RECENT DEVELOPMENTS IN SOIL EROSION CONTROL PRACTICES AND MATERIALS

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The primary purpose of the Soil Conservation Service is to assist farmers and ranchers with the development and application of basic conservation plans fitted specifically to the soil and water resources involved. It extends this on-site technical assistance for soil, water and plant management and sound land use to owners and operators primarily through soil conservation districts. The Service is also authorized to enter into agreements with state and other federal agencies for the purpose of providing assistance with problems of soil and water conservation.

Plant technology, properly applied in coordination with engineering and soil survey activities, plays a highly important part in the total soil and water conservation effort. Standards, specifications, and technical guides for the many erosion control practices used are based on Service experience and research data available from state experiment stations, private research stations, and other state and federal agencies authorized to conduct research.

There are, however, many specialized problems which refuse to respond to the normal recommended treatments for establishing and maintaining vegetative cover. Particular problems often have been neglected or ignored in the absence of proven techniques and/or adapted plant materials. In recognition of this fact, the Soil Conservation Service has been authorized to conduct observational tests of new or untried plant materials, including establishment and use studies. The Service's plant materials testing program begins at Service Plant Materials Centers located throughout the country so as to serve broad geographical or climatic areas. The Northeast Plant Materials Center is at Big Flats, New York, and is operated by the New York State Agricultural and Technical Institute under agreement with the Service. Here, strains and varieties of grasses, legumes, trees and shrubs are assembled and evaluated against "standard" plants for conservation value and use. Later, stocks of the more promising ones are increased for comparison in the field by Service plant materials technicians. Here, adaptation to varied site, soil and climatic conditions is determined and establishment and management techniques are worked out. The final stage of testing is in "field plantings" where plants surviving the preliminary screening are tested directly on specific problem sites on a management or use scale. In other words, the new plant and/or technique is applied directly to the problem.

PRACTICES AND MATERIALS

Many of the problems confronting Service technicians are similar to those encountered by persons responsible for highway construction and maintenance, therefore any new developments in methods and materials are often of mutual interest. Actually, the Soil Conservation Service is cooperating with highway departments in a number of states by establishing field plantings designed to improve existing methods or materials.

Direct Seeding of Shrub Species

In Connecticut, for example, the highway department favors shrub cover for certain areas of their roadside cuts and fills. The obvious fact is that hand planting of nursery grown shrub stock on a large scale is both laborious and expensive, and gets more so each day. At the request of the highway department, the Connecticut State Conservationist assigned the plant materials technician to work with highway department technicians in establishing field plantings in which various desirable shrub species are direct seeded in plots under different exposures and slopes. Numerous combinations of establishment methods and species will be tried. To date, wichura and multiflora rose have germinated into acceptable stands. Other desirable species presently slated for these tests include aromatic and shining sumac, sweet fern, silky and greystem dogwood, hardhack, bush honeysuckle, rose acacia, and false indigo. Because many of Connecticut's roadbank grass seedings eventually revert to native shrubs, why not help nature and the highway department to hasten the transition?

Open-Mesh Fabric for Holding Mulch

The establishment of vegetative cover by seeding slopes or structures subjected to water flow has long been a major problem. In the farm conservation program, water disposal systems handling field runoff must be quickly protected to prevent disastrous gullying. The same holds true on highway systems. Advances are continually being made in developing improved methods of establishment, plant varieties and strains, and management procedures for these critical areas. The Service is aware that the use of straw mulch when used with adapted grasses has vastly improved the successful establishment of vegetation on the more difficult slopes.

Mulch also permits more flexibility in seeding dates. However, where concentrations of high-velocity water must be coped with during the establishment period, mulch anchored with twine or emulsified asphalt usually fails to provide adequate protection. The Service's technicians have been working with this problem in farm waterways. A relatively new material is performing well in holding mulch in place in spite of water flow. This is an open-mesh fabric woven from paper (1), costing about four cents per sq yd, and used over the straw the same way expensive chicken wire has been used. Twine, properly strung and pegged, holds the netting against the mulch. Netting applied in this way has successfully held the mulch and resulted in good stands of grasses in waterways having grades up to 15 percent. The netting can also be used to prevent the loss of mulch on wind-swept slopes where other tie-down methods are inconvenient or ineffective.

