ESTABLISHING ROADSIDE SLOPES BY DIRECT
SEEDING WITH LEGUMES AND WOODY
ORNAMENTALS AND BY SEEDLINGS OF
ORNAMENTAL PLANTS

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BY

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PURDUE UNIVERSITY AND
INDIANA STATE HIGHWAY COMMISSION

Interim Report

ESTABLISHING ROADSIDE SLOPES BY DIRECT SEEDING WITH
LEGUMES, AND WOODY ORNAMENTALS AND BY SEEDLINGS OF
ORNAMENTAL PLANTS

TO: J. F. McLaughlin, Director
Joint Highway Research Project

June 22, 1972

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Project: C-36-48C

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The attached Interim Report on Part II, "Selection, Establishment and Maintenance of Woody Ornamentals for Highway Plantings" of the HPR Research Study, "Research in Roadside Development and Maintenance" is presented for acceptance as partial fulfillment of the objectives of this Study. The Report is titled "Establishing Roadside Slopes by Direct Seeding with Legumes, and Woody Ornamentals and by Seedlings of Ornamental Plants" and has been authored by Messrs. D. F. Hamilton, R. E. McNiel and P. L. Carpenter.

The conclusions of this Report include recommendations for spacing of seedlings of desirable species for roadside plantings, species which were found less suited for roadside use and species not suited for roadside use under present knowledge and conditions. Recommendations as to direct seeding of several species are also included.

The Report will be forwarded for review, comment and acceptance of the ISHC and FHWA after acceptance by the JHRP Board.

Respectfully submitted,

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those of the Federal Highway Administration.

Purdue University
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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 need to be evaluated and rates of planting determined.

Whitaker (2) 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 if 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). Pennsylvannia 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).

In other situations where direct seeding does not cover rapidly enough, seedlings may be useful. Establishment by seedlings is probably more expensive and time-consuming but have the advantage of having begun growth.

The objectives of these experiments were:

- (1) To evaluate seedlings of ornamentals usable on roadside slopes.
- (2) To evaluate legumes useful for establishment along roadside slopes by direct seeding and to determine rates of seeding.
- (3) To evaluate woody plants useful for establishment along roadside slopes by direct seeding and to determine rates of seeding.

Experiment 1: Establishing Roadside Slopes
with Ornamentals Planted as Seedlings

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes with plants planted as seedlings was established in May 1968 along Interstate 74. The planting site was a slope with an eastern exposure and a three-year cover of grasses. The slope was cleared of natural vegetation by hand with no additional disturbance to the soil. Seedlings were then hand planted with a trowel or spade. The plants studied are listed in Table 1. Woody species were planted at 2-feet and at 4-feet spacings. Yucca sp. were planted at 12 inches, 15 inches, 18 inches, and 24 inches. Each species was planted in plots of 144 square feet and replicated 3 times at random positions on the slope.

No fertilization or watering program was maintained, although rainfall supplied ample moisture for seedling establishment. The average weekly rainfall for the period was: 1.98 inches in May, 0.82 inches in June, 0.88 inches in July, 1.38 inches in August, and 0.49 inches in September.

The planting site was mulched with bark to 4 inches immediately after planting seedlings. Dichlobenil (casoron) was incorporated in the bark mulch at 6.25 g/ft^3 . Mulch was spread manually.

Table 1. Plants Studied for Possible Roadside Use and Size at Planting

Plant	Seedling Size
<u>Yucca filamentosa</u>	1-year
<u>Yucca glauca</u>	1-year
<u>Yucca whipplei</u>	1-year
<u>Viburnum dentatum</u>	6-18 inches
<u>Ligustrum amurense</u> (Amur Privet)	24 inches
<u>Salix purpurea nana</u> (Blue Artic Willow)	24 inches
<u>Cercis canadensis</u> (Eastern Redbud)	6-18 inches
<u>Taxodium distichum</u> (Bald Cypress)	4-12 inches

RESULTS AND DISCUSSION

Initial plant counts, September 1968, showed no differences in survival between two- and four-foot spacings of Ligustrum amurense and Salix purpurea nana (Tables 2 and 3). Both plants gave almost complete establishment over the three-year testing period. Even though establishment of Salix was good, growth and adaptability on the roadside slope was poor. Height of Salix at both spacings in September was virutally the same as the height of the seedlings planted in May 1968 (24 inches) (Tables 1, 4, and 5). On the other hand, seedlings of Ligustrum gave rapid establishment and cover at both spacings. At a two-foot spacing 72% of the plants were 40-65 inches tall (Table 4), while at a four-foot spacing 94% were from 40-65 inches (Table 5). Also, a much larger percentage of the plants spaced at four feet were 65 inches tall than of those at two feet.

