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Report of Committee on Roadside Development

WILBUR J. GARMHAUSEN, Chairman
Chief Landscape Architect, Ohio Department of Highways

•THE Committee on Roadside Development is continuing with its study of the many aspects of Roadside Development as they contribute to the complete highway.

At the 43rd Annual Meeting of the Board, the committee scheduled three business meetings and two program sessions. Papers were prepared and presented by twelve persons on the following general topics: highway location—the computer vs the brain, sprinkler irrigation for roadside vegetation in urban areas, property values as affected by highway landscape developments, scope of pesticides in highway operations—hazards and values, pesticides or hunger, planting for headlight glare screening and traffic guidance, lime and fertilizer requirements as related to turf establishment along the roadsides, effect of fertilizer slurries used with hydro-seeding on seed liability, roadside erosion research studies, woody and herbaceous plants for roadside ground-cover, mulches for steep cut slopes, and progress report on noise abatement.

The business meetings were attended by 11 committee members and 15 guests. The two open sessions were attended by an average of 70 persons. This year was the first time that the sessions were held at the Shoreham Hotel and it is not felt that this had any effect of keeping anyone from attending.

During 1963 the committee submitted its material to the Board, which printed it as Highway Research Record No. 23. Three distributions of material were made from its clearinghouse and one program committee meeting was held.

Among topics to be considered for the next program are (a) seeding of woody plants, (b) study of deicing chemicals, (c) maintenance of vegetation on the Interstate Highway System, (d) highways as environmental elements, (e) dune stabilization, and (f) sod and soil on slopes.

Work will be continued on the preparation of a number of circulars on special topics. A study and review of the committee members will be studied and the revised list will be submitted for approval.

Highway Location—The Computer Vs The Brain

DONALD A. OSTROWER
Vollmer Associates, New York City

•TWO THOUSAND YEARS ago in Rome, a single symbol was used to represent the quantity 1,000, and the Appian Way was built. Today computers require ten symbols to represent this quantity and highways are being built which are too often eyesores.

In many cases, taste and judgment have given way to machines whose complexity surpasses human understanding. Because of this inability to comprehend the machine, powers are ascribed to it that it simply does not have and its product is accepted as gospel. Also, taste and judgment are surrendered to those who require numerical evaluations and who would replace the criterion of beauty with that of the dollar and replace a rationale with a ratio.

Any blame for this rests largely with the administrators and designers who have stood by while that which was meant to be a tool for design has been transformed into a total design procedure, and while the "auditors" set dollar values to intangibles and use a logarithm in place of logic. This paper attempts to take some of the mystery out of the computer and to outline ways in which it is being used and misused in highway location and also to demonstrate the absurdity of using certain dollar value or ratio approaches to the location of highways.

THE COMPUTER AND THE BRAIN

The modern computer (such as the IBM 7090) has more than a million memory storage cores and can perform a hundred thousand additions per second while its electrical impulses travel at the speed of light—186,000 mi/sec.

Although the human brain's electrical impulses travel only 320 ft/sec, it possesses 10,000 times as many storage units as the computer and occupies 0.01 of the space of the computer.

Basically, the computer is a machine which adds only two digits 100,000 times a second. Its versatility stems from the imagination and ingenuity of the human programers who reduce complex problems to what is essentially a series of additions. A complex computer program may require as many as 100,000 consecutive instructions to the machine. Yet, this overgrown arithmetic machine, with a working vocabulary of only two symbols, cannot function unless humans translate problems into a series of additions of these two symbols. Yet it is worshipped and its answers are being substituted for human judgment in areas which cannot be mathematized.

USE AND MISUSE OF COMPUTERS IN HIGHWAY LOCATION

One of the early uses of computer programs in highway location is the Digital Terrain Model. Here, the computer is used to store, in the form of digitized data, a three-dimensional model of a strip of terrain. A designer feeds into the machine a number of different alignment and profiles, and the machine computes the construction cost of each of these. In this fashion it is possible to compare a vast number of possible lines and grades to determine which is the most economical. It would be prohibitively time consuming to estimate the construction costs for this number of alternate alignments by conventional means. On the other hand, the experienced

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designer, whose mind can store 10,000 times as many bits of information as the computer, could probably discard many of these alternate lines by inspection. Nevertheless, the Digital Terrain Model represents an excellent use of the computer as a tool in highway location. This stems from the fact that the inputs and desired results are mathematical concepts. However, this machine or procedure does not determine which is the "best" location for the highway, which location serves traffic best, which location blends the highway to the terrain, or any one of a number of other factors which the human designer is conscious of in selecting a location.

"Misuse" of the computer occurs when an attempt is made to mathematize all of these many factors. There are actually too many factors which are too complexly interrelated for existing computers and computer programs to handle, and most of these factors influencing highway location cannot be reduced to numbers—which is the only thing which the machine can recognize.

Programs have been attempted which reduce each one of these many factors affecting highway location into numerical concepts and attempt to combine these numbers to produce the "best highway location." One such approach lists the many requirements which a highway must meet, evaluates on a quantitative basis how each point on the terrain meets each of the requirements, decides which requirements are interrelated, uses a computer to determine in which order the requirements are to be combined, and then combines the "solutions" to each of the requirements to produce the location which best satisfies all requirements. This would be fine if it were possible to evaluate numerically certain location requirements and if each requirement were of equal importance. A variation of this technique uses a series of diagrams to express how every point on the terrain meets each requirement and then combines these diagrams by eye in the prescribed order.

One of the computer's strong points is also its basic weakness in highway location. The advantage of the unemotional character of the machine should not be overlooked. Many designers have a pet bias in favor of certain characteristics of alignment and other factors, and it is difficult for the human brain to avoid the pride of authorship in the "location I have come up with." The machine avoids these traps because it is devoid of emotion; however, the spark of creativity, which stems from human emotions, is missing.

Vigilance is necessary to keep these overgrown adding machines from taking over what is essentially a creative field.

Property Values as Affected by Highway Landscape Developments

MORRIE CHERNER
Landscape Engineer, Cook County Highway Department

•BECAUSE there are no known statistics or precise formulas to gage the true effect of highway plantings on adjoining property, it is apparent that the information and data available must be judged in a broad manner, and any conclusions drawn must be in the form of a generalization.

The greatest changes in land, both physically and economically, in the Chicago land area have occurred on the sites adjacent to the Chicago Metropolitan Expressway System. When completed, a total of 120 miles of expressways will be in operation, radiating in all directions from the central business district (the "Loop") to connections with interstate expressways and toll roads at the boundaries of Cook County.

From the congested Loop these expressways pass through every type of zoned land conditions, including slums, that exist in any large city. Eighty-two miles of existing expressways pass through single- and multiple-residential districts, commercial and industrial areas, educational and recreational sites, and they have direct access to railroad stations and airports. Because many portions of the expressway network have been given more intense landscape treatment than other roads, except those in the Chicago Parks Boulevard System, this study has been limited to a portion of the expressway system.

Limitations of time made it necessary to confine investigations to Edens Expressway, the most northerly route; to J. F. Kennedy Expressway, the O'Hare Airport Highway and to D. D. Eisenhower, an east-west expressway.

Not being trained as real estate brokers, bankers or economists, it was decided to pursue three available avenues of approach to obtain cogent facts and data, as follows:

1. Trace the changes in values of property adjoining expressways, and areas within a half mile range, to note the effects, if any, of living along a modern highway as compared to a convenient location a short distance away;
2. Investigate the resale of excess property by the Cook County Highway Department for changes in values; and
3. Conduct a house-to-house survey of the actual experiences, reactions and opinions of people living in the vicinity of these roads.

The prime target was Edens Expressway. Its fifteen miles became operational in 1951, and it has had greater changes occur along its borders than along any of the Chicago expressways. Ever since its opening, this road has been a vital factor in a tremendous and fantastic change in land development patterns. Most of the mileage of Edens adjoins some of the better suburban neighborhoods which contain thousands of homes, large shopping centers, two $5,000,000 high schools and a great number of fine commercial establishments constructed in areas that were formerly open farmland or old abandoned subdivisions untouched since the depression years.

Edens passes through a number of higher-income villages and towns, and for most of its length is at grade with surrounding terrain so that the adjacent residents look directly across and into the expressway. The landscaping, therefore, should be of

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vital importance in these neighborhoods, and should definitely influence the character and values of the surrounding countryside.

The 16.7 miles of the J. F. Kennedy Expressway, on the other hand, runs its course through old established neighborhoods of Chicago and its northwest suburbs to its terminus at O'Hare Field, one of the world's largest airports. It is logical to presume that the airport itself would have a direct effect on the value of property along this highway. An entirely different aspect of the problem was analyzed along this expressway. The investigation here was limited to cut sections with adjacent areas occupied with multiple dwellings and apartment buildings from which the residents looked "down-into" the right-of-way.

On Eisenhower Expressway, which cuts through 14.5 miles of the west side of Chicago and the western suburbs, attention was focused on the slum area just west of the Loop and through the established Village of Maywood where the highway was opened in 1954. The area in Maywood was chosen because extensive plantings have created a more parklike landscape effect than on any of the other expressway sites located in heavily populated areas. This particular section is also in cut and its borders contain a mixture of single-family units and small apartment buildings.

Olcotts Land Value Blue Book of Chicago was used as a guide in tracing the changes in land values along the sections of these three expressways. This publication is issued yearly and is, in fact, the "bible" of property values in the Chicago and Cook County areas. Inasmuch as negotiations for right-of-way acquisitions were actually started in 1939, that year was used as a starting point for the study, and the following years of 1945, 1950, 1955, and 1963 were used to gain a fair representation of the changes in values.

According to the charts, land values remained static during the war years, doubled shortly after the war, and then increased at a fantastic rate after the advent of the expressways system. In some instances, these increases have been as high as 500 percent—due not only to the expressways but more probably to prosperity and the population explosion. Inasmuch as this pattern, no doubt, has occurred in areas far distant from the expressways, a most interesting observation is that the value of property has risen and remained stable in areas adjacent to the expressways just as it has in areas two and three blocks removed. Thus, there is an implication that landscaping probably affected adjacent properties so as to impart a value equal to lots several blocks away, which are considered more desirable.

This is even more surprising because the subdividers and builders along Edens always priced homes along the expressway at several thousand dollars less than those a block away, yet, in a comparatively few years involving few resales, these "close in" homes are equal in value with adjoining homes.

Although values have doubled along the Kennedy Expressway, the fact remains that adjacent property values have increased along with the more distant desirable properties. Similar changes have taken place through the slum area of Eisenhower Expressway where rehabilitation and remodeling of existing undesirable property have occurred due to the spaciousness and green freshness of the highway, and the influence of a new transportation facility and its promise of rapid transit.

This same pattern of land value increases was found associated with the resale of excess property along Edens Expressway. Two typical examples were 8,100 sq ft of land originally purchased in 1944 as part of a unit for $1,333.26, and resold in 1959 for $3,600. Two triangular parcels, purchased as part of full lots in 1943 for $796.73, were sold for $3,150 in 1960 without benefit of any change in zoning to affect the values. Again the increase must be attributable to proximity to a landscaped highway.

The third phase of the investigation was based on a house-to-house survey conducted on a modest scale, because the people interviewed (150) constituted a small percentage of the population living along the expressways. Inexperience in poll and opinion surveys is a factor to be considered; however, the results have an important bearing on the conclusions arrived at. Following are the landscape survey questions and answers:

1. How long have you resided here?
   - Edens 5 yr (House)
   - Kennedy 3 yr (Apts.)
   - Eisenhower 19 yr (Mixed)
2. Did you live here prior to the construction of the Expressway?
   - Edens 3% Yes 97% No
   - Kennedy 20% Yes 80% No
   - Eisenhower 50% Yes 50% No
3. Why did you choose to live near the Expressway?
   - Edens 74% House, neighborhood, convenience of highway
   - Kennedy 80% House, neighborhood, convenience of highway
   - Eisenhower 50% House, 50% relocated by construction
4. Does the noise disturb you?
   - Edens 83% No
   - Kennedy 67% No
   - Eisenhower 50% No
5. Do you think that the Expressway has affected the value of your home?
   - Edens 40% No
   - Kennedy 50% No
   - Eisenhower 33% No
6. Do you consider the Expressway a thing of beauty?
   - Edens 70% Yes
   - Kennedy 100% Yes
   - Eisenhower 80% Yes
7. Due to the landscaping?
   - Edens 100% Yes
   - Kennedy 83% Yes
   - Eisenhower 100% Yes
8. Do you think that there is a sufficient number of trees and shrubs planted on the Expressway in the view from your home?
   - Edens 70% Yes
   - Kennedy 50% Yes
   - Eisenhower 67% Yes
9. Would you like to see trees and shrubs planted so as to block out the view of the Expressway from your home?
   - Edens 14% Yes
   - Kennedy 17% Yes
   - Eisenhower 0% Yes
10. After living here and knowing what it's like to live near an Expressway would you consider purchasing another home near an Expressway?
    - Edens 69% Yes
    - Kennedy 83% Yes
    - Eisenhower 50% Yes
11. Multi-residence building: Has the Expressway affected rental of your apartment(s)?
    - Edens 73% Increased
    - Kennedy 100% Increased
    - Eisenhower 50% Increased
12. Do the tenants stay longer?
    - Edens -
    - Kennedy 100% Yes
    - Eisenhower 70% Yes
13. Comments:

It is interesting to note that: (a) 64 percent were willing to purchase another house adjacent to the highway, (b) 74 percent would like additional landscaping in their area of the expressway, (c) 44 percent did not think that the highway would affect the value of their property in any way, (d) only 25 percent wanted a screen planted to block

their view of the highway, and (e) almost 100 percent agreed that the beauty of the highway was due to the landscaping.