Jute Matting

Recently, a woven jute material has been under test as a protection to new seedings in waterways and other areas subject to hydraulic forces. The material is a heavy netting often used to cover cotton bales. Initially, it was tried both as a tie-down for straw and directly in contact with the seedbed. It was soon evident that the combination of the jute mat and straw gave excessive cover which inhibited germination. The results with the jute mat used in direct contact with the seedbed have been nothing short of remarkable. Plantings were made under jute in highway ditches, farm waterways, and on highway banks subjected to surface water overfalls. Jute is also being used in plantings for shoreline stabilization along tidal rivers and bays. Earlier plantings were made with the standard weave matting which has about $\frac{1}{2}$-in. openings between strands. The manufacturer (2) is now weaving two additional grades of matting of a more open mesh. All grades are being made available to the Service for comparative test on the various sites. If the wider

spaced weaves prove satisfactory, rolls of the jute can be produced for about 13 cents per sq yd as compared to 18 cents per sq yd for the standard grade. Jute is manufactured in rolls 75 yd long and 50 in. wide, each roll weighing about 90 lb.

In using jute, the seedbed is prepared the same as where straw mulch is used. The jute is rolled on over the part of the seedbed which will be subjected to concentrations of moving water, and the remaining area can be mulched with straw. The jute should be pegged down tight to the soil with wooden pegs or 6- to 8-in. staples made from No. 8 wire. Intervals of the pegs will vary according to the nature of the cross-section to be protected. On a wide parabolic waterway pegging every 6 ft seems to be sufficient. Where rolls are laid adjoining each other they are lapped the width of the edge strands.

Much testing remains to be done before the full potential of this material is known. It appears that the use of jute will provide a method of establishing vegetation by seed on areas which have formerly required sodding or even paving. Cooperative tests on roadside ditches and slopes are under way in Maryland. A waterway in northern New Jersey has been stabilized with an excellent stand of tall fescue using this method. The jute mat provided protection against the erosive forces of water flowing from a 19-acre watershed on a 15 percent slope while the grass germinated, grew through the mat, and became established. It has been interesting to note that grass seed germinates several days earlier under the jute than on adjoining areas. Also the standard weave jute appears to inhibit germination of some of the troublesome broadleaf weeds, particularly lamb's-quarters, giving the grass seedlings additional freedom to develop strongly. Soil Conservation engineers will conduct hydraulic studies to determine the maximum velocities that can be handled over the jute mat without soil and seed loss.

PLANT MATERIALS UNDER TEST

Native Grasses

The majority of seedings being made currently on eastern farm, watershed, and highway earthen structures involve the use of "tame" grasses such as tall fescue, red fescue, and bluegrass. These species require fairly high fertility for establishment, and continuing annual management if they are to be maintained on such difficult unnatural sites. Native grasses such as switchgrass, big and little bluestem, indiangrass, and eastern gamagrass have much lower fertility requirements and are better able to stand adversity. The Service is beginning to collect, test, and produce seed of strains of these grasses selected from native stands. The importance of developing strains adapted to local climatic and soil conditions cannot be overemphasized. For example, a very vigorous leafy strain of switchgrass native to North Carolina was a complete disappointment when tested at Big Flats, New York. A selection of this species made near Concord, New Hampshire, offers promise for use in the northernmost states of the Northeast. Switchgrass volunteers naturally on low fertility soils which range from poorly drained to drouthy. Indiangrass may be found healing old, dry roadbanks and gullies, where previously tame grasses had been established but had petered out through neglect. The native grasses often occur in mixtures, each species contributing an important share toward providing vegetative cover.