Viburnum dentatum showed 50% more survival at a four-foot spacing through the first summer (Table 3). After the first summer, only slight decreases in plants established were recorded at both spacings (Tables 2 and 3). Although more plants spaced at four feet survived initially, growth rates were very similar between the two spacings. No plants were found to exceed 40 inches in height at either spacing (Tables 4 and 5), indicating only marginal adaptability to highway conditions.

Initial plant counts, September 1968, showed Cercis canadensis surviving much better at a four-foot spacing, even though this was only fair (Table 3). Survival at a two-foot spacing was extremely poor (Table 2). Unlike most of the other plants, overwintering of Cercis was poor at both spacings the first year (Tables 2 and 3). After the first winter complete establishment was found. Even though initial survival and overwintering of Cercis was not promising, growth and performance of established plants along the highway was good. At a two-foot spacing all of the plants were 40 inches tall or higher (Table 4). At four feet plants were found from 24 to 65 inches tall, but a large percentage was concentrated at 65 inches (Table 5).

Taxodium distichum survived poorly at both spacings (Tables 2 and 3). However, of those established the first summer only slight losses were found in later counts. Taxodium would provide complete cover on the highway, although it would not be rapid. Growth rates were quite similar at both spacings with over 50% of the established plants about 40 inches in height.

Of the three Yucca species studied, Y. glauca appeared to be the most suitable for highway conditions, although it is only marginally suited. Initial survival of Y. glauca was best at an 18-inch spacing, but after the first winter only very small differences existed between 15-, 18-, and 24-inch spacings (Table 6). After these losses during the first winter percent establishment was almost constant. In the final count the only significant difference in spacing appeared

Table 2. Percentage of Woody Seedlings Surviving on Roadside Slopes
when Spaced at Two Feet and Planted in May 1968.

Plant	<u>Percent Survival</u>			
	<u>Date</u>			
	September 9, 1968	April 22, 1969	May 14, 1971	September 23, 1971
<u>Viburnum denatum</u>	40	38	36	36
<u>Ligustrum amurense</u>	86	84	83	83
<u>Salix purpurea nana</u>	99	99	99	99
<u>Cercis canadensis</u>	20	11	10	10
<u>Taxodium distichum</u>	29	23	22	21

Table 3. Percentage of Woody Seedlings Surviving on Roadside Slopes when Spaced at Four Feet and Planted in May 1968.

Plant	<u>Percent Survival</u>			
	<u>Date</u>			
	September 9, 1968	April 22, 1969	May 14, 1971	September 23, 1971
<u>Viburnum dentatum</u>	80	75	75	75
<u>Ligustrum amurense</u>	83	83	83	83
<u>Salix purpurea nana</u>	100	100	100	88
<u>Cercis canadensis</u>	64	42	42	42
<u>Taxodium distichum</u>	39	36	33	31

Table 4. Height of Woody Seedlings in September 1971 when Planted
on Roadside Slopes at Two-Foot Spacings in May 1968.

Plant	Percentage of Plants at Each Height (inches)		
	24	40	65
<u>Viburnum dentatum</u>	35	65	--
<u>Ligustrum amurense</u>	28	48	24
<u>Salix purpurea nana</u>	100	--	--
<u>Cercis canadensis</u>	--	79	23
<u>Taxodium distichum</u>	25	55	20

Table 5. Height of Woody Seedlings in September 1971 when Planted on Roadside Slopes at Four-Foot Spacings in May 1968.

Plant	Percentage of Plants at Each Height (inches)		
	24	40	65
<u>Viburnum dentatum</u>	33	67	--
<u>Ligustrum amurense</u>	6	32	62
<u>Salix purpurea nana</u>	80	20	--
<u>Cercis canadensis</u>	20	46	34
<u>Taxodium distichum</u>	19	62	19

between 12 inches and 15 inches (Table 6). It is difficult to attribute this entirely to reduced plant competition for moisture and nutrients, but spacings of 15 inches and above do show considerably better establishment. No trends in growth rates due to spacing were apparent. Over 80% of the plants at all spacings were 16-30 inches in height and 10-24 inches in width (Table 9), indicating good cover on the slopes.

