GROWING GRASSES UNDER EXISTING AND "MADE" ROADSIDE CONDITIONS

By

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This paper is a progress report upon the studies which are being made at Purdue University on the establishment of turf for road shoulders and berms. The studies were initiated early in 1943 at the request of the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture and Landscape division of the Indiana State Highway Commission. The results of the experiments conducted will be reported under two subdivisions: (a) establishment of turf on stabilized granular materials and (b) turf establishment under roadside conditions.

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Turf on Stabilized Granular Materials

At the start of these investigations very little information was available concerning the growing of turf on granular materials which had been stabilized and some doubt was expressed as to whether such a development were possible. Frequently a good turf is desirable where the soil has been stabilized or where granular materials are necessary to obtain sufficient supporting power for the anticipated load. Under such conditions, attention must be given to the factors which influence plant growth. The need for sufficient pore space (voids) proper pH, sufficient plant nutrients, and available water supply are factors which need much study before satisfactory recommendations can be made for the establishment of turf under such conditions.

Preliminary greenhouse experiments conducted early in 1943 using Kentucky bluegrass (*Poa pratensis*) on stabilized pit-run gravel having the larger stones crushed so as to pass a one-inch screen led to the following conclusions:

1. Kentucky bluegrass is able to obtain nutrients from stabilized aggregate which has received heavy quantities of fertilizer.

2. Greater root penetration occurred where fertilizers were omitted from the surface layer of soil making it necessary for the roots to penetrate the aggregate to obtain plant food.

3. Heavy quantities of fertilizer in the aggregate appeared to stimulate rhizome development.

These investigations were conducted on materials having an apparent specific gravity of 2.06 (129 pounds per cubic foot), giving a total pore space of 22.1 percent. This pore space is to be compared with from 40 to 50 percent found in farm soils.

Field Experiment

After the preliminary greenhouse experiments indicated the feasibility of growing grasses upon aggregate material further studies were planned under actual field conditions. An experiment was established in the fall of 1943 to study further certain factors which might influence the growth of turf.

Figure 1 presents diagrammatically the cross-sections of the treatments now being studied. The principal factors are (1) Depth of stabilized layer, (2) Percent soil required in stabilized mixture, (3) Top soil and its modifications, and (4) Variety of grass. Figure 2 shows a general view of the 24" concrete cylinders which were used as individual plots and the procedure followed, in preparing the aggregate mixtures. The aggregate mixtures were compacted into the cylinders in a manner as illustrated in Figure 3. Where seed was used to establish the turf, Kentucky bluegrass was the sole species. A strain of red fescue and a special variety of bluegrass and Zoysia japonica were also planted to study their adaptation to such a condition.

In this experiment, three different materials commonly used for highway and airport construction in Indiana were used. These materials were pit-run gravel, (large stones crushed to pass a one-inch screen), crusher-run stone, (all passing a one-inch screen), and sand. The sieve analysis of these materials are given in Table 1, and also are presented graphically in Figure 4. These determinations were made under the direction of Mr. T. E. Shelburne, and his comments concerning these samples are as follows:

> "It will be noted that the curves for the pit-run gravel and the crusher-run stone are very similar to a Fuller's curve, except for the finer sizes. The addition of from 5 to 10 percent soil (-200 mesh material) to the stone and gravel will result in curves which more nearly approach the Fuller's curve".

Table 1.

Sieve Analysis of Materials Used in Experimental Sections in Turf Experiments*

Sieve Sizes	Stone: Percentage by weight	Stone: Accumulated percentage retained	Gravel: Percentage by weight	Gravel: Accumulated percentage retained	Sand: Percentage by weight	Sand: Accumulated percentage retained
1½"-3/4"	5.90	5.90	5.25	5.25	0.20	0.20
3/4"-3/8"	41.60	47.50	20.30	25.55	0.69	0.89
3/8"-No.4	24.75	72.25	15.77	41.32	5.85	6.75
No.4-No.8	13.50	85.75	17.27	58.59	22.22	28.97
No.8-No.16	5.38	91.13	20.52	79.11	28.80	57.77
No.16-No.30	3.33	94.46	15.37	94.48	25.92	83.69
No.30-No.50	2.01	96.47	2.95	97.43	12.68	96.37
No.50-No.100	1.29	97.76	0.91	98.34	2.11	98.48
No.100-No.200	1.66	99.42	0.87	99.21	0.36	98.84
No.200-Pan	0.58	100.00	0.79	100.00	1.16	100.00

*Determinations made by Mr. T. E. Shelburne, Research Engineer, Joint Highway Research Project, Purdue University.

> "The pit-run gravel curve shows a better graduation than does the crusher-run stone. This and also particle shape accounts for the greater density that you were able to secure with the pit-run gravel. The stone contained an excess of coarse particles and a deficiency of the finer particles to fill the voids. Likewise, the sand, lacking material above the No. 4, was less stable. All three materials, however, are typical of those employed for highway or airport construction."

The amount of material which was weighed up for each cylinder was based upon the premise that a density of 135 pounds per cubic foot should be obtained with all three materials. An accurate record was kept of the amount of material compacted into each cylinder and it was found that pit-run gravel gave nearly this degree of density but both crusher-run stone and sand did not approach the proper graduation to give a density of 135 pounds per cubic foot.

This can be explained upon the basis of Mr. Shelburne's remarks that the crusher-run stone did not contain enough of the finer fractions to fill the voids in the compacted material and sand did not contain a large enough portion of the larger fractions to make a stable aggregate. Nevertheless, these three materials are typical of those used for construction purposes in Indiana.