In answer to the general comments question, the consensus of opinion indicated that on Edens Expressway people purchased their homes because they wanted the particular building, liked the neighborhood, wanted the direct access convenience of the expressway to get to work and recreation, and preferred to view the expressway planting and openness rather than look across the street at a neighbor's house. The noise problem was minor and only affected those sections where trucks "gun" their motors to drive up a grade under a structure.

On Kennedy Expressway the apartment dwellers and home owners were most happy to exchange a crowded built-up street location for the open cut area of greenery which this highway presented. This green belt, in fact, drew people to its borders for the open beauty as well as for the convenience of transportation.

On Eisenhower Expressway the road was a definite factor in revitalizing the slum areas adjacent to the highway. Obviously, the grass and plantings encouraged these people to "breathe" again and certainly stimulated the cleaning and rehabilitation of the area. In the Maywood section of Eisenhower Expressway, the residents have come to regard the area as their park—to be enjoyed visually, not physically. Many of these residents were relocated from their original homes on the right-of-way, preferred to remain in the neighborhood, and were happy with their decision because of the beauty of the expressway planting.

Now that the data have been compiled for portions of the three expressways, what conclusions can be drawn? It is obvious that property values along these roads have increased from 100 to 500 percent; residents are cognizant of the landscaping and will increase their appreciation of it as the plants mature. Recognition must be given to the fact that the landscape designs were intended to benefit the driving public and that the by-product has been the enhancement of the areas adjacent to these highways.

Imagine the adverse effects if these same roads were merely pavements, retaining walls and steel structures. When the original plans for the expressway system were announced many years ago there were vehement objections from home owners associations, nature lovers, and others with selfish interests. They thought in terms of individual inconvenience and had the mistaken notion that their properties would decrease in value with the advent of the expressways. After turf and plantings of woody species were established, no objections were heard from individuals or organizations; only comment indicating surprise at the limited amount of planting. Property values along the expressways certainly have kept pace with those in surrounding areas.

The exodus of great numbers of families and businesses to "suburbia" was spurred by the opening of the expressway system and the lack of adequate middle income housing in the city. It does not appear that this trend will be reversed, especially when it is noted that since 1949 the number of families owning more than one car has increased from 1,500,000 to 12,000,000—meaning that one of every five families is now a multiple-car owner. While personal incomes have risen 1 ½ times in this period and the suburban population has doubled, the increase in multiple-car ownership has been sevenfold. Because limited public transportation has exerted so tremendous an influence, it becomes increasingly clear that the interstate highways will become the life lines of this country.

Approximately 575,000 cars per day use the 82 miles of existing expressways in the Chicago metropolitan area. This represents more than 17 million trips per month. Because the character of urban environment precludes long scenic views, but affords instead mile after mile of "built up" background, the landscape developments have provided values far in excess of the initial 1 ½ percent of the total cost of construction. Landscape plantings have influenced the constantly increasing value of adjoining properties by far more than 1 ½ percent.

The Scope of Pesticides in Highway Operations

WILLIAM C. GREENE
Engineer of Roadside Development, Connecticut State Highway Department

•PESTICIDES have become important and exceedingly valuable tools in highway operations to control or eliminate the creatures emanating from highway trees. With the application of pesticides in accordance with very carefully developed programs, the heritage of beautiful shade trees and natural flora has been preserved and conserved from the ravages of insects and diseases. The establishment, maintenance, and control of vegetation along roadsides have benefited by pesticide applications. Similarly, as pesticides are essential in the abundant production of food and fiber, so they are important in the development of a safe and healthy environment for the highway user, the abutting property owners, and the highway maintenance employees. Chemical pesticides have also become exceedingly important in the economy of highway operations.

In Connecticut, as in many other state highway departments, the following pesticides have been in use: Insecticides, such as DDT, Dieldrin, Chlordane, Aramite, Lindane, Malathion, Nicotine Sulphate, Toxaphene, and some others; Fungicides, such as Bordeaux Mixture, Ferbam, and Phygon; Herbicides, such as 2, 4-D, 2, 4, 5-T, Dalapon, Simazin, Diuron, Baron and numerous combinations and formulations of these other synthetic chemicals.

In June 1962 three excellent articles, entitled "Silent Spring," by Miss Rachel Carson, appeared in the New Yorker Magazine. In October of the same year, it was the Book-of-the-Month selection. This book served to alert each and every citizen and prompted the late President of the United States to appoint a special committee to investigate what was being done to control the use of chemicals with the so-called wanton destruction of wildlife and its attendant ramifications and effects on humans.

Connecticut had a finger pointed in its direction:

> Botanists at the Connecticut Arboretum in New London declare that the elimination of beautiful native shrubs and wild flowers has reached the proportions of a "roadside crisis." Azaleas, mountain laurel, blueberry, huckleberry, viburnum, dogwood, bayberry, sweet-fern, low shadbush, winterberry, chokeberry, and wild plum are dying under the chemical barrage. So are the daisies, the black-eyed Susans, the Queen Anne's lace, the goldenrod, and the fall asters. In the spring of 1957, trees within the Connecticut Arboretum Natural Area were seriously injured when the Town of Waterford sprayed the roadsides with chemical weed killers. Even large trees not directly sprayed were affected. The leaves of the oaks began to curl and turn brown, although it was the season for spring growth. Then new shoots appeared, and these grew with abnormal rapidity, giving a "weeping" appearance to the trees. Two seasons later, large branches on some of these trees had died, other branches were without leaves, and the deformed, weeping effect of whole trees persisted.

The author of this paper can attest to the latter part of this statement being true, for it touched off an explosion of criticism of the Department that was anything but pleasant. Did not the Highway Department sponsor and encourage the spraying? Why were town crews allowed, even though they were not under the Department's general

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direction, to go out and plaster the countryside with these lethal chemicals?

This unfortunate application was not sponsored by any of the personnel in the Department; and it was not performed in accordance with any directives that were developed by the Department. Upon investigation, including complete testing of the chemicals used, it was found that the spray rig operators had a pressure of 400 lb instead of the desired 40 lb and the nozzle tips were of such a small orifice that the mixture was atomized. Also, one of the operators of the rig, instead of selectively directing the spray to the plants that were supposed to be treated, stood on the running board of the truck, opened the gun, and the driver drove down the road at a rapid speed. The consequence was drift of 2, 4-D solution over the countryside.

Miss Carson's book was critical of the operations in many other states and numerous governmental bodies. And, of course, she took many jabs at the chemical industry and the dedicated scientists that have been alert to develop the materials that afford such healthful comfort and abundance.

Miss Carson made no mention of the potato famine in Ireland when a fungus disease turned the food supply into a stinking black slime and the people perished from starvation; or the abandonment of the French plans for a canal across the Isthmus of Panama because malaria, carried by the mosquito, took such a toll of human life. Nor did she recall the farmer's wheat fields being flattened by stem rust; rows of young corn destroyed by cutworms and wire worms; pigs dead from cholera; the high-pitched buzz of flies that were struggling in the sticky festoons hanging from ceilings and the stealthy patter of cockroaches that darted across floors.

Miss Carson did not mention that before the use of herbicides, dermatitis cases of highway employees from toxic vegetation caused many valuable lost hours of work in addition to the untold suffering of hay fever victims aggravated by the pollen from Ambrosia (Ragweed) that incapacitated many people for long periods or made them asthmatic victims; or the lives that have been lost and the property damage experienced that are the result of inadequate vision at an intersection or a railroad crossing because it had not been sprayed with an herbicide. Miss Carson does not bring out the facts that countless trees have been lost and woodlands depleted because of the ravages of insect pests, disease infestations, and that the consequent wildlife cover and natural habitat for birds have been destroyed.

However, Miss Carson did point out that the use of pesticides and herbicides might be causing a multitude of indirect causes of future troubles. Therefore, in addition to the Federal inquiries, numerous states, through an alarmed citizenry, set up investigating bodies. Connecticut was no exception, and Governor Dempsey was urged to appoint a committee to look into the situation. The author had the privilege to serve on the Connecticut Governor's Pesticide Investigating Committee.

On January 30, 1963, the Governor appointed a Committee to review present State laws and procedures governing the use of chemical pesticides and to render a report by April 15, 1963. This Committee of eight members, comprised primarily of trained and experienced professionals in the field of biology, brought a considerable fund of knowledge to the assigned task. The appointment of a layman to chair the Committee insured concentration on the objective as viewed by the general public.

An exceptionally impartial and expert evaluation of current pesticide practices and their effect on man and wildlife was made before recommendations on legislation could be developed. To supplement the knowledge of the Committee with the views of those citizens having a deep interest in pesticide use, information was sought by mail from 40 groups representing Connecticut agriculture, business, conservation, custom application, garden clubs, industry, naturalists, natural resources, and sportsmen. They were asked to submit pertinent facts concerning misuse of pesticides and recommendations for corrections of inadequacies in laws or practices. Fifteen additional representative groups were invited to appear before the Committee to present their views. Forty-seven people attended these hearings and 23 statements were heard. During the course of the 9 meetings, 62 letters and statements were received and reviewed by the Committee.

The research covered numerous publications of the College of Agriculture of the University of Connecticut, Connecticut Agricultural Experiment Station, State Highway

Department and State Board of Fisheries and Game on the use of pesticides. In addition, 42 news articles, books and other publications concerning pesticides were thoroughly discussed and all the pertinent facts noted.

Many laws and proposed laws were studied by the Committee in light of the testimony received; these laws included Connecticut's legislation, Federal laws, and laws from numerous other states.

The following is the Committee's evaluation of practices and laws:

> Chemicals that control our pests are both an amenity and a necessity in our way of life. Their benefits are large and obvious. Our bodies are free from insect-borne diseases. Our food comes abundantly, daily and flawlessly. Our timber, even the green cover of our hills, can be protected from caterpillars. In our fields and along our roads, weeds and brush can be cleared with little money or sweat.
>
> All agree (the Committee) to the necessity of some and most to the convenience of these chemicals. The Committee's task was to determine the cost in side effects and to recommend reasonable and effective means of minimizing or eliminating this cost. The side effects to both man and wildlife were considered....
>
> Synthetic pesticides, especially DDT, have been in use and experiment for a score of years. No evidence of an insidious menace to human health has been obtained. On the other hand, some pesticides, like some of our most valuable drugs, can have a clear, even fatal effect, if misused. There is evidence that a parathion bomb was stolen and ignorantly sprayed on a child's clothing in Connecticut; the child died. The following authenticated accidents have been reported in Connecticut. Two applicators of parathion have been sick and have recovered. Another applicator was affected by a similar experimental material.

Incidentally, this was a Connecticut Highway Department employee and the only known person to be adversely affected in the author's 30 years of experience with the Department, and this despite the tremendous volume of pesticide materials that are used for specific purposes in Connecticut's highway operations.

> Among those who bought at retail, one injury is known: a lindane bomb that was misused made a housewife sick. Occasionally, applicators have suffered dermatitis from pesticides.

Here again, dermatitis from toxic vegetation and other causes are not listed for comparative purposes.

> The other part of the health problem is pesticide residues in food. Many pesticides have no known toxicity to man. Nevertheless, people are generally uneasy about strange molecules in their food. Thus, both State and Federal inspectors and chemists monitor our food. The effectiveness of these officers is attested both by actual condemnations of food and by the myriad reports of pure samples. Happily, Federal officials judged that local products had less residue than those moving between states. In fact, they have found no excessive residues on any fruits or vegetables grown in Connecticut. Significantly, Connecticut milk is inspected at the farm; thus, milk containing pesticides is eliminated from the market before it can be mixed with pure milk.
>
> Finally, the nuisance of pesticides was considered. Witnesses again and again pointed to Connecticut's aerial spray law and regulations as a model and the strictest known. For example, materials known to be toxic to man are forbidden for general use; only a landowner or his legal representative can obtain a permit; inspectors visit each area before a permit is granted. Nevertheless, during aerial application the drift of harmless dust can be a nuisance to neighbors.
>
> Thus the Committee found farseeing laws and vigilant inspectors combined to prevent any ominous or subtle menace to public health.

It also found potentiality for nuisance to neighbors and for accidents to uninformed applicators. The cost of pesticides in terms of human health is, therefore, not from use, but from ignorant use. Hence, the Committee's recommendations contain means of improving the labeling of materials for the homeowner and the examination of the competence of professional users....

Wildlife has been killed in Connecticut, not en masse, but accidentally in isolated instances. In 1962, there were 7 cases reported among aquatic wildlife: 3 associated with aerial spraying of gypsy moth, 1 with aerial spraying of mosquitos, and 3 with other types of spraying. In addition, aerial spraying of gypsy moth was associated once with the killing of bees and once with the killing of Cecropia larvae. Also, one robin was reported killed by unspecified spraying.

Fortunately, none of these episodes related in any manner to highway spraying of pesticides. And during the year 1962 only one slight accident occurred that related to highway operations. A gentleman in an open sports car went through warning signals and both he and his car were inadvertently covered by a fine mist of DDT. This resulted in a small bill for cleaning clothes and washing the vehicle, even though it was not the fault of the highway operators.

The death of any harmless creature is sad. They may, however, be viewed in terms of the creatures that die from other causes or in terms of the numbers that still prosper in our woods. To many people, therefore, these accidents seem no great cost to pay for freeing themselves of woodland pests that invade lawns and homes, or for protecting the trees that clothe the hills. Thus, these known deaths of wildlife are not the major concern.

Rather, the appearance and accumulation of DDT in fish and birds that have not been sprayed is the concern. Whether harmful or not, the persistence of DDT, which has commended it to man in the past, permits it to move about as one creature eats another. Thus DDT is found in wildlife although the massive spraying of all Connecticut woodlands has been prevented; and in spite of the fact that unnecessary spraying has been avoided by accurate scouting and predictions of defoliation; and that when defoliation was imminent, only about one-half the affected towns chose to spray.

