# Establishment of Vegetation on Subsoils

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•THE extent of roadside erosion and the importance of its control were recognized more than thirty years ago. Formation of the Soil Conservation Service in the early thirties helped spread this recognition. In 1936, cooperative demonstrations on roadside erosion control between the SCS and the Bureau of Public Roads were initiated. The advent of the National System of Interstate and Defense Highways emphasized the need for initial revegetation and the tremendous responsibility of maintenance which would fall on the shoulders of the State highway departments. Their problems are shared by the airports, military and housing developments, and others. In all of these there is involved the need for revegetation. It is not necessary to dwell on the recognition of erosion nor to point out nearly everyone's conviction that something has to be done about it. What is concerning everybody involved is the maintenance costs of this vast acreage of publicly owned land.

If you travel today's highways with a critical eye, you will notice failure after failure appearing. If you travel the same area for a number of years, you will note gradual deterioration. This is to be expected. Oh, we could blame it on our state legislatures' failure to provide adequate funds to do the proper kind of maintenance job—plus a lot of other "perhapses."

No one should be severly criticized for utilizing the farmers' feed and forage crops for highway erosion control. For the most part, it was the only seed available. Many people do not stop to think, however, that these species of grass and legumes were selected at our experiment stations specifically to give a high yield of top growth measured in tons per acre of hay or silage and that they were selected to be grown on the best agricultural land in the United States. By liming, fertilizing, manuring and crop rotations, their soil environment is conditioned to meet their needs. What was borrowed from the farmer and the horticulturist? Kentucky bluegrass and red fescue, which make good lawns; bromegrass, orchardgrass, tall fescue and others which can be cut for hay, processed for silage, or grazed. The agricultural experiment workers said just how many times to cut them, when to cut them, how many times they could be grazed, and what the waiting period should be after grazing. This was the seed supply you had on hand to revegetate roadbanks, borrow areas, and cuts and fills following construction. Is it any wonder that today we find that these same selections are not holding up except in a few favorable sites?

Various people are now looking with a critical eye at these plantings, and are thinking about the selection of species and strains that have a wide tolerance to a variety of soils and sites. They recognize that you are not in the business of producing tons of forage per acre, or trying to obtain maximum yields; they are recognizing that species which had previously been discarded because they did not produce enough are probably the ones that would also demand the least in the way of maintenance. This searching stretches from the hills of Idaho with its crested wheatgrass to the red clay banks of Georgia where native species plus fertilizer are surprisingly effective.

## NATURE OF THE STUDY

In the fall of 1959, the Soil Conservation Service entered into a cooperative agreement with the Navy Department to study and attempt to find low-growing vegetation for

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steep slopes. Realizing that the common commercially available forage species were not the answer because they required too much fertilization and too much mowing, we selected plants of low, dense groundcovers and seed of a number of species of grasses and legumes. In the second category, those selected had the inherent capacity of being easy to establish and persistent under a low order of management. In other words, they were the species which you will find taking over and filling the gaps. The third objective in the studies was to match cool-season grasses and legumes with warm-season grasses and legumes. The warm-season species would take over during the hot, searing summer months when everything else was burned up or dormant. With the coming of the fall rains and cool evenings, the cool-season material would recover, providing not only a highly efficient erosion cover but also an aesthetic view for a longer period of time.

A review of state and Federal road projects indicates an emphasis on stockpiling and salvaging topsoil for reuse. This, plus the purchase of topsoil, is one of the high-cost items in revegetation. It is fully recognized that the addition of topsoil to subsoil sites can be beneficial in establishing seedings. It is also recognized that fertilizers are more effective in soils having a good organic matter content. In many cases, however, the topsoil is placed as a thin layer on a highly compacted, machined surface. Following germination of the seeded materials, the entire mass will slip because no bond was made between the topsoil and the subsoil. In addition, large quantities of weeds are often introduced, which run severe competition with the desired species. Believing that adequate stands of desirable vegetation can be established on subsoil, we constructed an artificial embankment which had both north and south exposures. This embankment was built with a bulldozer and the soil was a heavy clay loam. All of the topsoil was pushed aside before construction. No topsoil was returned. The slopes were $2\frac{1}{2}$ to 1. The north slope was 22 ft long, the south slope 34 ft, with an 8-ft flat top.