Y. filamentosa showed over 50% survival the first summer at all spacings (Table 7), but the plant was apparently unable to adapt and grow under highway stress as percent survival decreased constantly throughout the three-year test. Percent survival in May 1971 was less than 45% at all spacings. Growth of Y. filamentosa was also much poorer than that of Y. glauca. A large percentage at all spacings of the plants were less than 10 inches tall and 10 inches wide (Table 10), indicating only slight highway suitability.

Y. whipplei survived very poorly the first summer, and after the first winter 0% establishment was recorded for all spacings (Table 8).

Table 6. Percentage of Yucca glauca Surviving and Establishing on Highway Slopes when Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.

<u>Percent Survival and Establishment</u>			
Spacing	September 9, 1968	April 22, 1969	May 14, 1971
12 inches	45.4	40.9	39.6
15 inches	61.1	54.1	51.6
18 inches	73.8	57.6	57.1
24 inches	53.3	53.3	53.3

Table 7. Percentage of Yucca filamentosa Surviving and Establishing on Highway Slopes when Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.

Spacing	<u>Percent Survival and Establishment</u>		
	September 9, 1968	April 22, 1969	May 14, 1971
12 inches	50.1	42.4	29.5
15 inches	52.7	44.4	44.4
18 inches	80.9	59.5	30.9
24 inches	60.0	60.0	36.6

Table 8. Percentage of Yucca whipplei Surviving and Establishing on Highway Slopes When Planted at 12-, 15-, 18-, and 24-inch Spacings in May 1968.

Spacing	<u>Percent Survival and Establishment</u>	
	September 9, 1968	April 22, 1969
12 inches	6.8	0
15 inches	9.7	0
18 inches	28.5	0
24 inches	33.3	0

Table 9. Height and width of Yucca glauca at 12-, 15-, 18-, and 24-inch Spacings along Roadside Slopes in May 1971*

Spacing (inches)	Percentage of Plant at Each Height and Width (inches)		
	H†(10-15) Wd(6-10)	H†(16-24) Wd(11-15)	H†(25-30) Wd(10-24)
12	12.2	38.7	48.9
15	20.0	53.3	26.6
18	12.0	60.0	28.0
24	6.2	13.2	62.5

* Planted May 1968

Table 10. Height and width of Yucca filamentosa at 12-, 15-, 18-, and 24-inch Spacings along Roadside Slopes in May 1971.*

Spacing (inches)	<u>Percentage of Plants at Each Height and Width (inches)</u>		
	Ht(10-15) Wd(6-10)	Ht(16-24) Wd(11-15)	Ht(25-30) Wd(10-24)
12	25.6	48.7	25.6
15	18.1	45.4	36.3
18	30.7	15.3	53.8
24	45.4	9.1	45.4

* Planted May 1968

Experiment 2: Additional Evaluation of Ornamental Plants for Use in Establishing Roadside Slopes When Planted As Seedlings

A field experiment to evaluate plant materials for possible use in stabilizing roadside slopes was established along the JCT of I-65 and Ind 43. The planting site was an east-facing slope with a pH ranging from 7.3 to 8.3. The slope site had been seeded with legumes in May 1970, and seedlings were planted by hand in this cover. Survival of two planting dates was compared, October 1970 and April 1971. Plants were planted at three-foot spacing in plots 300 square feet and replicated three times randomly on the slope.

No fertilization or watering program was maintained at either planting date.

The following plants were used: (Table 11)

Results and Discussion

Seedlings of Cornus, Sassafras, Taxodium, and Betula gave very poor survival both of the planting dates. An early-dry spring and the lack of nutrients probably hastened the death of these plants.

Nitrogen-fixing species appeared to withstand the high pH of the soil and give good survival. Of the nitrogen-fixing species planted both in fall and spring, Elaeagnus umbellata, Cercis, and Robinia gave good survival in both plantings, but survival from spring plantings was more than needed for complete cover. Other nitrogen-fixing species, Elaeagnus angustifolia, Alnus and Comptonia overwintered poorly when planted in fall, and gave marginal survival when planted in spring. Polygonum and Hemerocallis gave excellent survival and cover both planting dates.