The Committee finds, therefore, that Connecticut's regulation of spraying and elimination of spraying where pests are not a menace has prevented catastrophes to wildlife. It also finds that regulation has not prevented the appearance of DDT in wildlife. Thus, regulation seems less important than reducing the total dose of DDT received by our land.

There are few problems more worthy of public concern than that of protecting the individual user of pesticides and all forms of desirable life exposed to his activities. Today, the citizen finds himself swept along the path of rapidly changing technology—both complex and mysterious. Small wonder that public reaction to the use of pesticides varies from irreasonable or misplaced fear at one extreme to reckless indifference at the other.

No matter how vocal some citizens may be about real or imaginary fears of this new world of everyday chemistry, we cannot retreat from it. We must through education and understanding learn to live in this new world safely and wisely.

The intensification of science instruction in our schools is already preparing the younger generation to recognize the opportunities and to cope with the problems more effectively than their elders have done.

We (the Committee) are in accord with sincere naturalists and their love of the outdoors. We believe that minimum harm should befall wildlife and this minimum only when it is found necessary to preserve or protect our citizens' welfare.

During the extensive hearings and study of information submitted to the Committee, no evidence was found to indicate that our food

supply in Connecticut is unsafe because of the use of pesticides. On the contrary, convincing facts were presented to show that pesticide residues in foods produced in the State, and especially milk, were lower than similar products moving legally in interstate commerce. Through the cooperative efforts of Federal and State agencies, continuing food inspection helps provide our citizens with safe food. The need does, however, exist for faster and more intensive inspection in order to increase the number of examinations and thereby provide even greater protection.

In regard to the effect of pesticides upon wildlife in Connecticut, the Committee heard conflicting statements. There was a wide difference of opinion as to the gravity of the situation with some citizens being genuinely concerned about the degree of danger, while others expressed no serious alarm. The only concrete evidence of direct loss of wildlife from use of pesticides in Connecticut during the past year (1962) were the ten cases cited earlier in the report. The problem of persistent DDT has also been cited.

In order to maintain the safety of our food, continue to protect human life and prevent unnecessary loss of wildlife, while still recognizing the essential need and economic benefits derived from the proper use of pesticides, the Committee recommends the following:

1. Connecticut should strengthen its Food and Drug Act to make its standards uniform with Federal regulations concerning pesticide residues and to provide legal authority for the control in intrastate commerce.

2. Connecticut should expand its inspection for pesticide residues on crops. While it has done a reasonably adequate job so far, it is in the public interest to examine more samples of produce for sale in the State.

3. Connecticut should have a pesticide registration law in order to regulate better the distribution, sale and transportation of pesticides within the State. The Committee, therefore, recommends the enactment of "An Act Regulating the Distribution, Sale and Transportation of Insecticides, Herbicides, Fungicides and Rodenticides."

4. Connecticut should create a pesticide control board. Such a board should have the authority to approve pesticide materials to be used in ground or aerial spraying for hire and should also regulate the disposition of pesticide containers. The composition of the board should represent those State interests most directly concerned with the health, wildlife and pesticide use. Funds should be provided for the board to employ competent personnel to carry out its duties.

The Committee, therefore, recommends the introduction and enactment of "An Act Concerning Custom Application of Pesticides and Establishing a State Board of Pesticide Control."

5. Connecticut must employ all reasonable means to assure the competence of custom applicators of pesticides. This is especially true with the discovery of new and highly potent chemicals that are invaluable to the control of pests.

6. Connecticut should maintain its leadership in exploring new and better ways of meeting the growing problems that confront its citizens in the field of pest control. To do this, it should support research, especially on new approaches, techniques, and materials that will provide the greatest possible protection to human life, health and to the conservation of our wildlife and natural resources, while meeting the economic criteria.

These recommendations provide broad and flexible authority for dealing with problems that may arise; they do not create a complex mechanism, costly in dollars and harassment beyond the magnitude of the pesticide problem; they attack the tangible problems of accidents, of ignorance, and of the persisting pesticide molecule; and they should reduce the cost in side effects from necessary and convenient use of miraculous modern pesticides.

With this report the Committee presented legislation that was enacted with few, if any changes, during the 1963 Legislative Session. This legislation was effective January 1, 1964, and the machinery for enforcement is in the process of implementation; in fact, the most recent meeting was held January 6, 1964, and the approval of the Board was requested for the Connecticut Highway Department to continue with its program for the use of chemical pesticides.

In this legislation the Highway Commissioner is a member of the Board of Pesticide Control. He, like several others on this Board, may have a voice but no vote. The author of this paper has appeared at the meetings to represent the Commissioner.

But what are the hazards that are evident from the use of pesticides; the previous report reveals the extent that has been evident with the possible side effects. There may be the loss of earthworms in grub-proofing operations; or there may be insects that have been eaten by birds that may cause sterility. There have been times when an inexperienced operator, despite all the precautions required, will hit a desirable plant item and cause a brown-out and injury to the plant.

However, if pesticides are not used valuable trees and vegetation may be lost. (Just the control of the Elm Bark Beetle, the carrier of the Dutch Elm Disease, is responsible for the preservation of stately elms that add such charm and beauty, with attendant functional value, to village roadsides.) With the loss of trees, many unsafe conditions would be evident along the highways, the real estate values would be depreciated, and the consequences would be huge expenses for the cost of removal of dead and dying trees.

It would be difficult to determine what would happen if a pesticide were not used to control insects that damage turf areas, such as the Army Worm, the Japanese Beetle, the Asiatic Beetle, the Sod Web Worm, the Chinch Bug, and numerous other destructive pests or to determine the hazards to the highway user who may be blinded by swarms of insect pests, or the erosion that would take place, with the attendant unsafe conditions, if the functional value of well-developed grass areas were lost.

Criticism has been made and hazards noted because some of the natural habitat along roadsides has been destroyed so that wildlife does not breed abundantly in this environment. But what about the hazards to the highway user who attempts to avoid such wildlife as it scampers across the road? And certainly there is a tremendous loss of wildlife because of contacts made with motor vehicles when there is too much natural environment along highways. Should motor vehicles be labeled a pesticide and their use eliminated because they too are a hazard?

What about the exposure of manpower in highway maintenance operations to high-speed traffic when this work can be easily, expeditiously, economically, and safely performed with pesticides?

What about the hazards created to the millions of highway users with the abandonment of pesticide applications to eliminate toxic vegetation? (Incidentally, it was proposed by an eminent ecologist that is quoted as an authority in Miss Carson's book, that the Connecticut Highway Department plant poison ivy in one of the large picnic areas in order to keep people away from the certain spots where trees might be damaged by constant pedestrian traffic over the root areas.)

What about the rodents, particularly rats, that have infested, on numerous occasions, the homes adjacent to the high fill on the approach to a bridge—should not a rodenticide be used to eliminate these disease carrying creatures? (The fill on this approach was largely made up of rock. The rodents find this a most desirable habitat and move in en masse. And the homes adjacent to this neighborhood are a source of food. Consequently, in the interest of health and to foster good public relations, appropriate rodenticides are used to control the pests.)

What are some of the other hazards that accompany the use of pesticides? It is the uneducated operators that do not take seriously the importance of proved application techniques. This makes the highway administrator's life much too exciting because some employee has sprayed petunias instead of dandelion.

All the legislation in the world will not cope with this problem. Therefore, it is important to educate and to train thoroughly each and every man as to the proper use of each and every pesticide tool. All too often this phase of the work is neglected, and

John Doe employee will inadvertently do something that is entirely wrong because he was not made aware of the consequences.

There are perhaps numerous other hazards that might be listed but the values of pesticides in highway operations are as follows:

1. The conservation of trees and natural flora has already been cited.
2. The health and safety of highway employees is improved.
3. Litter along highways is less evident because of well-maintained roadsides.
4. Insects, diseases, and weed growth harmful to the adjacent farmer's fields are controlled.
5. Safety for the highway user is improved because sight-lines are not impeded, trees are not as hazardous because they are kept in a healthy condition, free from insects and diseases, safety devices are not obscured from vision, and the maintenance employee with his equipment is not as frequently in the travel path.
6. The entire highway environment is better because the aesthetics are given proper consideration.
7. The dollars saved by the use of pesticides can be used for much needed construction to extend, expand, or improve highway facilities.
8. They are valuable in the field of good public relations between the highway department and the public.

Therefore, it seems appropriate to conclude that pesticides are important for a multitude of highway operations in the establishment, maintenance and control of vegetation. There are hazards that are evident if improperly applied and used. There are hazards that are apparent if pesticides are not used. However, the tremendous values that are evident far offset the hazards that may seem evident. Pesticides are valuable tools in the entire scope of highway operations and their use must be continued for the benefit of the safety, health, economy of operations, and beauty of highway systems.

Pesticides or Hunger

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•FOOD AND FIBER production is America's greatest asset; it is the basis of its standard of living and national prosperity. The efficiency of farms is such that the burgeoning population is more than adequately nourished by the work of less than 5 percent of the people, releasing 95 percent to advance industry, public works, education, research, and to enrich America's culture and to maintain its defense. For the first time in man's long struggle against want, America has, in this century, accomplished the means to banish hunger and exposure from the Earth. This is by far the greatest victory that democracy has won.

This achievement has been the work of many people in all walks of science and farming. Each area of scientific research has played its own significant role. Among these, chemistry has contributed substantially to the many advances in soil fertility, plant and animal nutrition, pest control and food processing, preservation and distribution. These contributions are abundantly reflected in the vast array of wholesome, nutritious and high-quality foodstuffs available, virtually at all seasons, to the consumer, at an average cost of less than 20 cents of the take-home dollar. This is the lowest cost for the highest nutritional level of any country. Agricultural chemicals, including pesticides, are essential factors in the efficient production of foodstuffs and, in addition, these chemicals are primarily responsible for the reduction and control of many major insect-vectored diseases, thereby contributing to the health and longevity of America's people.

The recent clamor directed against agricultural chemicals is generally gross distortion of the actual facts, completely unsupported by either scientific experimental evidence or practical experience in the field. The assertion that pesticides are the sinister companions of radioactive nuclear fallout is simply ridiculous. The contention that the land and the waters beneath have been universally and irrevocably contaminated by a rain of pesticides is firmly contradicted by documented Federal and state surveys and records which show less than 5 percent of the land area actually exposed to such chemicals in an average year. The suggestion that insecticides, fungicides, herbicides and nematocides are in fact "biocides," destroying all life, is obviously absurd in light of the fact that without selective biological activity these compounds would be completely useless. The claim that resistance to an insecticide among a particular species of insect necessarily invokes biological superiority is confronted with the experimental evidence that insecticide-resistant strains are found to be biologically inferior.

The asserted damage to wildlife by pesticides has been crassly exaggerated. At worst it can only be considered a minute fraction of that caused by natural causes such as frost wastage, flood, drought and epizootic diseases and predation. At best, pesticides have contributed substantially to wildlife welfare by protecting forest canopy and grazing verdure through control of insect ravage and disease.

There are many other areas of man' s activity which press upon wildlife that are considerably more harmful than the worst of agricultural chemical practice, notably highways, airports, cities, factories, mines, power lines, TV towers and, especially, the overwhelming encroachment of billions of humans upon the haunts and feeding grounds of wild creatures.

The real danger to man's survival lies not in the controlled use of chemicals but in the hoards of insects and miasma of disease which would sweep over crops and

Paper sponsored by Committee on Roadside Development.

animals, denude the forests and leave hunger and destitution and want in their wake.

If many of the proposals recently directed against the use of chemicals in agriculture were to be actually carried out, life in America and all over the world would return to the Dark Ages, and insects, disease and vermin would once again inherit the Earth.

Planting for Screening Headlight Glare And Traffic Guidance

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•THIS IS a supplemental report on "Planting for Screening Headlight Glare and Traffic Guidance" to record and show what progress has been made in the use of various species of plant materials for special problems. This record of information as of 1963, is to supplement information already published by the Highway Research Board (1, 2, 3). The committee is interested in the functional use of plant materials along roadsides for the purpose of making the highways safer to drive, more attractive and pleasant to travel, and less costly to maintain.

SOURCES OF INFORMATION

Twelve state highway departments (Connecticut, Illinois, Kansas, Maine, Maryland, Michigan, New Jersey, New York, North Carolina, Oregon, Pennsylvania and Virginia) have replied to requests for information concerning functional planting for screening headlight glare and traffic guidance. The replies furnished a considerable amount of new information and showed that these states are using plant material effectively in screening out headlight glare, framing traffic ramps by introducing vertical dimension with plant material, screening side distractions along service roads and arranging plantings to form a "hooding" effect at bridge abutments.

FUNCTIONAL PLANTING DESIGN

Maryland

Information from Maryland indicates that planting for screening headlight glare and traffic guidance is incorporated in almost every planting contract being designed. The report states that headlight glare has been reduced in some instances and eliminated in others.

Monotony in design has been relieved by using several varieties of shrubs in dense, straight row plantings. Skyline changes created by different types of plants including minor deciduous and evergreen trees have reduced driver tension.

New Jersey

On Rt. 34, informal groupings of Red Cedar have been used in combination with Rugosa Rose and Japanese Rose to relieve the monotony of the planting as well as to provide year around screening effect against glare. On wide medians some headlight glare plantings have been effective as snow fences during the winter months.

PLANTING COST

Connecticut

The State Highway Department's cost for planting deciduous shrubs is approximately $1.85 per plant installed. For Red Cedars, used in the median to help relieve the monotony of hedge plantings, the average cost has been $8.45 per plant (Fig. 1).

