JOINT HIGHWAY RESEARCH PROJECT

JHRP-76-34

EVALUATION OF SEVERAL METHODS
OF ESTABLISHING PLANT COVER
BY SEEDING ON THE ROADSIDE

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Interim Report

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PLANT COVER BY SEEDING ON THE ROADSIDE

TO: J. F. McLaughlin, Director Joint Highway Research Project	December 1, 1976 Revised November 1977 Project: C-36-48G
FROM: H. L. Michael, Associate Director Joint Highway Research Project	File: 9-5-7

Attached is an Interim Report on the HPR Part II Research Study titled "Development of Techniques for Plant Establishment on the Roadside". The Report is titled "Evaluation of Several Methods of Establishing Plant Cover by Seeding on the Roadside" and is authored by four researchers from the Horticulture Department under the direction of Professor Philip Carpenter.

The Report describes several experiments concerned with seeding of roadside slopes with woody plants, erosion control by rapid plant cover, a comparison of three mulch materials for newly seeded slopes, and an evaluation of several herbaceous plants for direct seeding on roadsides. A number of recommendations which can be implemented by the Highway Commission are made.

The Report will be forwarded to ISHC and FHWA for review and approval after acceptance by the JHRP Board as partial fulfillment of the objectives of the Study.

Respectfully submitted,

Harold L. Michael

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Interim Report
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PLANT COVER BY SEEDING ON THE ROADSIDE

by

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and the

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The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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15. Supplementary Notes Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. Research Study titled "Development of Techniques for Plant Establishment on the Roadside".			
16. Abstract Several woody plant species were direct seeded on a roadside slope. Of the species that germinated, seedling survival declined over time. <u>Cercis canadensis</u> and <u>Robinia pseudoacacia</u> appeared to provide some cover, however natural seeding of these native plants also occurred in unseeded plots and buffers. Mixtures of grasses and herbaceous legumes were used for erosion control. <u>Avena sativa</u> provided rapid cover and held the seeds of more desirable species in the bottom of the existing gullies. <u>Coronilla varia</u> established permanent cover and halted erosion by the second season. Wheat straw, shredded hardwood bark and shredded rubber tires were evaluated as mulch materials for newly seeded slopes. Shredded bark and wheat straw gave excellent results, however, shredded rubber was inferior even to the check. The coverage and hardiness of twenty-six grasses and herbaceous legumes were evaluated. <u>Vicia villosa</u> and <u>Trifolium pratense</u> showed excellent cover and hardiness over a two year period. Other species showed very good cover and hardiness. <u>Trifolium repens</u> , <u>Lotus corniculatus</u> and others did not provide acceptable cover or hardiness to be considered for use.			
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Highlight Summary

The feasibility of direct seeding woody plant and herbaceous species for cover and erosion control and the effect of several mulch materials on establishment was evaluated. Cercis canadensis and Robinia pseudo-acacia provided some cover, and natural seeding of these native species occurred. Further work in the areas of seed dormancy and germination is indicated before this can be an economic method of providing perennial cover. Moderately eroded slopes can be reclaimed and erosion halted without extensive reworking by use of rapidly fermenting nurse crops, perennial herbaceous species and fine textured mulch materials. Wheat straw and shredded wood bark proved to be superior to shredded rubber tires for mulches on newly seeded areas. Twenty-six species of grasses and herbaceous legumes were evaluated for coverage and hardiness. Of those, Trifolium pratense (Red Clover) and Vicia villosa can be recommended for inclusion in roadside seeding mixtures. Several others warrant consideration for use in mixtures and further large scale experimentation.

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Evaluation of Several Methods of Establishing Plant Cover by Seeding on the Roadside

Introduction:

The most economical means of establishing plant cover on the roadside is by seeding. But many times good plant cover is not achieved. Erosion results and maintenance costs increase accordingly. Improvement in establishing plant cover can be accomplished by improving the plant selection and the mulch materials used to cover the seed. This report is of four experiments that were carried out to help provide information on how to achieve good plant cover on the roadside.