Table 11. Plants Evaluated for Roadside Stabilization and Method of Planting.

Plant	Size at Planting
<u>Cornus stolonifera</u>	6-18 inches
<u>Sassafras albidum</u>	6-18 inches
<u>Elaeagnus umbellata</u>	6-18 inches
<u>Taxodium distichum</u>	6-18 inches
<u>Cercis canadensis</u>	6-18 inches
<u>Robinia pseudoacacia</u>	6-18 inches
<u>Elaeagnus angustifolia</u>	6-18 inches
<u>Alnus glutinosa</u>	6-18 inches
<u>Betula nigra</u>	6-18 inches
<u>Comptonia peregrina</u>	2-year container plants
<u>Hemerocallis sp.</u>	2-to 4-inch root cuttings
<u>Polygonum reynoutria</u>	2-year container plants

Table 12. Plant Survival and Establishment of Two Planting Dates on Highway Slopes

Plant	<u>Percentage Survival and Establishment</u> <u>in September 1971</u>	
	October 1970	April 1971
<u>Cornus stolonifera</u>	4	9
<u>Sassafras albidum</u>	0	9
<u>Taxidium distichum</u>	4	-*
<u>Elaeagnus umbellata</u>	32	93
<u>Elaeagnus angustifolia</u>	0	16
<u>Cercis canadensis</u>	25	87
<u>Alnus glutinosa</u>	16	21
<u>Comptonia peregrina</u>	6	36
<u>Robinia pseudoacacia</u>	59	-
<u>Betula nigra</u>	3	-
<u>Polygonum reynoutria</u>	64	70
<u>Hemerocallis sp.</u>	100	-

* (-) indicates none planted at that time

Experiment 3: Establishing Roadside Slopes by Direct Seeding of
Woody Ornamental Trees.

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes by direct seeding of trees was established at the JCT of Ind 43 and I-65 in May 1970. The slope site had an eastern exposure, with no natural cover and a pH from 7.3 to 8.3. Each plant used was seeded in a plot of 300 square feet and randomly replicated three times. Legumes were put into these plots at the same time (Experiment 5). Seeding was done with a cyclone spreader and bark mulch was applied manually to one inch.

The following seeds and rates of seeding were used: Taxodium distichum (bald cypress) at 0.14 lbs/100 sq ft (667 seeds), Robinia fertilis (moss locust) at 0.01 lbs/100 sq ft (300 seeds), Robinia pseudoacacia (black locust) at 0.04 lbs/100 sq ft (1000 seeds), Cercis canadensis (eastern redbud) at 0.06 lbs/100 sq ft (1000 seeds), and Rhus typhina (staghorn sumac) at 0.01 lbs/100 sq ft (267 seeds). Seeds had treatment according to the Woody Plant Seed Manual (3). No fertilization or watering program was maintained during this experiment.

Taxodium distichum and Rhus typhina gave very poor germination and need further study before direct seeding would be possible along highways.

Germination of Robinia fertilis was excellent. The marked loss of seedlings from June 15 to September 21, 1971, is not abnormal, although slightly larger than would be expected. Lack of available moisture to the young seedlings were probably the main cause of decrease. However 23 seedlings/100 sq ft would provide adequate tree cover.

Results and Discussion

Table 13. Number of Tree Seedlings on Roadside Slopes Following Direct Seeding in May 1970.

Plant	<u>Seedlings/100 sq ft</u>		
	August 13 1970	June 15, 1971	September 21, 1971
<u>Taxodium distichum</u>	2	3	1
<u>Robinia fertilis</u>	186	137	23
<u>Robinia pseudoacacia</u>	26	154	75
<u>Cercis canadensis</u>	175	236	107
<u>Rhus typhina</u>	0.67	0.67	0.33

Experiment 4: Establishing Roadside Slopes by Direct Seeding with Trefoil, Alfalfa, and Crownvetch.