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VARIETIES OF PLANT MATERIAL USED FOR SCREENING HEADLIGHT GLARE AND TRAFFIC GUIDANCE

State Highway	Botanical Name	Common Name	Size	Spacing	Unit Cost ($)	Remarks
			(a) Major Trees—Deciduous			
Mich. I-94	Acer platinoides	Norway Maple	3½-4 in.[a]		45/mi	Detroit Freeway—depressed cross-section
N.J. I-295	Acer rubrum	Red Maple	1½-13/4 in.[a, b]		28	
Mich.	Celtis occidentalis	Hackberry	3½-4 in.[a, c]			
Mich.	Quercus palustris	Pin Oak	3½-4 in.[a, c]			depressed cross-section
N.J. I-295	Quercus palustris	Pin Oak	1½-13/4 in.[a, b]		28	depressed cross-section
N.J. I-295	Quercus palustris	Pin Oak	3-3½ ft[c]		98	Informal groups
			(b) Major Trees—Coniferous			
Kansas	Juniperus virginiana Ketteri	Ketteri Juniper	5-6 ft, 6-8 ft and 8-10 ft[c]		6.50, 9, 13-25	
Conn.	Juniperus virginiana	Eastern Red Cedar				
N.J. 129	Pinus nigra	Austrian Pine	5-6 ft hgt		42	Informal groupings in median
N.J. H.A.	Pinus nigra	Austrian Pine	5-6 ft hgt	10 ft		Hedge arrangement
Me.	Pinus nigra	Austrian Pine				Survived in spite of snow and salt
N.J. 129	Pinus strobus	White Pine	4-5 ft hgt		13.50	Median—84 ft wide
Kan.	Pinus sylvestris	Scotch Pine				
Md.	Pinus thunbergi	Japanese Black Pine		8 ft		
N.J. I-287	Pinus thunbergi	Japanese Black Pine	4-5 ft hgt		18	Informal groups
			(c) Minor Trees—Deciduous			
Conn.	Amelanchier canadensis	Shadblow	5-6 ft hgt[c]		7	
Neb.	Malus, in variety	Crabapple				
N.J. I-295	Malus coronaria Charlotte		6-8 ft hgt[b]		12	Informal grouping in 84 ft median
Mich.	Crataegus phaenopyrum	Washington Thorn				
N.J. US 1	Crataegus phaenopyrum	Washington Thorn	4-5 ft hgt[c]	5 ft		
N.Y.	Crataegus phaenopyrum	Washington Thorn	6-8 ft hgt[c]	5 ft		Planted in 10 ft median
			(d) Shrub—Deciduous			
Conn.	Cornus racemosa	Gray Dogwood	2-3 ft[b]		1.55	
N.J.	Cornus racemosa	Gray Dogwood	2-3 ft[b]			

Me.	Cornus alba siberica	Siberian Dogwood	2-3 ft[b]		1.50	Makes excellent screen in summer and contributes color in winter
Conn.	Ilex glabra	Inkberry			8.00	
Md.	Ilex glabra	Inkberry				
Conn.	Ligustrum obtusifolium regelianum	Regel's Privet			1.50	
Mich.	Ligustrum obtusifolium regelianum	Regel's Privet				
Conn. and N.J.	Myrica pennsylvanica	Northern Bayberry	1½-2 ft and 2-2½ ft[c]		3.50 and 4.50 (Conn.)	
Mich.	Rhamnus frangula	Buckthorn				
Md.	Rhamnus frangula columnaris	Columnar Rhamnus				Habit of growth—narrow
Conn.	Rhus aromatic	Fragrant Sumac			1.45	
N.J.	Rosa multiflora	Japanese Rose	2-3 ft[b]		1.50	
N.C.	Rosa multiflora	Japanese Rose			.75 per 1 ft	
Conn.	Rosa rugosa	Rugosa Rose	2-2½ ft and 2½-3 ft[b]		1.55 and 1.70	
N.J.	Rosa rugosa	Rugosa Rose	1½-2 ft[b]	5 ft	0.50	Informal mass planting
Mich.	Lonicera fragrantissima	Winter Honeysuckle				
Mich.	Lonicera tatarica	Tatarian Honeysuckle				
Kan.	Lonicera zabeli	Red Zabel Honeysuckle				
Conn., N.J. Md.	Euonymus alatus compactus	Compact Euonymus	1½-2 ft[c]		Conn. 3.50	
Conn.	Viburnum dentatum	Arrowwood	2-2½ ft and 2½-3 ft[b]		1.48	
Me., Md.	Viburnum dentatum	Arrowwood				Arrowwood has grown well
Mich.	Viburnum dentatum					
Mich.	Viburnum lantana	Wayfaring Tree				
Md.	Viburnum prunifolium	Blackhaw				
N.J.	Viburnum prunifolium	Blackhaw	3-4 ft[c]		9.00	
Kan.	Syringa rothoniagenis					

(e) Shrubs—Evergreens

Conn.	Ilex glabra	Inkberry	2-2½ ft[c]	8.00	
N.J.	Ilex glabra	Inkberry	15-18 in.[c]		
Me.	Pinus mugho			4.50	Survived in spite of snow and salt
Md.	Pyracantha, in variety				
N.J.	Pyracantha Lowboy	Lowboy	18-24 in. — Potted	7.50	

[a]Caliber. [b]B.R. [c]B&B.

Figure 1. Connecticut Turnpike near Old Saybrooke. Median planting of mixed shrubs provides effective headlight screen.

Figure 2. I-80 showing planting of Rosa multiflora in 60-ft median in vicinity of Rockaway, N. J.

Illinois

The State Highway Department reports that the average cost of plant material varied from $1.40 to $2 per plant depending on the species used. The average cost per mi for median planting was approximately $9,000.

Kansas and Maine

Thc State Highway Departments furnished no information as to cost of plant material for screening headlight glare and traffic guidance.

Michigan

On I-94, a depressed freeway in Detroit, the cost of planting 2.1 mi was $90,000. Larger sized plant materials were used to obtain a more immediate mature planting

effect. Large, 3½- to 4-in. caliber, balled shade trees were planted. Green Ash, Hackberry, Pin Oak and Norway Maple were used. Combined with these were lower growing plants such as Flowering Crabapple, Buckthorn, Crataegus in variety, spreading Cotoneaster, Regel's Privet, Tatarian Honeysuckle and Wayfaring Tree.

New Jersey

Shrubs consisting of Rosa rugosa, Rosa multiflora and Bayberry were planted on the Rt. 34 median in double rows with plants staggered 3 ft on centers (Fig. 2). Average cost for plant material was $1.85 per unit. Length of project was 7.75 mi. Width of median was 20 ft with a 3-ft gravel shoulder on each side. Red Cedars 4 to 5 ft high were used at a few locations to provide immediate effective height for screening headlight glare. The plants cost $10 each.

On Rt. 9 near Freehold, Bayberry and Rosa rugosa were used in median plantings. Average cost for plant material was $0.65 per unit, project was 1.78 mi long, and median varied in width.

New York

On FAI 505 in Syracuse, at the 7th North Street Interchange with N.Y. State Thruway Interchange No. 36, planting was installed for the purpose of reducing noise and headlight glare control. The cost of the planting project was $19,273. Here, a combination of deciduous and evergreen plant material was used in conjunction with an 8-ft woven wood picket fence. Background planting was 2½- to 3-ft B&B Norway Maples. Columnar Buckthorn 2 to 3 ft high, bare rooted, was planted behind the wooden fence and 5- to 6-ft high, balled, American Arborvitae was planted in front. Project was planted in spring and fall of 1962.

Virginia

The Department of Highways reports that planting for headlight glare control has been practiced for a number of years. Generally, Rosa multiflora (Japanese Rose) has been used for this purpose (Fig. 3). The average cost has been $0.75 per lineal ft of planting.

Figure 3. Rosa multiflora planted in 1952 on Virginia Rt. 350, Fairfax Co. Median is 24 ft wide. The Japanese Rose has grown 8 ft high providing a complete screen against headlight glare.

PLANTING PROBLEMS AND MAINTENANCE DIFFICULTIES

Illinois

On I-55, planting results have been poor as judged after two years of careful observation. These results have prompted a more cautious approach with new median plantings. At present, it is believed that proper plant selections are the key to successful median plantings and also that the use of large amounts of salt for snow and ice control has contributed somewhat to poor success with median planting.

Maine

Difficulty has been experienced in planting narrow medians due to the need for snow storage space. Cornus alba siberica planted in 1959 on an Interstate project has produced a rapid, thick, uniform growth. It affords an excellent headlight-glare screen during the summer months. It is less effective in winter, but the esthetic contribution of its red stems to the landscape scene is decidedly worthwhile.

The State has found that Forsythia, Snowberry and Ibolium Privet grow fairly well but tend to damage and break easily. Rodents cause some damage to crabapples and privet during the winter months.

On wide medians, yellow-stem Weeping Willow, with an under-planting of Siberian Dogwood, has produced a very colorful planting combination. Maine has eliminated Willow blight and canker by spraying with fungicide at planting time. A second spray is applied two weeks later. With this practice, the willow disease problems have been almost eliminated.

Maryland

The State Roads Commission reports that for several years it was thought that Rose multiflora was the best plant to use for headlight-glare screen planting. This opinion has changed because Rosa multiflora has to be trimmed at least once a year and sprayed regularly for control of the Japanese Beetle.

The State is using compact and slow-growing plants such as Euonymus alatus compactus, Lonicera fragrantissima, Viburnum dentatum, dilatatum, and prunifolium, Rhamnus frangula columnaris and Crataegus phaenopyrum. Some of the evergreen plants are Pyracantha, Ilex glabra, and Pinus thunbergi, 8 ft on centers, where space will permit.

New York

The Department of Public Works reports that in 1958 a hedge of Crataegus phaenopyrum 6 to 8 ft high was planted in a 10-ft turf median having mountable curbs. About 800 plants were planted on 5-ft centers. In October 1963, 67 plants had been damaged by traffic, 27 were missing entirely, and 40 had regrown to about 3 to 4 ft high. Traffic volume was reported as relatively light.

In 1959, a hedge of Regel's Privet 3 to 4 ft was planted in a 9-ft turf median having mountable curbs. One thousand four hundred fifty plants were planted on 4-ft centers. At the end of the year, 450 plants had been destroyed by traffic. In October 1963, only a few plants remained and they were only 2 to 3 ft high. Traffic volume is heavy on this highway.

North Carolina

The State has found that on highways where the medians are narrow and depressed a single row of shrubs planted for screening headlight glare has a disappointing effect. When plants are located too close to the edge of the pavement, considerable damage results from cars swerving into the median.

Rosa multiflora has given the best results at a low initial cost, as well as requiring less maintenance. This rose may be pruned roughly and it is the only shrub of its type that will self-heal after traffic damage.

Figure 4. Functional planting on highway slopes. Ground cover reduces maintenance, and pines and crabapples outline curve and screen objectionable old buildings from main roadway (Portland, Ore.).

Figure 5. Planting of Oregon Holly in median to eliminate headlight glare. Slopes covered with low-growing ground cover of Bearberry which helps to reduce amount of roadside mowing.

Figure 6. Typical planting of an evergreen ground cover, Bearberry, on interchange slopes too steep to mow mechanically. Native shrubs in median support existing trees, reduce headlight glare and prevent unauthorized crossings (I-5 south of Salem).

Figure 7. Median planting to delineate curve on I-5 and eliminate headlight glare. Native shrubs added to trees saved during construction.

Oregon

The State Highway Department has made much use of ground cover on slopes and medians to eliminate the need for mowing. Hybrid Bearberry, English Ivy, Hypericum, Sala, and Hall's Honeysuckle have been used. Oregon Holly, Dwarf Scotch Broom, and Japanese Rose have been used effectively in medians for headlight-glare screening and traffic guidance.

CONCLUSION

1. Reports from the various states indicate that much effective functional planting is being done for screening headlight glare, traffic guidance and noise abatement on highways.
2. Much experience and knowledge has been gained since the progress report of three years ago.
3. Planting in narrow medians creates many maintenance problems. These should be carefully considered by the designer to determine if the intended benefits justify the cost.
4. Screen planting for headlight glare and traffic guidance can never replace or be as effective as the acquisition of sufficient right-of-way for properly designed individual roadways separated by a wide median.
5. The cost of planting and maintaining narrow medians is much more expensive through the years than the acquisition of additional land for a wide median.

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gon, State Highway Department; and E. Walker Turner, Landscape Engineer, Commonwealth of Virginia, Department of Highways.

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Lime and Fertilizer Requirements as Related to Turf Establishment Along the Roadside

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•THE ESTABLISHMENT of grasses and legumes on highway rights-of-way is the most economical means of controlling erosion and providing pleasant scenery for motorists. Present practices in the establishment of grasses and legumes on Illinois rights-of-way include the use of "blanket" lime and fertilizer applications. Because the climate and soils of Illinois vary widely, considerable doubt has been expressed concerning the agronomic and economic feasibility of a standard lime and fertilizer recommendation for all highway roadside soils. It is well established agriculturally that soil testing provides the best information available when considering a fertility program for crops. Most of the plant species used for highway roadsides are utilized in various agricultural practices, especially where a grassland agriculture is prevalent. A study was conducted to evaluate the lime and fertility status of roadside soils, and the inadequacies of a blanket application of lime and fertilizer in providing the essential plant nutrients for optimum establishment of desirable grass and legume species.

PROCEDURE

One hundred thirty soil samples were taken at 80 sites on highway roadsides in Illinois. These samples were obtained from "raw" cuts on new highway construction or well-established roadsides where the fertility status of the soil had not been altered in recent years. The soil samples were taken with a bulb-digger. Cores of soil obtained by use of the digger were $2\frac{1}{2}$ in. in diameter and 8 in. long. The samples were taken from the soil surface to an 8-in. depth. On five different slopes samples were taken at the top, center, and bottom of the cut to determine the fertilizer and lime requirements within a highway cut.