Experiment 1: Seeding of Roadside Slopes with Woody Plant Species

For many situations grass may be the most practical roadside cover, for it combines good erosion control with attractive appearance and ease of establishment and maintenance. However, on roadside banks where grass survival is inadequate and mowing is impossible, deep-rooted legumes and woody ornamental plants that can maintain protective cover with little or no maintenance are very desirable. Also, as more naturalized roadsides are becoming preferred and as the nation seeks to preserve rural scenery, minimize erosion, and minimize the burden of mowing, legumes and ornamental plants are becoming more desirable.

Regardless of the plants used, a rapid and complete cover is very important. This is very difficult on the sterile and impoverished roadside slopes. Also, a low establishment and maintenance cost is very desirable. Direct seeding of legumes and ornamental plants seems

to fit most of these requirements, but species and techniques need to be evaluated and rates of planting determined.

Whitaker (5) says that the most desirable season to mass propagate woody plant materials by direct seeding is in the fall. He further states that natural stratification takes place during the winter months, and the seed is ready for germination as the spring temperatures start to rise. Plant materials requiring only a few days of stratification or those requiring no treatment can be sown in spring. Whitaker concludes by saying that it is desirable to hydroseed turf grasses, legumes, and woody plant material within the same operation of seeding can be done before October 15.

Many states use direct-seeded legumes often for roadside slopes. In upstate New York, birdsfoot trefoil has been widely employed (1). Pennsylvania pioneered the use of crown vetch for road bank stabilization, and many old stands still serve admirably for this purpose (1). Many legumes are well-suited to roadside conditions because they are long-lived, drought resistant, and have attractive flowers. Legumes also have not been attacked by disease and insects along highway (1).

The objectives of this experiment was to evaluate woody plants useful for establishment along roadside slopes by direct seeding and to determine rates of seeding.

Materials & Methods

Field experiments to determine the feasibility of stabilizing roadside slopes by direct seeding of woody plants were set up near the junction of I-65 and Indiana 43 in May 1970. The slope is located

south of the intersection on Indiana 43, and had no existing cover. The slope had an eastern exposure and a pH range of 7.3 to 8.3. The area was rough graded on May 8, 1970.

Prior to seeding, seeds of woody plants were provided with the recommended conditions to insure germination, as per the Woody Plant Seed Manual which included scarification and stratification. Woody plant treatments were randomized and seeded with an impeller spreader on May 8 and 9, 1970. Plant species and rates are shown in Table 1. Each plot contained 300 square feet and was replicated 3 times.

The upper 1/3 of each plot was seeded with a tree species, and the upper 2/3 was seeded with a shrub species (Table 2).

On May 15, 1970, the entire plot was seeded with nurse crop combinations using spring oats (Avena sativa) with Travois alfalfa (Medicago sativa 'Travois') or Dawn trefoil (Lotus comiculatus 'Dawn') and spring oats with red clover (Trifolium pratense) and Travois alfalfa or Dawn trefoil. Rates appear in Table 1 and treatments appear in Table 2. The areas outside the direct seeding plots were seeded with spring oats and either Teton alfalfa (M. saliva 'Teton') or Travois alfalfa.

After seeding, one inch of wood bark mulch was applied with a straw blower to the direct seeded plots. The buffer areas were mulched with wheat straw at the rate of 2 tons per acre.

Observations and plant counts were made on August 13, 1970, June 15, 1971, September 21, 1971 and August 27, 1975.

Results & Discussion

A count of plants on August 13, 1970 indicated Myrica pensylvanica

Table 1. Species and rates of plants used on slopes near junction of I-65 and Indiana 43.

Species	Rate (lb/A)	Seeds/100 sq ft
<u>Taxodium distichum</u> (bald cypress)	55.2	667
<u>Robinia Fertilis</u> (Bristly locust)	5.7	300
<u>Robinia pseudoacacia</u> (Black locust)	18.2	1000
<u>Cercis canadensis</u> (Eastern redbud)	24.2	1000
<u>Rhus typhina</u> (Staghorn sumac)	2.2	267
<u>Rhus copallina</u> (Shining sumac)	7.8	1000
<u>Alnus glutinosa</u> (European alder)	1.4	1000
<u>Myrica pennsylvanica</u> (Bayberry)	2.4	300
<u>Nurse Crops</u>		
Spring Oats	80	
Travois Alfalfa	10	
Dawn Trefoil	6	
Red Clover	6	

Table 2. Direct seeding treatments applied to slope near I-65 and Indiana 43 junction.

