

under conditions of high nitrogen feeding. It takes traffic well, and divot scars are quick to heal, desirable qualities for any hard-wear areas. Even during its dormant season, bermudagrass remains dense, and its off-color is masked by volunteer *Poa annua*.

Bermudagrass is at its peak during the hot summer months, when the cool-season grasses are dormant or dying. The balance of *poa* and bermuda is a natural one, and who are we to fight nature? We live with it and love it! We think our poa-bermudagrass turf is great!

RATES OF SEEDING TURF GRASSES

By A. M. RADKO

ACTING EASTERN DIRECTOR, USGA GREEN SECTION

There are many factors which contribute to the degree of success attained in establishing a good turf cover from seed. Some of these factors are seedbed preparation, nutrient level of soil, freedom of weeds and weed seeds in seedbed, time of seeding, depth of seeding, water management, fertilizer management, maintenance practices, rate of seeding and grasses or grass mixtures selected.

If all requirements over which we have control are carried out to the letter, we can be reasonably sure of success—if the elements are kind. Too much or too little rain immediately after seeding can alter the outcome greatly. However, seeding at the proper time keeps the odds in our favor. We cannot control the elements, so let us consider those factors over which we have control.

Seedbed Preparation

Proper seedbed preparation is the very important first step. The seed bed should be prepared with proper ingredients added to place the soil in good physical condition. The degree to which the physical conditioning will be carried out will depend upon the eventual use of the area. Preparation for a putting green would differ greatly from the preparation for a home-lawn seeding. However, the proper proportion of sand, soil and organic matter, thoroughly mixed so as to provide good granulation and aggregation without layering, will do much to provide good air, water, nutrient and root penetration.

Lime, nitrogen, phosphorous and potash also are essential to good seedbed preparation. When preparing a new seedbed,

these nutrients should be mixed thoroughly into the soil so that they will be available to the seedling plants as the plants can use them. Good fertility is necessary to the production of good turf. Although nitrogen is the element which needs to be applied in the largest quantities for good turf, relatively high levels of phosphorous and adequate potash are important also, especially to seedling plants. After the seedling plants have matured, nitrogen is the key element. Proper fertilization is essential to the production of good turf.

Seedbed-soil sterility is desirable also to begin with, in order to eliminate weed competition. Soil sterilization may be accomplished by the use of cyanamid or Dow-fume MC-2 where practical. Another method of reducing the weed population is to prepare the seedbed and allow it to remain idle for a week or two until the weed seeds germinate. At that time a good weed spray will kill all weeds, and generally all that is required to place the bed in order is a light raking. Good planning is essential to either method, so that the timing will be right.

The next logical step is the proper selection of grasses, and use of the proper quantities of each to provide the type of turf desired. There is a wide difference in the number of seeds to a pound. This factor is important in determining the percentage of seed of each species which will be needed in the mixture in order that the turf will contain the desired species in proper proportions. Table I, taken from the USGA's book "TURF MANAGEMENT" by H. B. Musser, shows these differences in numbers of seeds to pound in the more important turf grasses.

TABLE I
Quality Characteristics of Good Turf Grass Seeds

	Min. % Purity	Min. % Germination	Approximate No. seeds per lb.	Viable seeds per sq. ft. when sown at rate of 1 lb./1000 sq. ft.
Kentucky bluegrass	95	85	2,250,000	1,800
Merion bluegrass	98	80	2,500,000	1,950
Colonial bentgrass	95	90	7,000,000	5,950
Chewings and red fescue	95	85	600,000	480
Kentucky 31 fescue	95	90	500,000	425
Zoysia (Z-73) japonica	95	95	1,000,000	900
Ryegrass	98	95	275,000	256
Redtop	95	90	5,750,000	4,887

The following table shows how the numbers of seeds per pound vary when different percentages of the same grasses are combined. These figures are representative of the way these proportions work on paper; under practical conditions we know that some of the seeds of each grass will fail to produce plants. Therefore, the figures shown may be decreased by as much as one-third under practical conditions. The approximate ratios shown tell an interesting story when compared with the percentages of each grass in mixtures.