The University of Illinois Soil Testing Laboratory analyzed all of the soil samples for total and available phosphorus, available potassium, and pH. The percent unavailable phosphorus was determined by subtracting the available phosphorus from the total phosphorus, dividing by the total phosphorus, and multiplying by 100.

RESULTS AND DISCUSSION

The percent unavailable phosphorus increased as the pH increased (Fig. 1). At a pH of 4.1 only 25 percent of the phosphorus was unavailable for plant use as compared to approximately 75 percent unavailable phosphorus at a pH of 8.1. This implies that in soils with a high pH, phosphorus becomes unavailable to the plant.

It is well accepted that grasses make optimum growth at pH 6.0. Using pH 6.0 as a basis for determining the soil requirement for lime, soil tests indicated that on 73.5 percent of the sites where samples were taken, lime would not be required (Fig. 2). Of the remaining 26.5 percent of the samples, 81 percent would require more than 2 tons of lime for an optimum soil pH of 6.0 (Fig. 3).

Paper sponsored by Committee on Roadside Development.
[1] Now with Minnesota Department of Highways.

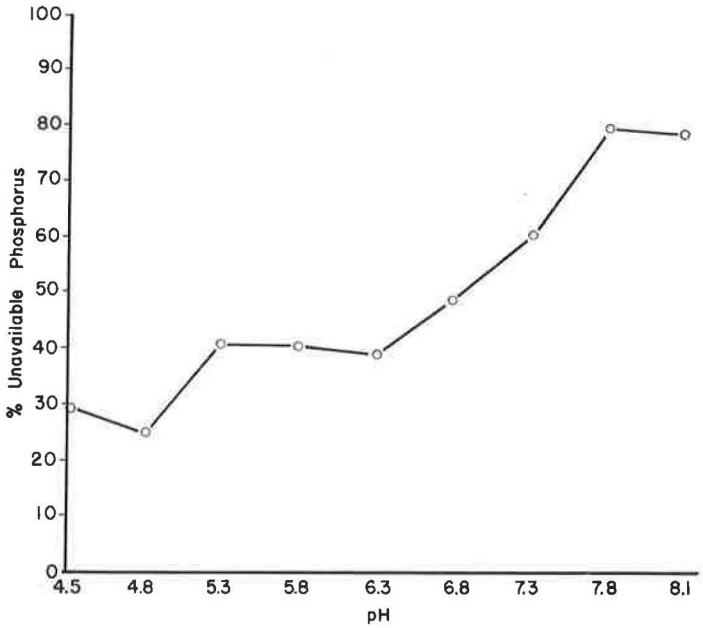

Figure 1. Availability of phosphorus at increasing pH levels.

At present on Illinois roadsides the State Standard Specifications provide: "Art. 110.3(c) (2) The agricultural ground limestone shall be applied at the rate of from 2 to 4 tons per acre, the exact rate to be specified by the Engineer." As indicated by these results, this practice does not provide the most efficient use of lime in correcting soil pH's. Although on some of the soils the added lime magnifies the problem of phosphorus availability to the plant, other sites are not receiving enough lime to raise the pH to a desired level for grass and legume establishment.

On the slopes that were differentially sampled, the samples taken at the top

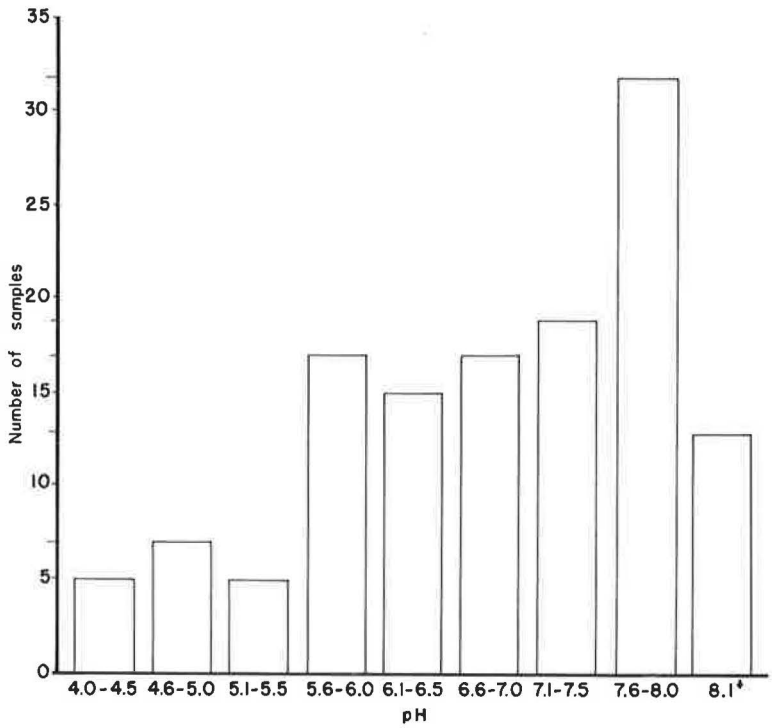

Figure 2. Frequency of occurrence at various pH levels.

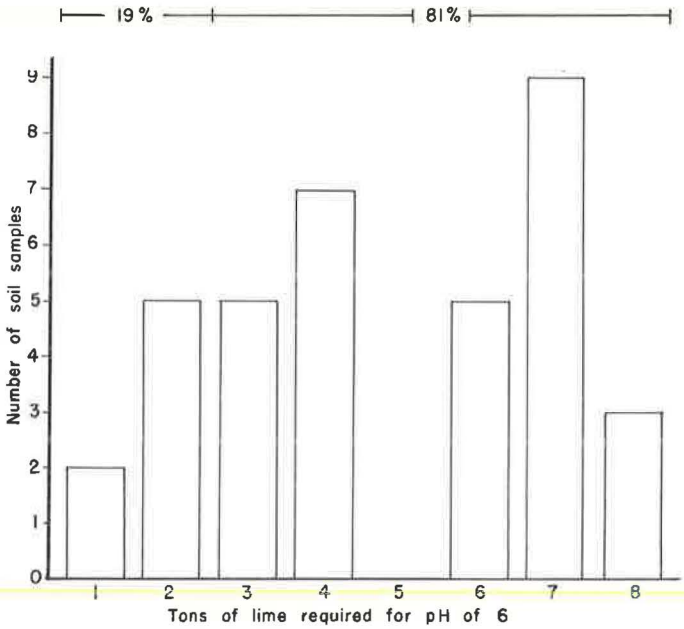

Figure 3. Distribution of lime requirements.

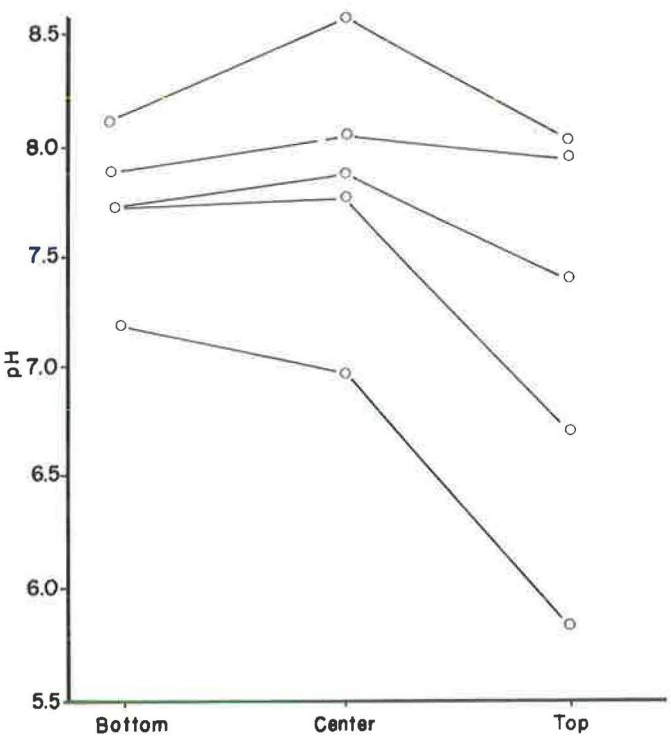

Figure 4. Soil pH as related to position on slopes.

of the slope had a lower pH than the samples at the center and bottom of the slope (Fig. 4). According to these data there may be considerable variability in soil pH within a specific slope or highway cut. The problem involved in such cases is in applying the proper amount of lime to correct soil pH over the entire slope. No uniform recommendation will be acceptable in all cases with respect to lime because too much lime may be of more harm in establishing grasses than too little lime. In such instances lime should be applied so that most of the surface expected to be covered in turf will be at a satisfactory pH. It is well known agronomically that most grasses will establish and develop at a pH as low as 5.5.

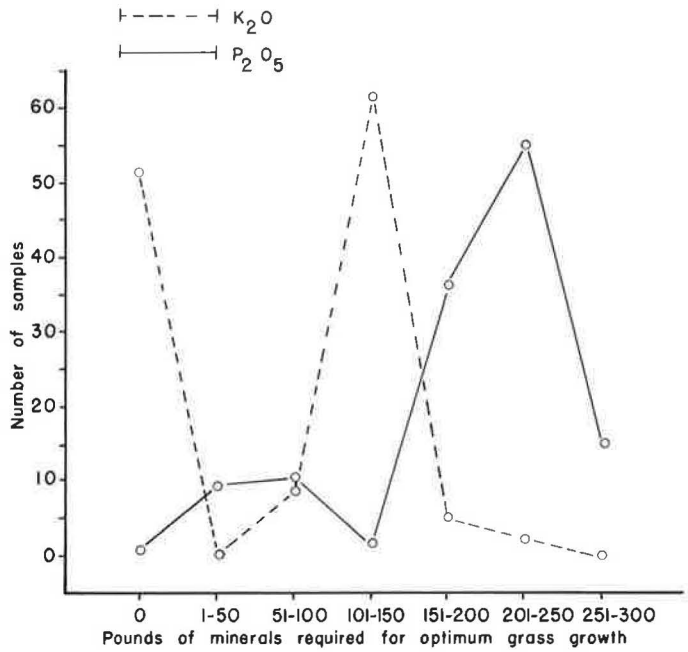

Figure 5. Frequency of soil samples requiring phosphorus and potassium.

In respect to phosphorus and potassium, adequate quantities of these minerals should be available in the soil for plant use. There is no reason to suspect that present practices in Illinois do not provide adequate phosphorus; however, the liming practices may limit the availability of this phosphorus.

From the soil samples it appeared that there was a greater requirement for phosphorus than potassium (Fig. 5). There were no identifiable trends in this study with respect to potassium. The usual soil tests do not include nitrogen analysis, but 80 lb of nitrogen on a per-acre basis is sufficient nitrogen for grass establishment.

SUMMARY

The value of a soil testing program in determining the fertility needs along new highway cuts is expressed by an agronomic comparison with the present blanket application method. The soil test data show that most of the sites do not need lime, but the majority do require phosphorus and nitrogen. The application of lime to those sites that are high in lime may cause a tie-up of essential nutrients such as phosphorus, and also increase labor requirements and costs. As a practical solution to such a fertility problem, soil tests taken prior to seeding could be utilized by everyone concerned in the establishment of grasses on the right-of-way to develop an adequate fertility program for grass establishment. Inasmuch as this research effort indicates that overliming has occurred on many roadsides, a pH test using pH 5.5 as a minimum pH could be used to determine the lime requirement.

ACKNOWLEDGMENTS

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Effect of Fertilizer Slurries Used With Hydro-Seeding on Seed Viability

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•THE APPLICATION of seeds in water in any combination with fertilizer or wood-fiber cellulose mulch for establishing turf is called hydro-seeding. This is a labor-saving technique because the seed and fertilizer or seed, fertilizer, and mulch may be applied in one operation. The method is especially suitable for making turf seedings on slopes where other mechanical methods cannot be used. Hydro-seeding methods have been employed by highway departments and seeding contractors on roadsides, industrial sites, parks, lawns, golf courses, athletic fields and other areas for establishing turf. This method is also very suitable for simultaneous reseeding, refertilizing and mulching degenerated slopes (1). This paper gives results on the effect of seed viability and germination as influenced by length of exposure and concentration of fertilizer solutions.

PROCEDURE

Experiment I

Seeds of the following species were used: Ky. 31 tall fescue (Festuca elatior arundinacea), redtop (Agrostis alba), oats (Avena sativa, var. Forkedeer), rye (Secale cereale, var. Abruzzi), millet (Setaria italica, var. Hungarian), red clover (Trifolium pratense), white clover (Trifolium repens), and perennial ryegrass (Lolium perenne). Seeds were exposed to different concentrations of fertilizer slurries for different lengths of time (Table 1). A 12-12-12 commercial fertilizer was used with all concentrations and exposures.

Germination tests of the seeds were made on moist blotters in two ways: (a) immediately after seed removal from slurries, and (b) removal from slurries, dried and then germinated. Seeds that were not soaked in slurries were used as controls. One hundred seeds were used for the germination test for each treatment. The trials were conducted twice to serve as replications.

Experiment II

This experiment was conducted to study germination as interrelated to soil moisture and fertilization. A sandy loam subsoil was used. The amount of moisture at field capacity was 20 percent and the permanent wilting percentage of the soil, as determined by the pressure membrane method was 11 percent (2). The soil was placed in shallow pans where it was equilibrated to supply different amounts of available moisture. Total soil moisture treatments of 12, 14, and 20 percent supplied 1, 3, and 9 percent of available moisture, respectively.

Abruzzi rye was soaked in a water-seed-fertilizer slurry for 30 min. This slurry, equivalent to 1,000 lb per acre of a 10-20-10, was applied on the soil surface to simulate hydro-seeding. Rye was also seeded dry with fertilizer, dry without fertilizer, and with distilled water equivalent to the water in the slurry treatment. These

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seed treatments were used with the three moisture levels already mentioned. The shallow pans with soil were placed in a controlled temperature germinator.