Following back-blading by the bulldozer to smooth the surface, no other seedbed preparation was employed except the removal of large clods of clay and a few stones. Since subsoil tests in this area generally fall within the range of pH 4.8 to 5.3, two tons of dolomitic lime per acre were applied to the planting sites. The fertilizer used was 1,000 lb of 10-10-10. Neither the fertilizer nor the lime was incorporated into the seed bed. Seedings were made on the surface, some prior to the application of mulch and some through mulch. Half of each plot was covered with straw at the rate of 2 tons per acre, the straw being held in place with an erosion netting. (See Fig. 1.) The other half was mulched with a coarse jute netting. Two planting dates (one in April and one in July) were selected, since contractors can finish a job any month of the year, and summer seedings are the most difficult. It should be pointed out that the seeding mixtures were specifically modified in these tests to compensate for the time of the year. For example, you would not plant lespedeza in late fall, because it is a warm-season crop; nor would you plant bromegrass in mid-July, because it is a cool-season species and should be planted only in the spring or fall. In addition to the actual seedings (Appendix) three species of plants were included in the July plantings: mother-of-thyme (Thymus serpyllum L.), drug speedwell (Veronica officinalis L.), and Japanese honeysuckle (Lonicera japonica Thunb.). Additional plantings were made in scattered locations in the surrounding territory.

## RESULTS

A final review of the trial plantings in the summer season of 1964 showed a number of results.

Seven of the mixtures contained either annual bromegrass (Bromus arvensis L.) or annual ryegrass (Lolium multiflorum Lam.). When used as a nurse crop, even with low rates of seeding (4 and 5 lb/acre, respectively), they produced considerable competition for the permanent species. July plantings of annual ryegrass and bromegrass resulted in excellent stands on northern slopes, but were practically complete failures on southern slopes. This is to be expected since both of these species are cool-season grasses and seeding should generally be confined to spring and fall seasons.

Figure 1. Laying jute and mulchnet on embankment.

The seed mixture containing Canada bluegrass (Poa compressa L.) and crownvetch (Coronilla varia L.), as well as the ones containing crownvetch and red fescue (Festuca rubra L.) are still retaining a good composition of both species and have provided an effective erosion cover since they were established.

Because of increasing interest in and use of crownvetch in highway seedings, a study was carried out at the SCS National Plant Materials Center on this species. The study dealt with depth of seeding. It showed that in heavy soils, the establishment of seedlings decreased by one-half for each $\frac{1}{8}$-in. increase in depth of seeding. This did not hold true on light soils. Surface seedings with mulch on subsoil resulted in one established seedling for every one and one-fourth germinable seed sown. This is brought out in an attempt to discourage deep seeding of this species.

The mixture of warm-season sericea lespedeza (Lespedeza cuneata (Dumont) G. Don) with Canada bluegrass has improved year after year. Incidentally, 1964 saw the severest drought in this area since weather records were inaugurated in 1871. Both species held up beautifully, going week after week without rain.

Three plantings were made which included small burnet (Sanguisorba minor Scop.) and crownvetch. Small burnet will germinate if planted in April or June or September,

Figure 2. Decumbent strain of Lespedeza cuneata.

and it provides an effective erosion cover until the slower-growing crownvetch can really get started.

Reed canarygrass (Phalaris arundinacea L.) was mixed with the native annual rabbitsfoot clover (Trifolium arvense L.). For some reason or other very little clover was seen the second year, so that the planting resulted in a pure stand of reed canarygrass. Despite aspect (i.e., north or south slope, or drought on top of the dam), this species is providing one of the densest sods.

One mixture, a combination of Canada bluegrass and red fescue, was seeded with white clover (Trifolium repens L.). This is a very good mixture, but the development of the white clover is conditioned by mowing. If there is no mowing, there is very little white clover. Several mowings increased the clover.

A few seedings were tried in the fall of 1962 on plots where previous seedings were near failures. A mixture containing birdsfoot trefoil (Lotus corniculatus L.), crownvetch and red fescue with western wheatgrass (Agropyron smithii Rydb.) failed to show any germination of the legumes. Consequently it was over-seeded in the spring of 1963. Although it is two years younger than the adjoining plots it appears to have promise.

The Lespedeza strains used in these trials were selected because of their low prostrate or decumbent habit. Lespedeza intermixta Makino rarely exceeds 6 in. in height, and Lespedeza virgata (Thunb.) DC, 18 inches, with Lespedeza cuneata (Dumont) G. Don intermediate between the two. (See Fig. 2.)