M. D. Atkins, Plant Materials Technician for the Great Plains States, describes (3) the use made of native grasses for stabilizing earth fills and spillways of watershed dams. Establishment techniques include mulching the seedbed with native prairie hay, then anchoring the hay in the soil with a heavily weighted tool composed of notched coulters. Mixtures of four or five native grasses adapted to the particular area are used. The mixture also usually includes several tame grasses

such as smooth brome and tall fescue for initial, temporary, protection. Native grasses provide permanent cover and require a minimum of maintenance. They are tall grasses and therefore may not appeal to those who strive for the "manicured" look of some of the tame sod-formers. Unfortunately, the choice seems to be either tame grasses requiring intensive management, or the rougher, tougher natives.

Indiscriminately piled spoil from strip mining of coal is a serious stabilization problem. In the states where strip mining is prevalent, the accelerated runoff from spoil piles is a major source of heavy silt loads. It pours down onto adjoining farm lands and highways, and fills streams and reservoirs with materials that reduce capacities and kill the aquatic inhabitants. Strip mine spoil bents consist of a conglomerate of soil and rock ranging in pH from below 2.5 to nearly neutral, the outer slopes of which are often too steep for man to walk. In West Virginia, the soil conservation districts are accepting the responsibility for stabilizing mine spoil by contracting for the seeding or planting. Elsewhere states are approaching the problem by other means, and some wish to cooperate with the Soil Conservation Service in testing plants for use on mine spoil. In the past, experience has shown that a number of tree and shrub species will establish and thrive if planted on spoil. Plantings of trees and shrubs do not provide the soil cover necessary to control erosion until after 4 or 5 years of growth and litter production. Service plant materials technicians have been testing a wide range of grasses, legumes, and herbaceous plants on spoil over the past 2 years. The goal is to develop a group of plants that will provide surface protection and insulation when direct-sown between the newly planted trees and shrubs. To date, the most promising results on acid spoil have been with a few native grasses—switchgrass, indiangrass, and eastern gamagrass. The herbaceous garden burnet also shows promise. Among the better legumes are crown vetch and sericea lespedeza. It is not too surprising that species normally associated with the early stages of ecological succession should show up to advantage on raw, disturbed, or otherwise adverse sites.

Sand-Binding Plants

Plantings on sand dunes, inland areas of windblown sand, and drouthy fine sandy soils have been initiated to determine establishment techniques, adaptability, stabilizing effect, and use of a range of species. Unstilled sand encroaches on fertile land, or its movement may cause an undermining of structures. Farmers in certain areas use drouthy, sandy soils as crop lands where these exist as a substantial amount of the total available acres. On farms, these soils require very careful and intensive management regardless of the plants used, because there is usually utilization of the crop for grazing or hay. This differs with dunes and sand blows where the primary objectives are stilling and stabilizing. The work on such areas should have application to highway construction where hydraulic fill is employed or where cuts and fills leave sands exposed.

Both American and European beachgrass have been established successfully on coastal dunes and inland sand blows. American beachgrass is prevalent along the coasts and provides vegetative material for planting new areas. The best planting stocks are divisions consisting of 4 or 5 culms. These are planted 6 to 8 in. deep at intervals of 18 to 24 in. on the square. Top-dressings of 10-10-10 fertilizer in two equal applications, 400 lb per acre at planting time and the same later in the growing season, hastens rhizome growth and the development of new plants. The best planting time appears to be April 1 to June 1. Once an area is stabilized by beachgrass, fertilizer need be applied only when the stand begins to thin or weaken materially.

Switchgrass and the closely allied beach panicgrass, Panicum amarulum, show value for planting on sands. They are seeded at a rate of 20 to 30 lb per acre. Mulching the seedbed with 3/4 to 1½ tons of straw per acre aids establishment. Seeding should be preceded by the application of 800-1,000 lb of 10-10-10 fertilizer per acre. The initial fertilizer application results in strong seedling vigor and rapid establishment. The low fertility requirements of both species will allow them to persist with minimum supplemental fertilization.

