbohydrate reserves in surviving storage tissues of bermudagrass, dallisgrass and smutgrass were evaluated at selected intervals following herbicide application.

Atrazine at 4.48 and 8.96 kg/ha, bromacil at 2.24 and 4.48 kg/ha were applied in water at 187 L/ha to smutgrass-infested permanent dallisgrass-bermudagrass pasture. The plots were initially treated in fall. The spring treatments were repeated applications with the same herbicides and rates for each plot. Tissue samples for carbohydrate analysis were taken from each plot at 2, 4, 6, and 36 weeks after the fall treatment, and at 2,4, and 6 weeks after the spring treatment.

The carbohydrate response of bermudagrass and dallisgrass to single and repeated applications of atrazine and bromacil in the Mississippi study showed that these species are capable of recovering to a normal metabolic level after at least one application of the rates used in this experiment. Since smutgrass was killed with atrazine and bromacil treatments, it appears that a feasible smutgrass control program could be developed with these herbicides for dallisgrass-bermudagrass pastures. Such a program would not endanger the desired species during periods of adverse growing conditions.

("Carbohydrate Response of Bermudagrass, Dallisgrass, and Smutgrass to Atrazine, Bromacil and MSMA," by J. E. Smith, A W. Cole, and V. H. Watson, **Weed *Science,*** Vol. 23, No. 5, September 1975.)

Use *of Nitrogen-Deficient Culture to Identify Kentucky Bluegrass Cultivars*

Although several useful characteristics are avialable for distinguishing one Kentucky bluegrass cultivar from another, additional ones are needed to separate those cultivars that cannot be identified using present techniques.

Cornell University researchers suggest that a new technique-growing seedlings in sand supplied with a nutrient solution lacking nitrogen-can be helpful in cultivar separation endeavors. They planted authentic seeds of 23 cultivars plus 7 experimental lines in inert sand and twice weekly applied a complete nutrient solution or a solution lacking nitrogen. Three weeks after the seeds were planted, notes were taken on color of the first leaf blade of each plant.

The Cornell researchers report that striking differences in color of first leaf blades were evident three weeks after planting. Those of some plants were entirely green. Others were strong red in color. Between these extremes wre plants in which only part of the leaf blade was light red. Of the cultivars and experimental lines tested, five had a high percentage of plants with strong-red leaf blades, and two cultivars had a high percentage with green leafblades. In the other cultivars, most plants had partly red or slightly red leaf blades. Although differences observed would not be useful in distinguishing many cultivars, the Cornell scientists note, they could be used to separate contrasting types.

("Identification of Kentucky Bluegrass Cultivars Using Nitrogen-Deficient Culture," by L. W. Nittler and T. J. Kenny, Agronomy Journal, Vol. 67, May-June 1975.)

Avoid ***Cold Injury to Seeded Bermudagrass***

Time of planting is critical for stands of common bermudagrass established from seed in areas with cold winters.

Bermudagrass usually is planted in the northern part of its belt of general adaptation from March through June by sprigging with rhizomes, stolons or both. Stands established by sprigging generally show little or no freeze injury the following winter. Establishment of pastures and lawns, in many instances, has not been satisfactory from seed. Winter kill often is extremely high in seeded stands, and they are slow to recover the following spring.

Researchers at Oklahoma State University are attempting to develop seeded bermudagrass cultivars with greater cold tolerance. In a recent study, they compared the winterhardiness of seeded common bermudagrass with an open-pollinated, seed producing, experimental clone.

Seeding differences were studies between and within the two strains established at two-week intervals beginning in April and ending in August. Fall measurements were taken of forage dry matter production and fiibrous root and rhizome volumes. The following January and February, rhizomes and crown buds were harvested from each establishment date, and their viability was determined. These measurements then were related to recovery and growth that spring.

Comparison of winter hardiness between strains demonstrated that the experimental clone initiated rhizome production earlier and in greater quantities than the common bermudagrass. Experimental clone plants emerged three to four weeks earlier than those of common bermudagrass in the spring. More plants from the experimental clone survived from the July planting than from the common bermudagrass plots.

Results from the study showed that winter survival of common bermudagrass depended almost entirely on crown-bud hardiness. Rhizomes and crown buds contributed to the survival of the experimental clone plants. Planting after July 21 for the experimental clone and May 25 for the common bermudagrass did not permit sufficient time for development of rhizomes and crown buds capable of complete winter survival.

("Stand Establishment of Bermudagrass from Seed," by R. M. Ahring, W. W. Huffine, C. M. Taliaferro, and R. D. Morrison, Agronomy Journal, Vol. 67, March-April 1975.)

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