<u>Treatment</u>	<u>Whole Plot</u>	<u>Top 2/3</u>	<u>Top 1/3</u>
1.	Spring oats Travois alfalfa	<u>R. Fertilis</u>	<u>T. Distichum</u>
2.	Spring oats Dawn trefoil	<u>M. pensylvanica</u>	<u>A. glutinosa</u>
3.	Spring oats Red clover Travois alfalfa	<u>R. typhina</u>	<u>R. pseudoacacia</u>
4.	Spring oats Dawn trefoil Red clover	<u>R. copallina</u>	<u>C. canadensis</u>

Rhus copallina, and Alnus glutinosa had failed to germinate. Taxodium distichum and Rhus typhina showed very poor germination. Further germination of these species were not apparent in later plant counts.

The germination of Robinia fertilis was approximately 60% on August 13, 1970. However, there appeared to be no further germination and the survival of germinated seedlings decreased significantly with each successive count. The final evaluation on August 27, 1975 showed approximately 2 plants per 100 square feet.

The germination of Robinia pseudoacacia was poor on August 13, 1970, but had increased to about 15% by June 15, 1971. Only about 50% of the germinated seedlings survived until September 21, 1971. There were a approximately 10 plants per 100 square feet in the seeded plots on August 27, 1975. However, R. pseudoacacia was growing in other plots and in the buffer area around the plots, indicating some natural seeding had occurred.

The germination of Cercis canadensis was about 17% at the time of the first count. Germination had increased to 24% on June 15, 1971. However, by September 27, 1975, the surviving plants only equated 10% of the seed sown. On August 27, 1975, there were 36 plants per 100 sq. ft. However, there were also C. canadensis in other plots and the buffer area, indicating some natural seeding.

Table 3 shows the number of seedlings of the more successful species on the slope.

The coverage of the Travois and Teton alfalfa nurse crops and straw mulch was good on September 1971. However, on August 1975, there was little cover remaining.

Table 3. Number of tree seedlings on roadside slopes following direct seeding in May 1970.

Plant	<u>Seedlings/100 sq ft</u>			
	Aug. 13, 1970	June 15, 1971	Sept. 21, 1971	Aug. 27, 1975
<u>Taxodium distichum</u>	2	3	1	0
<u>Robinia fertilis</u>	186	137	23	2
<u>Robinia pseudoacacia</u>	26	154	75	10 ^y
<u>Cercis canadensis</u>	175	236	107	36 ^y
<u>Rhus typhina</u>	0.67	0.67	0.33	0.83

^y Other plants of this native species were present in non-seeded plots and in buffers. This would indicate some natural seeding was occurring.

Conclusions

Results of this experiment indicate further study is needed before these species can be successfully direct seeded on roadside slopes. Studies in seed dormancy and germination have demonstrated that further consideration of dormancy could present solutions to these problems.

Hamilton and Carpenter (2,3,4) have studied various mechanisms of seed dormancy, particularly impermeable covering structures and the presence of inhibitors within the seed which prevent germinations. Successful germination depends on removal of physical barriers and a reduction in inhibitor level or an increase of the level of a germination promoter. Some seeds maintain both physical and physiological dormancy. Normally these requirements can be met over time by scarification of the seed covering structure and by chilling temperatures (stratification).

In their work with Cercis canadensis, Hamilton and Carpenter found that the testa or seed covering acts as a barrier to water in imbibition. Scarification of the testa allowed water uptake and immediate germination. In nature cold temperatures and time are required to complete this process. (3)

Elaeagnus umbellata (Autumn Olive) seed was found to contain germination inhibiting substances in the seed coat and embryo. Levels of the inhibitor did not decrease during cold stratification, but levels of growth promoting substances were found to have increased. This increase in promoter level and deterioration of the seed cover resulted in germination, this however, requires several months of chilling temperatures. Exogenous applications of the growth regulator, gibberellic

acid, was found to stimulate germination (2,4).