Bermudagrass had been used extensively as a sand binder and has naturalized itself on sands and sandy soils over much of the south. The range of this African native has been extended northward by the development of the "Midland" variety, and through selection of strains which have become naturalized in New Jersey. The actual northern (or climatic) limit of these strains is yet to be determined. They are doing well at New Brunswick, New Jersey, and Kingston, Rhode Island. Bermudagrass strains or varieties are established by planting sections of rhizomes or stolons after the soil is warm in the spring. Their use may be limited by the necessity for high fertility during the establishment period. If rapid, complete coverage is desired on sites low in fertility, a minimum first year application of 300 lb of nitrogen, 60 lb of phosphorous, and 120 lb of potash per acre is required. Once bermudagrass has formed the desired compact sod, it can be maintained at quite a low fertility level. It is second to few grasses in providing a dense, drouth-resistant, tough mat of protective vegetation.

Bearberry is a native, trailing woody plant of interest. It thrives on infertile, drouthy soils such as Lakewood sand, and provides a mat of cover on highway cuts made along areas where it abounds. Attempts to transplant it from the wild to road cuts and similar areas have mostly met with failure. The Service is growing bearberry at its plant materials centers from seed and cuttings. The young plants are being established in small pots containing varied medium. Sphagnum moss is one such medium, and was selected for test because plants establish well in it, are known to thrive, and are lightweight for shipment. The final test will be the effect of the various potting media on field survival, if any. The main purpose of this work is to develop a method of successfully handling this potentially valuable species so that commercial nurserymen can produce livable stock for highway plantings and other similar use. Direct seedings will also be made with bearberry, utilizing several methods.

Other Plants of Interest

Crown vetch has been under study for some time (4). This perennial rhizomatous legume is being tested on highway cuts and fills and problem areas of like nature, and appears to have a wide range of adaptability. It is most successful on the heavier soils where the pH is naturally slightly above 6.0 or adjusted to that figure. Seed broadcast at the rate of 20 lb per acre in the spring, followed with mulch at the rate of 1½ tons of hay per acre, gives generally good stands. The seed should be inoculated with a specific inoculant before sowing. Crown vetch develops a dense spreading cover and is highly attractive when in flower. If mowing for height or weed control is desirable, it should be done during mid-summer, for this species normally has a strong flush of spring and fall growth. It is comparatively dormant at the height of summer except for flowering and seed production. Seed is still somewhat scarce and expensive. The plant materials technicians are assisting cooperators with the production of crown vetch seed in an effort to overcome the shortage. Also, new vigorous strains are under test at the Centers. From these, improvement over types now available is expected.

The value of sericea lespedeza has been well demonstrated on a wide range of

difficult sites. A new strain of prostrate sericea is being watched at the plant materials centers to see if it retains its trueness to type over several generations. The low spreading habit of this strain should make it valuable for use on roadbanks and similar sites where a low growing plant is desired.

Wichura rose, extensively used for erosion control by the Pennsylvania State Highway Department between 1932 and 1942, appears to be a plant that deserves more attention for stabilizing difficult sloping sites. Older plantings of this species on dry gravelly streambanks have resulted in an amazing mat of prostrate runners and foliage. One- or two-year-old seedlings planted on 3-ft squares gave excellent survival. The testing of wichura rose is being expanded to include plantings on strip mine spoil and highway embankments. Results with direct seeding will be compared to plantings made with nursery grown stock. Survival on the mine spoil and highway plantings has been excellent and the technicians are looking forward to observing the end results of all plantings with this species. As a word of caution, it has been the Service's experience that some commercial lots of seed purchased as wichura rose have contained a predominate percentage of the upright multiflora rose. Because of this, the Service is using its older plantings as reliable seed sources where pure wichura rose seed can be collected for use in the stock production and direct seeding.

Importance of Mulch

It is recognized that the use of mulch over seeding on difficult sites often is the difference between success and failure. It has been the Service's observation that there is often the tendency to mulch too heavily. In studying the effect of varied rates of mulch application on numerous species in the Northeast, it has been noted that straw mulch should not be applied at a rate greater than $1\frac{1}{2}$ tons per acre. Germination of a number of the grasses is inhibited when wheat straw is applied at a rate above 2 tons per acre. This effect will vary somewhat according to local condition. Admission of the fact that mulch plays a most important part in stabilizing problem sites should encourage the use of this practice at its most effective rate of application.

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