Each treatment was replicated three times and there were 100 seeds per treatment. The seeds were pressed down to contact the soil, but they were not covered. All treatments received equal amounts of water, but the small amount added did not change the available soil moisture.

Dry Kentucky 31 fescue was placed on the soil surface, with and without fertilizer, to study germination under the 3 levels of available moisture.

TABLE 1

GERMINATION OF ABRUZZI RYE AND KENTUCKY 31 FESCUE AS INFLUENCED BY SOAKING TIME AND FERTILIZER CONCENTRATION

Fertilizer Concentration	Exposure Time	Germination (%)			
		Abruzzi Rye		Ky. 31 Fescue	
		Actual	Relative	Actual	Relative
Control		57a[1]	100	98a[1]	100
350 lb/750 gal water	15 min	48b	84	87a, b	89
350 lb/750 gal water	30 min	45b	79	86a, b	88
350 lb/750 gal water	1 hr	35c	62	89a, b	91
350 lb/750 gal water	4 hr	31c	54	70c	71
350 lb/750 gal water	8 hr	23d	40	79b, c	81
700 lb/750 gal water	30 min	30c	53	61c	62

[1]Germination values with same letters are not significantly different at 5 percent level.

RESULTS AND DISCUSSION

Experiment I

The germination of rye was injured by soaking seed with a water-fertilizer slurry (Table 1). The germination of unsoaked seed was 100 as compared with relative values of 79 to 84 when the seed was soaked for 15 to 30 min. Soaking the seed for 8 hr reduced germination to a relative value of only 40 percent. Increasing the fertilizer concentration from 350 to 700 lb of fertilizer per 750 gal of water caused a significant reduction in germination of rye.

Kentucky 31 fescue seed soaked in a slurry (equivalent to 350 lb of fertilizer in 750 gal of water) for as long as 60 min did not reduce germination (Table 1). The soaking of seed for 4 to 8 hr in a slurry, however, did reduce germination as compared with unsoaked seed. Doubling the concentration of the slurry was found to injure the germination of tall fescue seed.

The combined average germination of seed from six species (redtop, perennial ryegrass, red clover, white clover, millet, and oats) shows that germination was not injured by the less concentrated fertilizer slurries (Table 2). Exposing the seed for as long as 8 hr to the less concentrated water-fertilizer slurry did not injure germination. Germination values for seeds germinated immediately after soaking and for seeds dried after soaking in a slurry and then germinated were similar, except for the concentrated slurry where higher germination occurred with the latter method. This lower germination with the wet as compared with the dry method may be attributed to concentration of fertilizer salts in the seed environment during germination. Fertilizer salts apparently became separated from the seeds during drying. The results indicate that the soaking effect in concentrated fertilizers per se was not harmful.

The reduced germination of rye as compared with other seeds exposed to fertilizer-water slurries may be attributed to: (a) rye seed coats may be permeable to specific toxic ions, (b) rye may be susceptible to toxicity of certain ions, and (c) the embryo in rye may be more susceptible to plasmolysis or corrosive action of fertilizer salts than the embryo of other species listed.

Experiment II

Soil moisture, ranging from 1 to 9 percent available moisture, did not influence germination of rye (Table 3). The results were consistent for all seed-water-fertilizer treatments. Soaking the seed in distilled water gave an average germination of 83 percent as compared with 84 percent without soaking. Soaking rye seed for 30 min in a water-fertilizer slurry caused a drastic reduction in germination. Dry seed without fertilizer placed on the soil surface germinated 84 percent as compared with 72 percent where fertilizer was also placed on the soil surface. Rye, as for experiment I, was seriously injured when soaked with a fertilizer slurry, but the fertilizer per se after seeding also reduced germination.

TABLE 2

COMBINED AVERAGE GERMINATION PERCENT OF SIX SPECIES (REDTOP, RED CLOVER, WHITE CLOVER, PERENNIAL RYEGRASS, OATS, AND MILLET) AS INFLUENCED BY SOAKING TIME AND FERTILIZER CONCENTRATION

Fertilizer Concentration	Exposure Time	Wet	Dry
0	0	94	94
350 lb/750 gal water	15 min	90	96
350 lb/750 gal water	30 min	93	92
350 lb/750 gal water	1 hr	91	94
350 lb/750 gal water	4 hr	94	90
350 lb/750 gal water	8 hr	95	86
700 lb/750 gal water	30 min	77[1]	91

[1]Significantly lower than other mean values.

The germination of Kentucky 31 fescue in the absence of fertilizer averaged 62 percent for 1 percent of available soil moisture as compared with 67 percent for field capacity or 9 percent available soil moisture (Table 4). These values did not differ significantly. Conversely, when a 10-20-10 fertilizer at the rate of 1,000 lb per acre was applied on the soil surface with the seed, the germination increased as soil moisture increased. Germination averaged 12, 26, and 50 percent for 1, 3, and 9 percent available moisture, respectively. Sixty-two percent of the seeds germinated in the absence of fertilizer as compared with only 12 percent germination in the presence of fertilizer when 1 percent moisture was available. On the other hand, when available moisture was high, germination averaged 67 percent in the absence of fertilizer as compared with 50 percent when fertilizer and seed were in contact on the soil surface. These results show that fertilizer in contact with Kentucky 31 fescue seed causes a moisture stress at low available versus high available soil moisture.

APPLICATION TO HYDRO-SEEDING

Seeds are normally in contact with a water-fertilizer slurry in tanks of hydro-seeders for less than 20 min before making the applications. This brief contact would not cause a significant injury to germination of the perennial grasses and legumes such as Kentucky 31 fescue, redtop, perennial ryegrass, red clover, and white clover. Other work with bluegrass shows that it is not injured by fertilizer slurries. Likewise, the fertilizer slurry did not perceptibly injure annuals such as oats and millet, but the injury to cereal rye germination was severe for lengthy contacts with fertilizer slurries. The germination injury to rye was low for a short period of exposure.

During normal operations of hydro-seeders, the slight injury to germination that may occur with seeds of some species would not be responsible for seedling failures. The germination injury from a fertilizer slurry reported for rye would not cause seeding failure. The high seeding rates that are used for turf areas as an insurance for success more than compensates for germination injuries to species that may be injured by fertilizer slurry. In other experiments not reported here rye used as a companion grass in a fertilizer slurry with hydro-seeding has given good stands.

Fertilizers are used liberally for establishing turfgrasses because of the low inherent fertility of many soils and also because of the need of establishing stands quickly to control water and soil erosion. Excessively high rates of fertilizers whether applied by the hydro-seeding or other methods retard germination under moisture stress; soluble salts in the fertilizers inhibit moisture

TABLE 3

PERCENT GERMINATION OF ABRUZZI RYE AS INFLUENCED BY SOIL MOISTURE AND FERTILIZER TREATMENTS

Application to Soil Surface (1,000 lb/acre of a 10-20-10 as indicated)	Total Soil Moisture %			Average Germination for Fertilizer Treatments
	12	14	20	
	Available Soil Moisture %			
	1	3	9	
A. Seed-water-fertilizer slurry after soaking for 30 min	52a[1]	45a	44a	47a
B. Seed with water after soaking for 30 min	80c	83c	87c	83c
C. Dry seed and fertilizer[2]	70b	74b	73b	72b
D. Dry seed without fertilizer[2]	83c	84c	86c	84c
Average for 3 moisture levels	71	72	73	

[1]Values with different letters differ significantly.
[2]Same amount of water applied as for A and B.

availability for seeds. Favorable rainfall and soil moisture after seeding lowers the osmotic concentration of the soil solution and causes soluble nutrients to move into the soil away from the seed so that good results may be expected from contact placement of seed and fertilizer. Fertilizers incorporated before seeding can and do seriously retard germination during periods of drought. During evaporation, soluble salts move to the soil surface in closer proximity to the seed thereby adding to the moisture stress. The placement of seed and fertilizer in contact on the soil surface will normally cause more injury to germination than incorporation of the fertilizer material. Seed and fertilizer are not necessarily placed in contact with the hydro-seeding method as fertilizer materials do penetrate into the soil surface when the seedbed is reasonably friable. Data reported here show excellent germination with high moisture where fertilizer and seeds were placed in contact on the surface.

TABLE 4

PERCENT GERMINATION OF KENTUCKY 31 FESCUE AS INFLUENCED BY SOIL MOISTURE WITH AND WITHOUT FERTILIZER

Fertilizer Treatment	Total Soil Moisture %			Average Germination for Fertilizer Treatments
	12	14	20	
	Available Soil Moisture %			
	1	3	9	
10-20-10 fertilizer on soil surface at 1,000 lb/A	12[1]	26[1]	50[1]	29[1]
No fertilizer	62	65	67	65
Average for 3 moisture levels[2]	36	46	59	

[1]Significantly lower than values for the no fertilizer treatment.
[2]Mean values differ significantly.

Turf stands during establishment are not as good on warm sunny slopes as on cool slopes, regardless of seeding method, because of more available moisture and more favorable temperatures on cool slopes. High temperatures on sunny slopes coupled with high water loss due to transpo-evaporation causes a moisture stress. Moisture stress is more serious in the presence of fertilizers high in soluble salts than in the absence of fertilizer or with fertilizers low in soluble salt concentration.

Laboratory and field results show that it is better to use high analysis fertilizers as compared with low analysis fertilizers. Salt concentration per unit available fertilizer applied is lower for high analysis than for low analysis fertilizers. Concentrated phosphates, such as triple superphosphate, do not seriously inhibit germination even though seeds are in contact with it. On the other hand, ordinary superphosphate which is high in gypsum causes serious retardation in germination under moisture stress. Concentrated forms of soluble nitrogen fertilizers cause less burning than the less concentrated soluble forms. Organic and urea-formaldehyde sources of nitrogen do not inhibit germination because of the low soluble salts.

The effect of soil moisture on germination of Kentucky 31 fescue was linear where fertilizer was applied with seed. These results suggest that the harmful effects of fertilizer contact with seed are overcome by favorable moisture. This conclusion is substantiated by the results in experiment I, which showed that fescue was not injured by soaking in a slurry.

SUMMARY

Experiments were conducted to study seed germination as influenced by soaking in fertilizer slurries and by moisture stress where seed and fertilizer are placed in contact on the soil surface. The results apply to hydro-seeding methods that are commonly used by highway departments and other agencies.

The soaking of seeds in fertilizer slurries for short periods of time that simulate hydro-seeding did not reduce germination of Kentucky 31 fescue, redtop, perennial ryegrass, red clover, white clover, oats, and millet. The germination of rye was reduced 21 to 43 percent by soaking in a slurry for 30 min.

The results with Kentucky 31 fescue show that fertilizer-seed contact (fertilizer not watered in) on the soil surface is injurious to germination under low available moisture. Fescue seed soaked in a slurry and placed in contact with the fertilizer increased in germination from 12 to 50 percent as available moisture was increased

from 1 to 9 percent, respectively. Fertilizer in contact with seed aggravated the stress for soil moisture.

The application of the results to hydro-seeding has been discussed.

ACKNOWLEDGMENT

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Mulches for Steep Cut Slopes

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•IT IS NECESSARY to obtain a quick cover of grass or other vegetation for soil and water control along highways and approaches or interchanges to interstate highways. Steep 1:1 slopes are not generally recommended for grass stabilization, but such slopes in Virginia are often unavoidable because of the tremendous cost of earth removal due to topography or the lack of adequate right-of-way for establishing flatter slopes. This paper gives results of experiments on steep 1:1 sloping cuts that have been carried on since 1962 to study mulching materials including nets, straw mulch, asphalt, glass fiber, woodfiber cellulose, and combinations of these materials in view of establishing a sod quickly.

Published results show that certain mulches improve the soil environment and seedling establishment. Barkley (1) found that straw mulch and woodfiber cellulose (Turfiber) gave faster germination, better seedling stands, and greater seedling growth than no mulch, sawdust, or certain plastic type mulch treatments. Straw and woodfiber cellulose both moderated soil temperatures and improved soil moisture as compared with no mulch and certain other mulch treatments. Button and Porharst (5) found that wood cellulose fiber was equal to hay as a mulch material. Blaser (2) noted that sod development with straw mulch was somewhat faster than with wood cellulose fiber, but both materials were very satisfactory. Richardson and Diseker (6) found that a crop of Abruzzi rye, that later served as a mulch, was superior for establishing crown vetch as compared to net type materials such as jute, glass fiber, paper, and no mulch. On the other hand, seedling competition from fast-growing seedlings, such as small grains and ryegrass, usually retard slow-developing desirable seedlings (3). Brant (4) pointed out that grassing results with some of the newer mulching materials were inconclusive or unavailable for comparison.

GENERAL PROCEDURE

All experiments were designed to make the individual and combination mulch treatments the only variable; seed, lime, and fertilizers were uniformly applied. Randomized block designs, where all the treatments were randomized within a block, were used. There were three or more such replicated randomized blocks at each location. When possible, experimental sites were selected so that mulch treatments could be studied on each side of the road with shaded and sunny slopes. The mulch treatments were laid out on adjacent plots up and down the entire length of slopes ranging from 12 to 50 ft in length for the different experiments. All mulch treatments for a given site or for a replication were planned to apply all treatments on the same day so as to have valid comparisons.

Straw was applied by hand, after which the asphalt application was made to hold the straw in place. On the stakes-straw-asphalt treatments, wooden stakes were driven on 18-in. centers after which the other materials were applied. Glass fiber was applied by means of compressed air, and the equipment recommended by the manufacturer. The various nets were held in position with metal staples supplied by the manufacturer or with small wooden stakes. When used with nets or glass fiber, wood cellulose fiber

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was applied last. The methods of applying wood cellulose fiber are discussed with specific experiments.