Hamilton and Carpenter found the dormancy regulating mechanisms of Elaeagnus angustifolia (Russian Olive) was related to a coumarin - like substance in all parts of the seed. This inhibitor is reversed by synthesis of a promoter during a low temperature after ripening period.

Appropriate seed treatment before direct seeding on roadside slopes will result in increased seed germination and increased coverage. Additional knowledge concerning dormancy mechanisms would allow for greater control of the time of seeding and the degree of success.

Experiment 2: Erosion Control by Rapid Plant Cover

Introduction

Often it is desirable to establish rapid plant cover in small gullies that have developed on slopes where initial seedings failed to establish quickly enough to prevent erosion. If the plant cover can be established without reworking the slope the savings achieved should be substantial.

In a joint effort with personnel from the Division of Roadside Development, Indiana State Highway Commission, a small slope that was eroding badly was overseeded with two different seeding mixtures in an effort to stop the erosion and provide permanent cover.

Materials & Methods

During the first week in April, 1973, a small slope approximately

50' - 75' in height was seeded with the following seed mixtures:

Mixture 1

Crown Vetch	10 lbs/A
Red Clover	5 lbs/A
Tall Fescue	13 lbs/A

Mixture 2

Travois Alfalfa	10 lbs/A
Ryegrass	13 lbs/A
Timothy	8 lbs/A

The entire area was seeded with spring oats at a rate of 26 lbs/A. No soil cover was provided but the area was mulched with the residue from a commercial mushroom operation. The depth of the mulch was approximately $\frac{1}{4}$ " to $\frac{1}{2}$ ".

The plot size varied but was approximately 75' x 100'. The depth of the gullies was approximately 18". The slope had a western exposure. Mixture 1 was used in one plot while mixture 2 was used in the second plot. The third plot was seeded only with spring oats. The experiment was not replicated.

Results and Discussion

Visual observations on the rapidity of cover were made several times during the three growing seasons after seeding. All seed washed from the tops of the gullies and collected in the bottom of the gullies. The rapid germination of the spring oats in the bottom of the gullies trapped much of the other seed and prevented it from being washed to the bottom of the slopes. The Travois alfalfa germinated rapidly in

the bottom of the gullies and a thin strip of vegetation was growing in the bottom of each gully from the top to the bottom. The crown vetch was much slower to germinate and establish in the gullies, but by mid-summer the plot seeded with the crown vetch also had cover in the bottom of the gullies. The width of the cover was about 10" in each of the plots. The timothy, red clover, ryegrass and tall fescue were not competitive with either the crown vetch or alfalfa.

By the second growing season the alfalfa and crown vetch had grown substantially up the sides of each gully. Approximately 50% cover over the slope was established. Erosion in the gullies was completely halted. There was substantially no difference between the plot seeded with crown vetch and with alfalfa.

A marked change occurred during the third growing season. The crown vetch covered nearly 90% of the slope with essentially no bare areas. The alfalfa plot was only about 75% covered and the alfalfa was beginning to decline. It was apparent that alfalfa alone would not make a permanent type of cover for eroding slopes.

Conclusion

It is possible to establish cover on moderately eroded slopes and to stop erosion without reworking the slope. A mulch should be used that is relatively fine in nature and a very rapid germinating nurse crop should be used. The nurse crop will hold the more permanent cover crop seed in place until the young seedlings are established. In this study crown vetch proved to be more permanent than alfalfa. Perhaps the two should be seeded together with the crown vetch becoming the

dominant species in time.

Experiment 3: A Comparison of Three Mulch Materials for Covering Newly Seeded Slopes

Introduction

The cover provided seeds often influences how well they germinate. The standard mulch material for roadside seedings is wheat straw used at the rate of $1\frac{1}{2}$ - 3 tons per acre. The straw is chopped to approximately 6" lengths as it is blown through a straw blower. Recently other mulch materials have been tried. In Illinois shredded hard wood barks have been used successfully as mulches for newly seeded areas. The experiment was designed to evaluate three possible mulch materials.