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes by direct seeding was established along I-74 in May 1968. The planting site was a slope with a western exposure and a three-year cover of grasses. After being cleared of the natural vegetation, the area was overseeded with the various legumes. Each legume was seeded in a 400 square foot plot and replicated randomly three times on the slope. Half of each replication was covered by hand with corn-cob mulch to one inch and half the replication was left unmulched. Seed was spread by hand at the following rates, Dawn Birdsfoot trefoil at 10 lbs/acre, Viking trefoil at 10 lbs/acre, Travois alfalfa at 20 lbs/acre, and Penngift crownvetch at 20 lbs/acre. No fertilization or watering program was maintained during this experiment.

Results and Discussion

Travois alfalfa provided excellent cover when overseeded and covered with corn cob mulch; while cover without mulch was good but not as extensive as with the mulch, (Table 13).

A distinct difference was found between the two species of trefoil. Dawn gave about 50% cover when seeded and covered with mulch, while Viking gave virtually no cover when seeded and mulched (Table 13). Both gave extremely poor cover when seeded without mulch.

Penngift crownvetch gave fair cover when overseeded and mulched, but gave practically no cover when seeded without mulch (Table 13).

Table 14. The Percent Cover Obtained on Roadside Slopes by Direct Seeding with Trefoil, Alfalfa, and Crownvetch.

Plant	<u>Percent Cover*</u>	
	Corn cob Mulch	No. Mulch
Dawn Birdsfoot Trefoil	49.2	8.2
Viking Trefoil	4.5	0.3
Travois alfalfa	77.5	63.3
Penngift Crownvetch	36.6	1.2

* Percent cover was recorded October 1969, two growing seasons after seeding.

Experiment 5: Additional Studies on the Establishment of Roadside Slopes
by Direct Seeding with Legumes.

Materials and Methods

A field experiment to determine the feasibility of stabilizing roadside slopes by direct seeding was established at the JCT of Ind 43 and I-65 in May 1970. The slope site had an eastern exposure with no natural cover and a pH from 7.3 to 8.3. Each legume was seeded in a plot of 300 square feet and randomly replicated three times. Seed was spread with a cyclone spreader at the following rates and covered manually with a one-inch bark mulch: Travois alfalfa at 10 lbs/acre, red clover at 6 lbs/acre, and Dawn trefoil at 6 lbs/acre. Teton alfalfa at 20 lbs/acre and Travois alfalfa at 20 lbs/acre were seeded similarly but mulched with straw to one-inch by a strawblower. No fertilization or watering program was maintained during this experiment.

Results and Discussion

Travois and Teton alfalfa at 20 lbs/acre with straw mulch provided rapid and almost complete cover on the roadside slope. Alfalfa at 10 lbs/acre, red clover and trefoil did not give sufficient slope stabilization in this experiment.

Table 15. Number of Plants and Percent Cover on Roadside Slopes following Direct Seeding with Legumes and Mulching with Bark or Straw.

Treatment	Percent Cover	Number of Plants (1 sq ²)
	September 1971	
Travois alfalfa 10#/A (Bark Mulch)	5	4.0
Red Clover 6#/A (Bark Mulch)	1	1.6
Dawn Trefoil 6#/A (Bark Mulch)	1	2.0
Travois Alfalfa 20#/A (Straw Mulch)	90	10.0
Teton Alfalfa 20#/A (Straw Mulch)	85	9.0

Conclusions

Establishment by Seedlings

1. Spring planting of seedlings at spacings three feet or wider are recommended for roadside planting of the following species:

Ligustrum amurense

Cercis canadensis

Elaeagnus umbellata

Robinia pseudoacacia

Polygonum regnouria

Hemerocallis sp.

Yucca glauca

2. The following species were found to be less suited to roadside use but will give complete cover.

Viburnum dentatum

Taxodium distichum

Elaeagnus angustifolia

Yucca filamentosa

Alnus glutinosa

3. The following species are not suited for roadside use without further study.

Salix purpurea nana

Cornus stolonifera

Sassafras albidum

Comptonia peregrina

Betula nigra

Yucca whipplei

Establishment by Direct Seeding

1. Travois and Teton alfalfa at 20 lbs/acre, and Dawn birdsfoot trefoil at 10 lbs/acre will provide excellent cover on roadsides when planted in the spring and mulched.
2. Direct seeding of Robinia pseudoacacia and Cercis canadensis will give adequate roadside cover. Robinia fertilis does not survive as well but gives adequate cover. Taxodium distichum and Rhus typhina do not successfully establish when direct seeded.

Review of Literature

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