The various mulch materials and manufacturers were as follows: Soil Saver (heavy jute netting) by Ludlow Corporation; Erosionet (a closely woven twisted, about ¼-in., paper mesh material; Mulchnet (a lightweight paper fabric about 2-in. mesh); and jute (heavy matting of jute yarns) made by Bemis Bros. Bag Co.; Strandex (a knit wood pulp fiber net, about ¼-in. mesh) by Strandex Inc.; Turfiber (a wood cellulose fiber) by International Paper Co.; Silvacel by Weyerhauser Co.; Soil-Set or Soil Gard (an elastomeric polymer emulsion which forms a water insoluble film when dry) by Alcoa Chemical Co.; Glassroot (glass fiber) by Pittsburgh Plate Glass Co.; Troyturf.

Experiments I, II, and III

The lime, fertilizer, and seed were applied uniformly across all plots; the mulch treatments were applied last. About 100 lb per acre of Turfiber were applied with a fertilizer-seed slurry because the slopes were so steep that the materials would not otherwise adhere to the soil. There was a slight spotted downward movement of lime, fertilizer, and seed due to tramping when applying the nets; thus, more seed and fertilizer were added to all plots after the mulch treatment had been applied.

Experiment IV

The methods were similar to those just mentioned, except that the four replicated plots of each mulch treatment were sprayed with a slurry of seed-fertilizer-lime. These materials were applied before applying mulch treatments or combinations other than for Silvacel and Turfiber. A very light application of Turfiber, 100 lb per acre, was included with each mulch treatment to make the material adhere to the steep slopes. Turfiber or Silvacel was applied in one application (mulch-seed-fertilizer-lime), except for some treatments with Turfiber (indicated in Table 2). When Turfiber was used with Glassroot or nets, it was applied last (alone in a slurry). The area for the four replicated plots was carefully computed and a small hydro-seeder was loaded so that the rates per acre of lime, seed and fertilizer were alike for all treatments.

EXPERIMENTS AND RESULTS

Experiment I—Approach to Interstate 81 Near Salem, Virginia

The reddish subsoil (1:1 northern and southern slopes, 15 to 40 ft in length) was an acid, colluvial shale, low in fertility. Because of the 1:1 slope, topsoil was not applied. This was a very difficult environment for seedling establishment due to the drought, steepness, and the crumbling and loosening surface, which occurs soon after rain. Mulches were thus essential to stabilize the soil, moderate temperatures, and improve moisture.

The following mulch treatments were applied in August 1962: (a) straw with asphalt; (b) straw with Soil-Set; (c) straw held in place with Mulchnet; (d) straw; (e) asphalt; (f) jute net (Soil Saver); (g) Erosionet; (h) Turfiber (woodfiber cellulose); (i) horizontal scarification before seeding, then Turfiber; (j) Erosionet topdressed with Turfiber; and (k) Turfiber with a light application of Soil-Set. The mulch treatments were randomized on a cool slope (northern exposure) and repeated in two randomized blocks on a warm southern slope exposure. All plots received 2 tons of lime; 1,500 lb of 10-20-10 fertilizer; and a seeding mixture of 60 lb of Kentucky 31 fescue and 1 lb of redtop per acre.

TABLE 1

EFFECT OF VARIOUS MULCHES ON SOIL MOISTURE AND SURFACE TEMPERATURE ON A COOL SLOPE HIT BY AFTERNOON SUN, SEPTEMBER 18, 1962

Treatment	% Moisture in Soil	Soil Surface Temperature
No mulch	14.0	84
Asphalt	13.9	83
Turfiber + Soil-Set	14.1	81
Jute net	16.5	79
Turfiber	-	77
Straw + asphalt	15.2	75

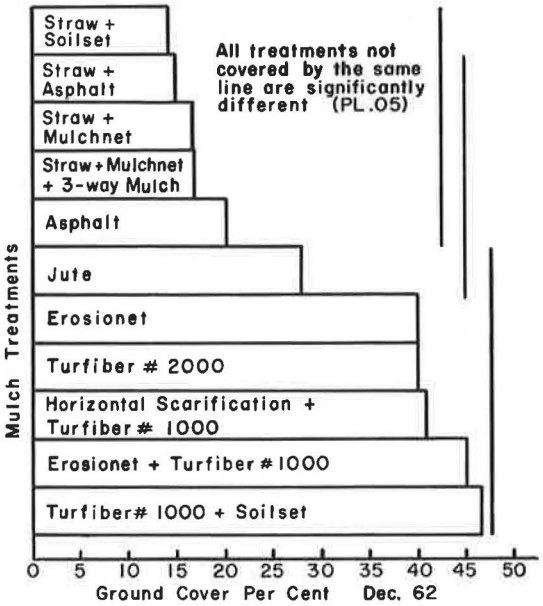

Figure 1. Soil covered with sod for various mulch treatments near Salem on an interchange to I-81. Experiment established in August 1962, and data obtained in December 1962. Treatments not intersected by same line are significantly different.

The moisture contents and temperatures for some of the treatments on September 18 are given in Table 1. Although no great differences are shown, the mulches which maintained the lower soil surface temperatures also had higher soil moisture contents. This is expected as higher temperatures stimulate evaporation of soil moisture. Figure 1 shows a decided improvement in sod cover by certain mulches $3\frac{1}{2}$ months after seeding. Any treatment combination with straw gave rather poor ground cover apparently because the straw was applied too heavily or lost due to erosion. The best sod cover was obtained with various nets, Turfiber, and combinations of Turfiber with nets or Soil-Set.

Although good sod establishment was obtained with certain mulches, the seedlings failed to develop deep root systems because of the impervious soil and inferior aeration. Growth was also retarded by low rainfall. The winter season was critically cold and alternate freezing and thawing was deeper than the roots. There was much slipping of sod on all plots, but sod retention was best on slopes with jute net or combinations of net-straw mulch treatments.

Experiment II—State Highway 614 Near Pilot Mt.

This experiment was established on September 14, 1962 on old slopes where all grass and woody vegetation had degenerated. The slopes were 1:1 and steeper with variable exposures due to the curving mountainous highway. The subsoil on cut slopes, sandstone in origin influenced by the presence of some limestone, was very acid and especially low in organic matter, nitrogen, phosphorus, and calcium. The mulch treatments were similar to those for Experiment I, except that Troyturf was included. Lime at 2 tons per acre; 1,200 lb of 10-20-10; and a mixture of 60 lb of Kentucky 31 fescue, 1 lb of redtop, and 5 lb of ryegrass were applied with all mulches.

The soil moisture under different mulches approximately one month after establishing the experiment is shown in Figure 2. All mulches tended to retain moisture better than no mulch. Certain combinations of Turfiber with other materials and Troyturf tended to have the most favorable moisture; however, moisture with straw or certain nets was about as good. (Other data are not given for Troyturf, because of a fertilizer and seed differential for this mulch.) The data help substantiate the earlier results which showed the beneficial effects of mulches in retaining moisture. Soil temperatures were not taken.

It is very important to obtain quick germination, dense stands and large plants for establishing a sod quickly. Mulches had a decided effect on seedling stands, there being about $2\frac{1}{2}$ times as many seedlings per unit area with Erosionet as with no mulch (Fig. 3). Asphalt used liberally by itself actually retarded germination and seedling stands. Seedling populations for straw-asphalt and Turfiber mulches were similar and not significantly different. Figures 2 and 3 show some relationships between the moisture level and population of grass plants. This relationship does not hold exactly

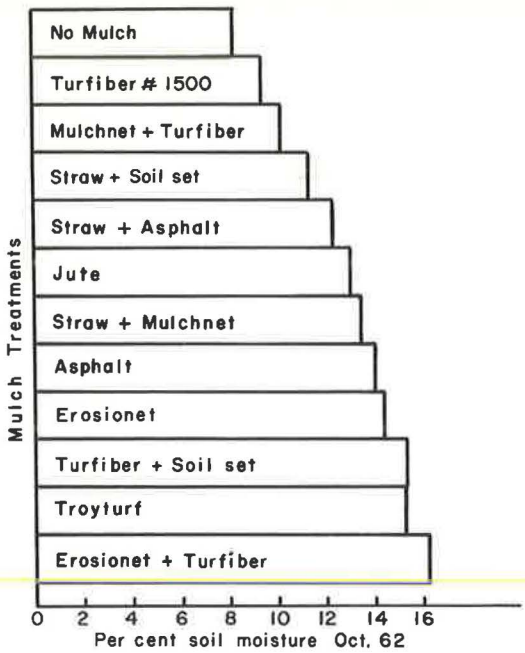

Figure 2. Influence of various mulches on total soil moisture for an experiment established along State Road 615 near Pilot Mountain; established in September, data taken in October 1962.

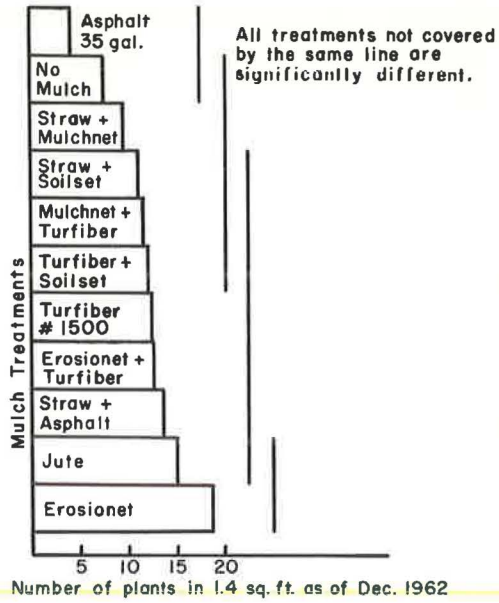

Figure 3. Grass seedling stands with various mulch treatments along State Road 615 near Pilot Mountain; established in September and plant counts made in October 1962. Turfiber was applied at 1,000 lb/a except as indicated. Treatments not intersected by same line are significantly different.

true because other factors besides moisture influence germination and growth. The variable environment, even with repeated treatments, also hindered a better association between stands and soil moisture.

Mulches should improve microclimate to encourage fast seedling growth to stabilize the soil with many roots and also to shade the soil to reduce temperatures and conserve moisture. The largest fescue seedlings occurred on Turfiber-Erosionet and Turfiber-Soil-Set mulch combinations (Fig. 4). The seedlings were smallest with no mulch and straw-Soil-Set mulches. The small seedlings with straw mulch treatments are attributed to applying the straw too liberally which caused excessive shading and retarded seedlings. Seedlings with some of the nets used for mulch were also small as compared with other treatments; the nets did not stay in contact with the soil, thus, seedlings under the nets were apparently shaded.

Seedling sizes tend to correlate with the moisture levels of the soil (compare Figs. 2 and 4).

Experiment III—Access Road to Interstate 81 Near Salem

This experiment was established April 1, 1963 on steep 1:1 cuts. The subsoil, deep red and calcareous in origin, was moderately fertile. All plots received 1,500 lb of 10-20-10, 60 lb of Kentucky 31 fescue, 4 lb of redtop, and 48 lb of Lespedeza sericea per acre. The mulch treatments were replicated twice on slopes with a cool northern exposure and once with warm southern exposure.

Data taken 6 months after seeding show poor sod cover during the first summer (Fig. 5). This is attributed to extremely dry soil during the spring and summer as there was a deficiency of 15 in. of rainfall. The area staked for stabilizing the straw

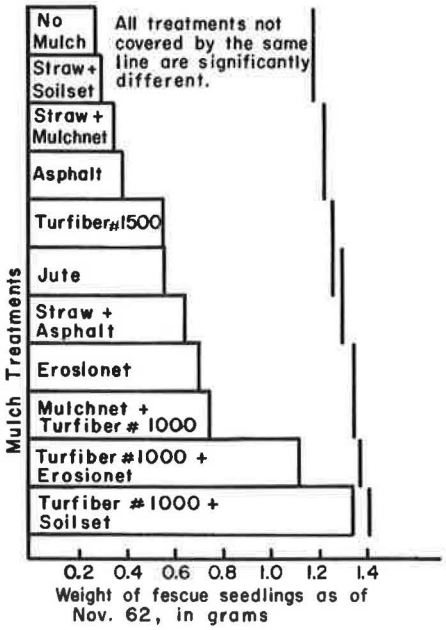

Figure 4. Growth of Kentucky 31 fescue seedling plants with different mulch treatments along State Road 615 near Pilot Mountain. Experiment on this steep cut slope was established in September, and plant weights were obtained in November 1962. Treatments not intersected by same line are significantly different.

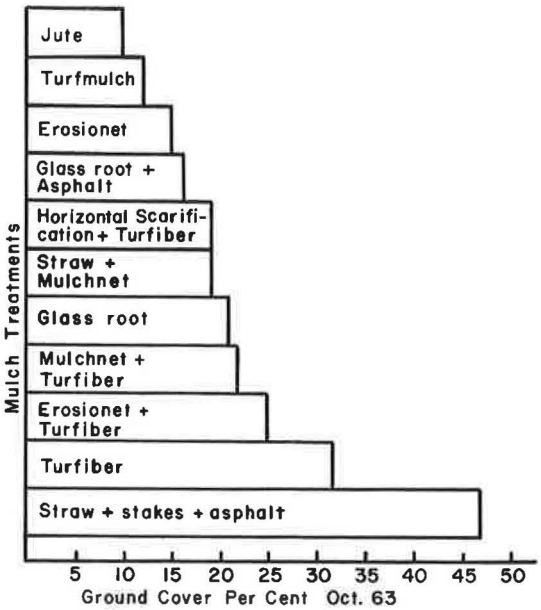

Figure 5. Effect of mulch treatments on percent ground covered with sod for cool slopes during fall of 1963. Experiment established April 1963, on access road to I-81 near Salem, Virginia.

mulch-asphalt treatment gave the best sod, yet straw with Mulchnet was inferior to Turfiber or two Turfiber-net combinations. The shading of the soil by the stakes with the straw mulch treatments may have improved soil moisture and sod development. Sod cover was very poor where various nets alone served as mulches. Grasses failed where the nets were not in contact with the soil. Turf mulch, an organic peat, no longer available, did not give a satisfactory sod cover. Glassroot mulch controlled erosion, but the sod was not as good as for some other mulches. The grasses failed to survive on all mulch treatments on slopes with a southern exposure due to drought.