Materials & Methods

A poorly covered slope approximately 50' in height was selected for this experiment. The slope was south facing and the soil had a pH of 7.3. Prior to seeding a complete fertilizer with an analysis of 12-12-12 was applied to the entire area at the rate of 600 lbs/acre. After the fertilizer application was made the entire area was seeded with Travois alfalfa. Seeding was carried out on June 1, 1973. The seed was broadcast on the surface and covered with mulch.

After seeding the following mulch treatments were applied to plots 25' wide by 75' in length:

1. Check - no mulch
2. Wheat straw - $1\frac{1}{2}$ Tons/acre
3. Shredded hardwood bark - $\frac{1}{4}$ " depth
4. Shredded hardwood bark - $\frac{1}{2}$ " depth

Table 1. Weight of clippings harvested in June 1976.^y

Treatment	Mean kg
Check	2.41
Straw	2.17
Bark 1/4 in.	2.61
Bark 1/2 in.	2.46
Rubber 1/4 in.	1.48
Rubber 1/2 in.	1.64

^y Fresh weight of mowing 5 sq meter areas at a height of 7.6 cm.

East slope untreated 0.17 kg

West slope untreated 0.34 kg

5. Shredded rubber tires - $\frac{1}{4}$ " depth

6. Shredded rubber tires - $\frac{1}{2}$ " depth

The mulches were applied by hand. All treatments were replicated three times. The plots were mown by highway personnel during the second and third growing seasons.

The wheat straw was not shredded but was well separated at time of application. The shredded hardwood bark was obtained as a waste product from a paper mill. The shredded rubber tires were a by-product of an operation that manufactured rubber products from used tires. The particle size was approximately $\frac{1}{4}$ " - $\frac{3}{8}$ " in size. Fresh weights of plant cover was determined by mowing 5 sq meters to a height of 7.6 cm during June 1976.

Results & Discussion

After the first growing season, visual observation indicated no difference between the straw and the hardwood bark. All rubber tire treatments were poorer than all other treatments including the check. By 1976 (after three seasons) the straw and bark maintained their superiority. Initially growth in the check was inferior but growth in the check had caught up to the mulch treatments after 3 years. The rubber tires were still inferior (Table 1). Areas where no overseeding was carried out were sparsely covered.

Conclusion

Either straw or shredded hardwood bark will provide adequate cover for overseeding an area. The depth of bark does not matter. Shredded rubber tires are not satisfactory probably due to the heat build up on a south slope. The high temperature in the mulch probably killed many

of the germinating seedlings. At the present time, either the straw or the hardwood bark should be used for mulching newly seeded areas. Cost, availability and ease in application should determine which mulch is selected. These conclusions may not be applicable to seeding under adverse temperature and moisture conditions as they were not encountered in the experiment.

Experiment 4: Evaluation of Several Herbaceous Plants for Direct Seeding on Roadsides to Provide Rapid Cover

Introduction

The number of plant species used to provide cover on the roadsides in Indiana is rather limited. Often rapid cover is not achieved before severe erosion sets in. The purpose of this experiment was to evaluate several different species of grasses and legumes in relation to rapidity of cover and to some extent the winter hardiness of these species. Twenty-six species were studied.

Materials & Methods

The planting site for this preliminary study was located on the Maxwell Tract, a section of the Ornamental Horticulture Research Park, Purdue University. The soil was a sandy loam with a pH of 6.9. Prior to planting the plots were cultivated with a Howard Rotorator to a depth of 4 inches (10cm). The area was leveled after cultivation. Each plot for each species was 10' (3 m) x 6' (1.8 m) and was replicated 4 times.

Seeding was carried out on May 12, 1975. Table I gives the species and rates used in each plot. The experiment was replicated four times.

In replication 1, the seed was sown in one foot rows and was not

Table I. Plant species evaluated and seeding rates.