Results: Due to the very dry weather conditions which developed after the seeding of bluegrass, it became necessary to irrigate the area in this experiment in order for the young grass seedlings to survive. The value of a straw mulch was indicated very early in the experiment by the more favorable moisture conditions under the mulch and the consequent greater survival of grass seedlings. Figure 5 shows the sparse stand of grass 15 months after the experiment was established.

During the 1944 season, several significant observations were made. A very wet spring was experienced in Indiana which resulted in a general deficiency of nitrogen for the proper nutrition of grass. Potash was likewise leached very badly, resulting in both nitrogen and potash starvation. These deficiencies were greatly accentuated in this experiment with granular materials because of the very small quantity of soil colloidal material present which would serve to hold certain plant nutrients and partially prevent their being leached. Nitrogen and potash deficiency symptoms were observed on all treatments regardless of the heavy quantities of fertilizers applied.

As the season progressed, certain differences in the turf were observed on each of the three types of aggregate, and on the quantity of soil used in the aggregate mixtures. No consistent differences have so far been observed in the quantity and quality of turf as influenced by the depth of aggregate, or by the quantity of top soil used on the compacted granular material. The pit-run gravel in general gives the best turf, sand giving the poorest with crushed limestone occupying an intermediate position. The addition of soil to the aggregate gave a significantly better turf as indicated by the density and the amount of growth. Little difference exists between the gravel mixture containing 5% soil and that containing 10%, but where no soil was added the growth is definitely inferior. With crushed limestone 5% soil appears to be insufficient whereas 10% soil with this aggregate produces a superior turf. The difference in the two materials may be due to the small quantity of colloidal material contained in the pit-run gravel under natural conditions. The addition of 5% soil supplements sufficiently the quantity of colloidal material in the gravel to provide a satisfactory medium for the growth of grass. This amount of soil mixed with crushed limestone is insufficient.

Figures 6 and 7 show the turf with no soil added to the aggregate (G 5), and 5% soil added (G 2). It will be noted that G 5 is inferior to G 2.

Conclusions:

(1) That Kentucky bluegrass will grow on compacted aggregate materials having a density comparable to that obtained in road bed construction has been established.

(2) The essential plant nutrients should be supplied in liberal quantities and probably should be mixed with the aggregate materials.

(3) The addition of 5 to 10 percent soil having a high clay content to the aggregate material is considered essential to supply sufficient colloidal material for the retention of plant nutrients and moisture in the aggregate.

(4) The penetration of bluegrass roots into the compacted materials is stimulated by the distribution of plant nutrients through the aggregate and apparently discouraged by the concentration of nutrients in the surface soil layer.

(5) A light straw mulch helps to retain the moisture in the granular materials and aids in the survival of grass seedlings.

Turf Establishment Under Roadside Conditions

In the fall of 1944 an experiment was started on state road #45 to determine the fertility factors which are deficient in the subsoils and parent materials in certain residual areas of southern Indiana. In the area studied the soils were derived from residual sandstone. Another study was conducted on a similar site to determine the use of various legumes and grasses on roadside seedings.

After the road construction has been completed by the contractor, the soil on the shoulders, berms, back slopes, and fills was tilled with an A-type spike harrow to prepare a seed bed for the grass and legume seedings. For the fertilizer trials three areas were selected on each of which was placed the entire series of fertilizing treatments. One series was placed on a fill, one on a long backslope and the third on a level right-of-way. Table 2 gives the fertilizers applied and the quantity per acre.

Table 2. Fertilizers used on Turf Experiment State Road #45

Pounds per Acre		
Nitrogen as N	Phosphorus as P_2O_5	Potash as K_2O
80	160	160
40	160	160
0	160	160
80	160	80
80	160	0
80	80	160
80	0	160
80	0	0
0	160	0

The fertilizer series was seeded uniformly with a mixture of Kentucky bluegrass 20 pounds; Red Top 20 pounds; and Domestic Ryegrass 15 pounds.

After seeding the area was mulched with bluegrass hay. This was the only mulch available at the time and the hay contained some bluegrass seed. During the week following the seeding several inches of rain fell at a low intensity which was ideal for the germination and establishment of the grass seedings.

Results: Excellent germination and establishment of grasses was obtained and within six weeks after seeding a good growth had been made. The two fertility factors which demonstrated immediately their deficiency in the soil were nitrogen and phosphorus. On the back slope very poor growth was obtained wherever either nitrogen or phosphorus were omitted in the treatment. Potash treatments showed only a slight response on all three series.

A number of legumes and grasses were tested alone and in combination to determine their suitability for roadside turf. A uniform treatment of 1000 pounds per acre of an 8-8-8 fertilizer was used throughout this test. Duplicate tests were made on a backslope and fill.

Ladino clover was seeded in this series of plots and this legume has performed very well on the fill with a north exposure but was almost a complete failure on the backslope with a south exposure. Apparently Ladino clover is not sufficiently drought tolerant to withstand the dry conditions of the raw subsoil and parent materials during the summer months.

Birdsfoot trefoil gave only a scattered stand on both the backslope and fill but on each of these sites the birdsfoot trefoil has survived and the few plants appear to be healthy. It is hoped that these plants will become well enough established to reproduce and reseed the surrounding area. The deep root system, drought tolerance and low habit of growth should make this an ideal roadside turf legume. It will of course need to be tested under a wide variety of soil and climatic conditions before it can be recommended.

Alta Fescue, a strain of meadow fescue has shown possibilities as a grass to be grown under roadside conditions. It is an extremely tough grass and has withstood considerable traffic in trials conducted in other States.