Experiment IV—US 58 Near Martinsville

This experiment, with various mulch materials in different combinations, was established in September 1963, in the Piedmont region. The residual reddish subsoil, of crystalline rock origin, was acid, very low in calcium, phosphorus, and nitrogen, and high in exchangeable aluminum. The 1:1 slopes on each side of the newly constructed east-west highway (US 58) were from 10 to 50 ft in length. All mulch treatments received 1 ton of lime, 1,000 lb of a 10-20-5 fertilizer, 60 lb of Ky. 31 fescue, and 1 lb of redtop per acre. Crown vetch was seeded on the cool slopes, and Lespedeza sericea was sown on the warm slopes. There were two replications on each of the two slope exposures.

Twenty days after applying fertilizer and seed with various mulch treatments, there was an average of 42 percent sod cover on cool slopes with a northern exposure as compared with only 12 percent sod cover on warm slopes with southern exposures (Table 2). There was more rapid germination and growth of turf plants on the semi-shaded slopes with a northern exposure because cool soil temperatures per se favored

TABLE 2

EFFECT OF MULCH TREATMENTS ON GRASS SOD ESTABLISHMENT FOR STEEP 1:1 CUT SLOPES WITH NORTHERN AND SOUTHERN EXPOSURE, US 58, MARTINSVILLE, ESTABLISHED SEPTEMBER 10, 1963

Treatment	Soil Covered with Sod[1] (%)					
	September 30			December 11		
	Southern Slope	Northern Slope	Average	Southern Slope	Northern Slope	Average
No mulch	8	29	14e	19	39	29c
Straw + asphalt	13	70	41ab	33	70	51ab
Stakes + straw + asphalt	15	75	45a	33	73	52ab
Mulchnet over straw	20	40	29abcde	40	63	51ab
Turfiber, 1,000 lb	16	50	33abcd	25	45	35bc
Turfiber, 1,500 lb	14	40	27abcd	35	50	42abc
Turfiber, 2,000 lb	11	35	22cde	22	60	41abc
500 lb Turfiber with seed, 1,000 lb after	16	58	37abc	33	65	46abc
Turfiber, 1,500 lb, patched 30 days later	7	50	28abcde	53	60	56a
Turfiber, 1,500 lb + Sea Magic	12	31	21cde	25	40	32bc
Turfiber + Mulchnet	18	40	29abcde	43	63	53ab
Silvacel, 1,000 lb	5	30	17de	18	50	34bc
Silvacel, 2,000 lb	10	48	29abcde	24	55	39abc
Silvacel, 750 lb—Turfiber, 750 lb	15	23	21cde	30	40	35bc
Glassroot	10	30	20cde	26	60	43abc
Glassroot + Turfiber	12	35	23bcde	33	43	40abc
Glassroot + asphalt	7	45	26abcde	20	60	40abc
Strandex	5	25	15de	25	63	44abc
Soil Saver	12	43	27abcde	45	43	47abc
Average	12	42	27	31	55	43

[1]All treatments not having same letter are significantly different.

germination and improved soil moisture. It is invariably more difficult to establish a sod and to maintain it on warm sunny slope sites than on cool slope sites. Mulches that improve the microclimate (reduce temperatures and increase moisture) are especially necessary on steep sunny slope sites.

When averaging the sod cover for cool and warm slopes, 20 days after seeding, the sod cover averaged 14 percent for no mulch as compared with significant increases ranging from 29 to 41 percent for the straw mulch treatments. Sod cover for Turfiber at various rates ranged from 22 to 33 percent. The values tend to be lower than those for straw, but variances were large so differences were not significantly different. The initial sod cover was 33, 27, and 22 percent when applying Turfiber at rates of 1,000, 1,500, and 2,000 lb per acre, respectively. Applying 500 lb of Turfiber per acre in a lime-fertilizer-seed slurry and then 1,000 lb of Turfiber as a mulch by itself was not significantly better than applying 1,500 lb of Turfiber in the seed-lime-fertilizer slurry.

Data on percent of soil covered with sod about three months after establishing the mulch treatments are also given in Table 2. It was very dry during late October and November; thus, all values for sod cover are low. The average sod cover for all treatments was 43 percent; in seasons with normal rainfall, values higher than 75 percent are usually obtainable. Sod cover was 80 percent better for cool as compared with the warm slope exposures.

Three months after seeding, the sod cover for straw mulch used in combination with stakes or held in place with a net averaged about 51 percent. A Turfiber-sod-fertilizer-lime slurry applied over Mulchnet gave an average sod cover of 53 percent. Silvacel applied at 1,000 and 2,000 lb per acre gave sod covers of 34 and 39 percent as compared to 35 and 41 percent for Turfiber at the same respective rates. Applying Turfiber at rates of 1,000 to 2,000 lb per acre did not improve sod cover significantly as the rate was increased. The differences in sod cover of the treatments mentioned in this paragraph were not large enough to be significant (Table 2).

The sod cover of Glassroot used alone or top sprayed with Turfiber or asphalt ranged from 40 to 43 percent. Glassroot controlled soil erosion very effectively. Strandex and Soil Saver gave sod cover values of 44 and 47 percent, respectively.

TABLE 3

EROSION AND APPEARANCE OF STAND 20 DAYS AFTER ESTABLISHMENT FOR MULCH TREATMENTS

Mulch	Soil Erosion[1]	Appearance[2]
Mulchnet over straw	0	1.3
Soil Saver	0	2.5
Glassroot-Turfiber	0	3
Straw-asphalt-stakes	0	2.5
Glassroot	0.3	2.6
Mulchnet-Turfiber	0.5	2.5
Straw-asphalt	0.8	2.5
Silvacel, 2,000 lb	0.6	2.5
Strandex	0.8	3.3
Turfiber (500 with seed, and fertilizer, then 1,000 lb)	1.0	2.1
Glassroot-asphalt	1.3	1.3
Turfiber, 2,000	1.3	2.4
Silvacel, 1,000 lb	1.3	2.7
Turfiber, 1,000 lb	1.5	2.6
Turfiber-Sea Magic	1.8	3.2
Turfiber, 750—Silvacel, 750 lb	1.9	2.8
No mulch	2.8	3.6

[1]0 is no erosion, 5 is very serious erosion.
[2]1 is very good germination and growth, 5 would be no germination and growth.

Sea Magic did not improve sod cover. When Turfiber mulch was used at seeding followed with a "patch-up" operation 30 days later, the sod cover was 56 percent. A very light application of a Turfiber-seed-fertilizer slurry was applied in spots where grass appeared thin in the "patch-up" operation.

Table 3 gives the effect of materials on erosion and appearance of the slope seedings 20 days after establishment. There was one heavy rain of approximately 1 in. between establishment and time of observation. Erosion was not serious; it was moderate without mulch; nil with Mulchnet over straw, straw-stakes-asphalt, Soil Saver and Glassroot-Turfiber; and mild with the remaining mulches. The sod appearance was best with Mulchnet over straw; the other mulch treatments did not differ significantly (Table 3).

Experiment V—Water Runoff with Mulches

Water runoff was studied with no mulch as compared with Silvacel and Turfiber, each applied at 1,000 and 2,000 lb per acre. The mulch treatments were applied on 3- by 3-ft plots with a 1:4 slope and an arrangement to catch surface runoff. The treatments were replicated three times. One inch of simulated rain applied in 30 min was used with each treatment. The runoff water was collected and measured (Fig. 6). An average of 43 percent of the water was lost as surface runoff without a mulch as compared with a water loss of only 28 percent from plots receiving 1,000 lb of the mulch materials. The 2,000-lb rate of mulch reduced the runoff to 25 and 18 for the Silvacel and Turfiber.

CONCLUSIONS

Rainfall and soil moisture were very deficient during the period when the reported mulching experiments were conducted. The data for evaluating the effectiveness of the mulches should not be considered conclusive. More research has been initiated. The results for establishing grass apply to adverse conditions, steep 1:1 slopes, drought, and subsoil materials that sluff easily due to alternate freezing and thawing or wetting and drying.

The following mulch materials tested gave satisfactory to excellent turf: various nets, Glassroot, straw with asphalt, Turfiber and Silvacel.

Net mulch materials must be applied to maintain firm contact with soils. It is necessary to prepare a

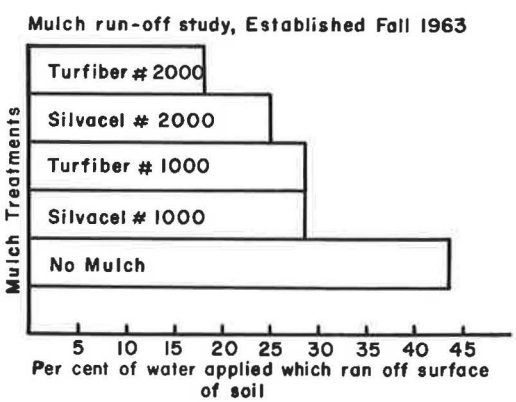

Figure 6. Effect of cellulose and woodfiber mulch on retention of rain water expressed as percent of water lost from 1 in. of water applied artificially.

uniform soil surface to maintain good soil-net contact. Considerable hand labor and time were required to apply net mulches to steep slope sites.

One of the best methods of obtaining good stands on adverse steep slope conditions is to use wooden stakes spaced on 18-in. centers followed with straw mulch topped liberally with asphalt. Without stakes, straw mulch topdressed liberally with asphalt is suitable if the soil under the straw does not become supersaturated to cause slipping of straw and soil. Stakes with straw mulch are required on long slope faces.

A practical method for large-scale steep slope seedings is where a woodfiber cellulose-fertilizer-seed slurry is applied hydraulically in one operation. It is recommended that second patch-up operations be specified in seeding contracts. Irrespective of what seeding method is used, there will invariably be spotted turf stands on slope sites such as those discussed in this paper, making a retreatment necessary.

ACKNOWLEDGMENT

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Progress Report on Noise Abatement

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•THIS IS a report of progress on noise abatement from 1962 to 1964. It supplements information previously presented to this committee and published by the Highway Research Board in the separate Reports of the Committee on Roadside Development.

A previous progress report with 1960-1962 references on noise was printed by the Highway Research Board in 1963 (1) and prior to that report, a summary of progress on noise abatement from 1953 to 1961 was published by the Board (2).

National Cooperative Highway Research Program

In the United States, high priority has been given to research in the abatement of traffic noise on highways. The National Academy of Sciences—National Research Council has entered into an agreement with the American Association of State Highway Officials and the U. S. Bureau of Public Roads in which it is provided that the Highway Research Board will administer the National Cooperative Highway Research Program for the participating members of the Association. Project 3-7 for the "Establishment of Standards for Highway Noise Levels" was a new project recommended to the National Academy of Sciences by the Executive Committee of the American Association of State Highway Officials for inclusion in the NCHRP for Fiscal Year 1964.

The project statement issued June 25, 1963, by the Highway Research Board includes a concise statement of the research problem, particularly in urban areas, and an outline of objectives to guide the research work through its several phases of evaluation, design control, legislation and enforcement.

Noise—Prevention, Isolation, and Insulation

These are the methods of approach by which the highway engineer can tackle the problem of noise abatement. Clearly, the engineer's goal should be threefold:

Prevention. —The engineer can seek to minimize traffic noise generated by the motor vehicle at the source. Previous reports have shown that much as been accomplished by the automotive industry and the highway industry in this phase of noise research. Based on the results of comprehensive study of motor vehicle exhaust noise for the purpose of determining feasible objective noise limits, and methods for determining compliance, the December 1962 Report by Bolt, Beranek and Newman (4) recommended that (a) current practice in the State of California for citation of vehicle noise offenders should be continued, and (b) legislation should be enacted to establish maximum noise limits measured at a distance of 50 ft from the vehicle for two classes of vehicles:

Group 1: Passenger vehicles other than motorcycles, trucks of less than 10,000-lb gross vehicle weight, and buses having capacity for 15 or less passengers.

Paper sponsored by Committee on Roadside Development.

Group 2: Trucks of more than 10,000-lb gross vehicle weight, motorcycles, and buses having a capacity for more than 15 passengers.

The basic purpose in establishing a numerical limit on permissible vehicle noise is to limit this noise to a value which most individuals will judge acceptable. The limit should be expressed, therefore, in a measure or unit that correlates well with human reactions to noise. Unfortunately, the complexities of human hearing make a simple approach difficult to correlate. For example, a diesel truck and a motorcycle might have the same overall sound intensities, but still elicit quite different reactions from listeners.

Isolation.—The highway location engineer can separate the source of noise from the people who might be disturbed by it. This is a matter of foresight and sensible planning of highway routes when alternate locations are being studied. For example, care in location will avoid locating heavily traveled highways too near residences, schools, hospitals, churches, and other institutions. Alternate truck routes can by-pass congested and residential areas.

Insulation.—The highway design engineer can shield the individual property from potential noise. For example, right-of-way will be acquired sufficiently wide for roadside buffer planting. Building setback lines will be included wherever possible to keep structures farther back from the traffic lanes. Frontage roads, where provided, will also increase the distance between buildings and traffic. Various types of barrier walls and combinations of structural barriers and buffer plantings may be used in special situations.

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