Since the day of planting these plots have been mowed only once a year. During the first year they were mowed to suppress weeds. Subsequent mowings have been timed to periods when the seed heads had ripened, which in a few cases strengthened initially thin stands. This is an important point to remember, particularly with crownvetch and small burnet.

## SELECTION OF GROUND COVER PLANTS

More than 150 ground cover plants were assembled. The selections included recognized ground covers as well as other plants with a potential for this use. The first step was to establish 20-ft rows of spaced plants where survival from drought and cold, diseases, height, rate of spread, soil preference and other pertinent factors could be observed. These rows also served as a source of propagating material for subsequent tests. Many fell by the wayside quickly. Those which showed a good potential were increased in sufficient quantities to make field trial plantings.

Practically all of the selected items were spaced 2 ft apart in the row, with rows either 3 or 4 ft apart. For Roseacacia (Robinia hispida L.) and Wichura rose (Rosa wichuriana Crepin) the spacing was 4 by 4 ft.


Figure 3. Carpetbugle—showing spread from plants spaced 12 inches apart, 2 years after planting.

Most of the planting areas had lime and fertilizer broadcast prior to planting. For a few sites all of the fertilizer was placed directly under the plant; a special slow-acting, non-burning fertilizer was used. The analysis was 7-35-7.

Again the planting sites were typical subsoil exposures and again many of the selections which appeared promising in the single rows failed to live up to expectations. Those that are doing the job in a respectable manner and should be tried in a wider range of soil and site conditions are discussed below. (See Figs. 3, 4, 5, and 6.)

## RESULTS

Carpetbugle (Ajuga reptans L.) is a dense, compact evergreen ground cover. It is tolerant of both sun and shade. It does not like droughty sands, but does persist well in the heavier soils and can stand mowing without damage. Its response on low organic subsoils is not 100 percent satisfactory. It appears to do better on northern exposures and responds to additions of organic matter, i.e., topsoil or peat moss.


Figure 4. Mother-of-thyme, showing spread from plants spaced 12 inches apart, 2 years after planting.

Figure 5. Foreground: Liriope strains. Background: other ground covers under test.

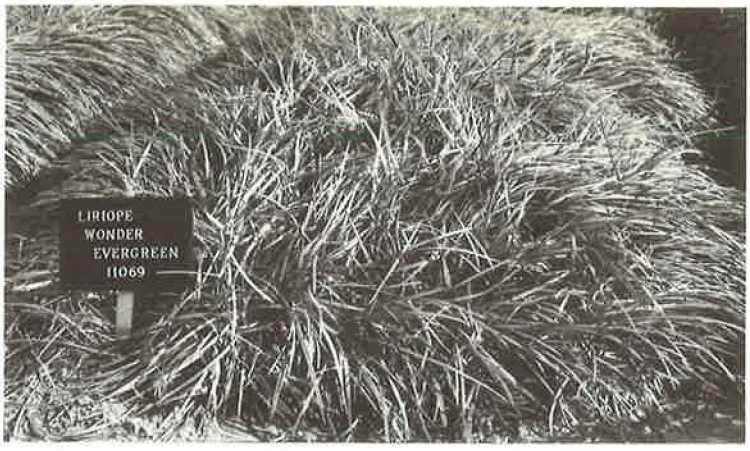


Figure 6. One of the most rapid spreading of Liriope spp.

Wintercreeper (Euonymus fortunei (Turcz.) Hand.-Mazz.) is a creeping evergreen vine which tacks at the nodes. It gets off to a slow start in the first year, but persists and spreads even in competition with weeds and grass, finally making a dense mass which excludes practically all other vegetation. The rate of cover could probably be stimulated by suppression of grass species with a selective herbicide.

Arnold dwarf forsythia (Forsythia sp.) attains a height of approximately 3 ft and develops sufficient prostrate and drooping stems to form a solid mass. It should not be planted directly in subsoil. Holes should be excavated and refilled with a good soil mix, plus fertilizer. Once established it requires very little maintenance. There is one major fault for the landscape architect, and that is the paucity of bloom.

Tawny day lily (Hemerocallis fulva L.), the common day lily, once established, I believe, will persist forever. On raw subsoil sites its rate of spread to fill the areas between rows is so slow that it needs a companion crop, such as annual lespedeza or similar plant, to prevent erosion until it takes over completely. Where there is a little extra moisture from runoff or ground seepage, the rate of increase is highly satisfactory. It has found limited use along highways at culvert outlets.