Latin Name	Common Name	lbs/A
<i>Panicum virgatum</i>	Switchgrass	8
<i>Poa pratensis</i>	Kentucky Bluegrass	2
<i>Lolium perenne</i>	Ryegrass	26
<i>Agropyron cristatum</i>	Crested Wheatgrass	12
<i>Agropyron smithii</i>	Western Wheatgrass	15
<i>Agrostis alba</i>	Redtop	10
<i>Bromis inermis</i>	Smooth Brome grass	20
<i>Dactylis glomerata</i>	Orchardgrass	15
<i>Festuca elatior</i>	Tall Fescue	26
<i>Festuca rubra</i>	Red Fescue	40
<i>Phalaris arundinacea</i>	Reed Canarygrass	10
<i>Poa trivialis</i>	Roughstalk Bluegrass	26
<i>Bouteloua curtipendula</i>	Sideoats Grama	26
<i>Bouteloua gracilis</i>	Blue Grama	42
<i>Coronilla varia</i> 'Penngift'	Penngift Crownvetch	20
<i>Coronilla varia</i> 'Emerald'	Emerald Crownvetch	20
<i>Trifolium pratense</i>	Red Clover	10
<i>Trifolium repens</i>	White Dutch Clover	2
<i>Trifolium repens</i> 'Ladino'	Ladino Clover	2
<i>Trifolium hybridum</i>	Alsike Clover	8
<i>Lotus corniculatus</i> 'Empire'	Birdsfoot Trefoil	5
<i>Medicago sativa</i> 'Travois'	Travois Alfalfa	20
<i>Medicago sativa</i> 'Teton'	Teton Alfalfa	20
<i>Vicia villosa</i>	Hairy Vetch	40
<i>Lespedeza stipulacea</i>	Korean Lespedeza	15
<i>Lespedeza cuneata</i>	Sericea Lespedeza	20

covered. In replications 2, 3, and 4, the seed was broadcast over the surface of the plot and was lightly raked to provide cover. All plots were covered with wheat straw used at the rate of 2 tons/acre.

The plots were observed frequently for germination rate, growth rate, and general cover of the plot. Crabgrass and weeds, however, began to give severe competition. Because of this, the plots were mowed to four inches, raked, and restaked the first week of August 1975.

On May 14, 1976, the plots were evaluated on general cover and a pre-emergence herbicide, Dacthal, was applied to control the crabgrass. The herbicide was used at the rate of 9 lbs/acre active ingredient.

Results and Discussion

The results of the 1976 evaluation are shown in Table II. On the basis of this information, the various species were given a performance rating. These ratings, along with a rating for overall 1975 coverage, are also shown in Table II.

The plots were treated as highway slopes, neither supplemental water nor fertilizer was supplied, and with only the one mowing in August 1975. The one exception was the application of the herbicide, but the magnitude of the crabgrass competition was many times what one normally finds on a highway slope in need of revegetation. In 1975 the weed competition became so great that it became difficult to evaluate the coverage of many of the plant species, especially some of the grasses.

On the basis of the two-year cover evaluation, a summary of the ratings is shown in Table III.

Table II. Coverage rating by year.^z

Species	1975 coverage	1976 Coverage
Switchgrass	4	4
Kentucky Bluegrass	4	4
Ryegrass	1	2
Crested Wheatgrass	4	4
Western Wheatgrass	4	4
Redtop	2	2
Smooth Bromegrass	2	2
Orchardgrass	2	2
Tall Fescue	1	2
Red Fescue	1	2
Reed Canarygrass	3	3
Roughstalk Bluegrass	1	3
Sideoats Grama	4	4
Blue Grama	4	4
Penngift Crownvetch	3	4
Emerald Crownvetch	3	4
Red Clover	1	1
White Dutch Clover	3	4
Ladino Clover	4	4
Alsike Clover	2	1
Birdsfoot Trefoil	3	4
Travois Alfalfa	1	3
Teton Alfalfa	1	4
Hairy Vetch	1	1
Korean Lespedeza	1	4
Sericea Lespedeza	2	4

^z 1 = very good to excellent

2 = good

3 = fair

4 = poor

Table III. Coverage acheived over two year period.