TABLE II

Number of Viable Seeds per Square Foot of Grasses Indicated in Mixture Sown at the Rate of One Pound per 1,000 Square Feet

Mixtures per Pound	NUMBER OF VIABLE SEEDS PER SQ. FT.				Total Seeds per Sq. Inch
	Kentucky Bluegrass	Creeping Red Fescue	Colonial Bentgrass	Totals	
30% Kentucky Blue 60% Creep. Fescue 10% Colonial Bent	545	291	599	1435	9.9
Approx. Ratio	2	1	2		
60% Kentucky Blue 30% Creep. Fescue 10% Colonial Bent	1089	145	599	1833	12.7
Approx. Ratio	8	1	4		
10% Kentucky Blue 30% Creep. Fescue 60% Colonial Bent	181	145	3591	3917	27.2
Approx. Ratio	1	1	23		

These figures are based on the following number of seeds per pound:
 Kentucky Bluegrass 2,250,000 (purity 95%—germination 85%)
 Creeping Red Fescue 600,000 (purity 95%—germination 85%)
 Colonial Bentgrass 7,000,000 (purity 95%—germination 90%)

The following table is taken from correspondence from C. R. Runyan, Superintendent of The Spring Grove Cemetery, Cincinnati, Ohio. Mr. Runyan's chart shows the theoretical number of seeds per square foot, using seed which numbers 2,250,000 seeds per pound when sown at the rate of one pound per acre.

TABLE III

Viable seeds per square foot using seed which numbers 2,250,000 seeds per pound, sown at the rate of one pound to the acre.

<i>% Live Seed Purity X Germination</i>	<i>Approximate Seeds per square foot</i>
85.....	44
83.....	43
81.....	42
79.....	41
77.....	40
75.....	39
70.....	36

Example: Wanted — 500 live seeds per square foot

Live seed 77%

$500 \div 40 = 12.5$ pounds per acre.

With regard to rates of seeding, the generally recommended rate on normal areas is 2 pounds to each 1,000 square feet. If we go back to the second table, we see that 2 pounds of seed contain 2,870,000 seeds of the first mixture, 3,666,000 seeds of the second mixture, and 7,182,000 seeds of the third mixture. These figures represent a difference of about $4\frac{1}{2}$ million seeds between mixtures one and three, which is quite a difference in two separate lots of seed of the same weight. As mixture two is more nearly representative of the mixtures recommended for normal areas, we must therefore conclude that between three to four million seeds to each thousand square feet are required to produce a satisfactory cover in a relatively short time.

For large-scale plantings on the acre basis this seeding rate should be halved. This is also true on areas where fast turf cover is not required.

Fertility level is closely tied in with the

establishment of new turf. In general, a heavy rate of fertilizer with low rate of seeding is more effective in producing good turf than a heavy seeding rate with or without a heavy rate of fertilizer.

A. E. Rabbitt's work at the Arlington Turf Gardens in 1939 was a striking demonstration of the role of fertilizer with various seeding rates. Those trials indicated that best results were obtained where seeding rates of one, two and three pounds of seed to 1,000 square feet and fertilizer at the rate of 4 pounds of nitrogen to 1,000 square feet were applied. The plots seeded more heavily were very badly diseased during the following summer and a serious infestation of weeds resulted.

Time of Seeding

Time of seeding is another important consideration. It is generally agreed that early fall seeding of the cool-season grasses give best results. Seedings made early enough to allow the seedling plants to germinate and become established before cold weather arrives are best. At that time competition from weeds is slight.

On golf courses and athletic fields fall seedings are not always possible. Oftentimes spring seedings must be made as necessity or playing schedules dictate. Spring seedings in northern locations usually become heavily infested with weeds; the seedling plants hardly become established when they become dormant and weeds take over. Spring seedings are especially difficult throughout the so-called crabgrass zone.

All the factors discussed contribute to the degree of success which may be attained in attempting to establish turf from seed. The careful accomplishment of each step is necessary. Neglect of any one of the processes of seedling establishment may cause failure. The experienced and painstaking operator will find, however, that if he properly takes care of all controllable factors, he will not fail often. If weather or some other non-controllable factor intervenes, no amount of seed will change the results appreciably.