Lilyturf (Liriope graminifolia Baker) is one of the best. It spreads by short underground rhizomes, forming a thick mat of grasslike vegetation 6 to 8 in. deep. It will take good soils and bad soils, is tolerant of sun and shade. This is one of the most cold-tolerant of all of the Liriope selections tested. One called "Wonder Evergreen" has a more rapid rate of spread than the above. This plant is easily increased by plant divisions and has consistently given a high rate of survival on all sites.

Japanese honeysuckle (Lonicera japonica Thunb.) is excellent for holding the soil together where there is absolutely no chance of its encroaching on woodlands or other areas. It will permit some tree species to volunteer through it, but these can be controlled easily by spot spraying with herbicides.

Wineleaf cinquefoil (Potentilla tridentata Ait.), with waxy evergreen leaves, makes a 3-in. mat which is good looking the year round. Its density excludes most weeds. A little slow to start, it finally pushes everything out of its way. Extra care given at the time of planting and for a period thereafter will result in one of the most satisfactory of ground covers. It is tolerant of both light and heavy soils.

The original planting of Roseacacia (Robinia hispida L.) was 18 ft wide. Underground runners have now extended this species an additional 30 ft in four years. About 4 ft high, it will take some of the roughest sites but should be used with caution lest it get out of hand completely.

Wichura rose (Rosa wichuraiana Crepin) puts out runners which twine and intertwine until it becomes a solid mass of dark glossy green foliage. Where the runners hit the ground they take root. Superimposed on the background of green foliage are the white single roses in season. One test planting was adjacent to Japanese honey-

suckle. Due to spread of both they are occupying the same territory and after four years appear to be a compatible mixture. This plant should be used much more widely than it is.

Mother-of-thyme (Thymus serpyllum L.) presents the difficulty of getting good planting stock which will give a high percentage of survival in field planting. Once established, it forms a solid ground cover which is mowable. Plantings made in the spring of 1961 have excluded all weed species except a few dandelions and scattered sericea lespedeza plants.

## *Appendix*

SEEDING MIXTURES AND AMOUNTS[a] PER ACRE ON ARTIFICIAL EMBANKMENTS

| | | | | | |
|---|---|---|---|---|---|
| 1. | Crownvetch | 20 | 11. | Crownvetch[b] | 15 |
| | Annual ryegrass | 4 | | Canada bluegrass | 5 |
| | Canada bluegrass | 15 | | Red fescue | 10 |
| 2. | Crownvetch | 20 | 12. | Prostrate sericea | 30 |
| | Annual bromegrass | 5 | | Annual bromegrass | 5 |
| | Red fescue | 25 | | Canada bluegrass[c] | 5 |
| 3. | Hybrid lespedeza | 25 | 13. | Crownvetch | 10 |
| | Annual ryegrass | 5 | | Small burnet | 25 |
| | Red fescue | 20 | | Red fescue | 15 |
| 4. | Black medic | 10 | 14. | Small burnet | 25 |
| | Canada bluegrass | 25 | | Prostrate sericea | 20 |
| | Annual bromegrass | 5 | | Crownvetch | 15 |
| 5. | White clover | 5 | 15. | Birdsfoot trefoil[b] | 10 |
| | Red fescue | 15 | | Crownvetch | 10 |
| | Canada bluegrass | 25 | | Red fescue | 10 |
| | Annual ryegrass | 4 | | Western wheatgrass | 10 |
| 6. | White clover | 3 | 16. | Velvet lespedeza | 20 |
| | Crownvetch | 10 | | Annual lespedeza | 20 |
| | Annual ryegrass | 1 | 16a. | Velvet lespedeza | 30 |
| | Canada bluegrass | 5 | | Canada bluegrass | 15 |
| 7. | Willow lespedeza | 30 | 17. | Hybrid lespedeza | 30 |
| | Annual ryegrass | 5 | | Red fescue | 15 |
| 8. | Prostrate indigo | 30 | 18. | Crownvetch | 20 |
| | Annual lespedeza | 40 | | Annual lespedeza | 20 |
| 9. | Rabbitsfoot clover | 5 | 19. | Small burnet | 40 |
| | Reed canarygrass | 20 | | Annual lespedeza | 20 |
| 10. | Canada bluegrass | 30 | 20. | Red fescue | 25 |

[a] Pounds.
[b] Legumes re-seeded spring of 1963.
[c] Added to plot fall 1962.