<u>Plants</u>	<u>Rating</u>
Hairy Vetch	Excellent
Red Clover	Excellent
Alsike Clover	Very Good
Tall Fescue	Very Good
Ryegrass	Very Good
Red Fescue	Very Good
Smooth Bromegrass	Good
Orchardgrass	Good
Redtop	Good
Travois Alfalfa	Good
Roughstalk Bluegrass	Good
Reed Canarygrass	Fair
Teton Alfalfa	Fair
Penngift Crownvetch	Poor
Emerald Crownvetch	Poor
White Dutch Clover	Poor
Birdsfoot Trefoil	Poor
Switchgrass	Very Poor
Kentucky Bluegrass	Very Poor
Crested Wheatgrass	Very Poor
Western Wheatgrass	Very Poor
Sideoats Grama	Very Poor
Blue Grama	Very Poor

Conclusion

The evaluation of various herbaceous plants reported here was not performed on the roadside and such research should be the next step. The conclusions therefore are directed at such implementation.

On the basis of their ability to form excellent coverage during both the 1975 and 1976 growing seasons, it is strongly recommended that both Hairy Vetch and Red Clover be planted on roadsides where rapid and substantial cover is required to prevent erosion. Alsike Clover, Tall Fescue, Ryegrass and Red Fescue gave very good two-year coverage, and appear to be important considerations for establishing good coverage. The species giving good coverage, i.e. Smooth Bromegrass, Orchardgrass, Redtop, Travois Alfalfa and Roughstalk Bluegrass, also merit use on highways. Teton Alfalfa, Korean Lespedeza and Sericea Lespedeza all gave very good results the first year, but very poor coverage the second year, indicating a usefulness when only one year coverage is required. The remaining species studied exhibited coverage inferior to that of the above mentioned species and so, on the basis of this study, it is suggested that their use be limited and preference be given to the better performance species.

It should also be pointed out that hairy vetch is normally an annual in this part of the country and permanent cover probably will not be achieved unless a mixture of perennials are not seeded at the same time.

Review of Literature

- 1.) Duell, R. W. Highway Vegetation: for Utility, Safety, Economy, and Beauty. Bulletin 822. New Jersey Agri. Exp. Sta., Rutgers University, New Brunswick.
- 2.) Hamilton, D. F. and P. L. Carpenter. 1975. Regulation of seed dormancy in Elaeagnus umbellata by endogenous growth substances. Canadian Journal of Botany 53(20):2303-2311.
- 3.) Hamilton, D. F. and P. L. Carpenter. 1975. Regulations of seed dormancy in Cercis canadensis L. J. Amer. Soc. Hort. Sci. 100(6):653-656.
- 4.) Hamilton, D. F. and P. L. Carpenter. 1976. Factors influencing low-temperature after-ripening in seed of Elaeagnus umbellata Thumb. J. Amer. Soc. Hort. Sci. 101(2):171-175.
- 5.) Whitaker, S. E. Establishment of woody plants on roadsides. Research Report 304. Division of Roadside Development. Department of Highways, Lexington, Kentucky.
- 6.) Woody Plant Seed Manual. 1948. Publication no. 654. U.S.D.A. Prepared by the Forest Service, U. S. Government Printing Office, Washington D.C.

APPENDIX

Pertinent Photographs

Figure A-1. Erosion occurring on a slope of I-65 at time of seeding the experiment. Initial seeding by the contractor had failed. Slope faces west. On east facing slope initial seeding was successful.

Figure A-2. Cover established in bottom of gullies 12 months after seeding. Plant is crown vetch. Seed was held in the bottom of the gullies by rapid germination of spring oats and mulch materials.

Figure A-3. Cover established on slope
24 months after seeding.
Erosion was stopped completely.

Figure A-4. 36 months after seeding, cover on the slope was nearly completed. No reworking of the slope was necessary.

Figure A-5. One year after seeding cover by hairy vetch. Hairy vetch is an annual that reseeds readily.

Figure A-6. Complete cover was established within a year using Teton alfalfa. This alfalfa was developed for use in the Dakotas is very hardy.

Figure A-7. Alsike clover provided rapid cover (within 1 year) but site conditions were ideal.

Figure A-8. Smooth brome grass covered fairly rapidly but was not as vigorous as the legumes shown in the previous photograph.

COVER DESIGN BY ALDO GIORGINI