IMPROVING VEGETATION AND MOWING MANAGEMENT IN HIGHWAY CORRIDORS

by

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prepared in cooperation with the
United States Department of Transportation, the
Federal Highway Administration, the Virginia
Department of Highways and Transportation, and the
Virginia Highways and Transportation Research
Council

INTERIM REPORT

December 1978

ACKNOWLEDGEMENTS

This research was conducted by personnel of the Agronomy Department of Virginia Polytechnic Institute and State University as part of the highway research program in cooperation with the Virginia Department of Highways and the Federal Highway Administration. Personnel of the Virginia Highway Research Council and of the Department of Highways and Transportation have provided much appreciated advice as well as materials and supplies for the experiments reported herein.

Assistance by technical and secretarial staff and faculty consultants is gratefully acknowledged.

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ABSTRACT

Ky-31 Tall Fescue was found to be the best adapted cool season perennial grass for use in Virginia. Persistence of fine-leaved, short grasses was poor. Late winter-early spring seeding of perennial legumes was found to be the best season for seeding for renovating medians with degenerating grass sods. Crownvetch growing together with tall fescue was found to persist with different mowing regimes during two successive growing seasons. No enhancement of establishment of legumes was observed from micronutrients at several Coastal Plain sites nor by coating of bacterial inoculant onto legume seeds. Buckwheat was found to be an adequate substitute for millets as a summer annual companion species. Lehmann lovegrass is not adapted to Virginia. Successful seedings of velvet bentgrass as a companion perennial species were confined to the early favorable seeding season. American beachgrass shows some promise for stabilizing coarse textured, sloughing slopes if soil acidity is not limiting.

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I. SUMMARY OF RESEARCH

A. PERENNIAL LEGUMES

1. Introduction

Because soil materials in highway corridors initially have negligible quantities of nitrogen supplying organic matter and because nitrogen applied as fertilizer is very soluble and subject to loss by leaching, grassy areas often degenerate unless a persistent leguminous component is present or costly nitrogen refertilizations and reseedings are periodically applied.

The annual legumes that occur in grassy areas in many Virginia highway corridors do not provide a stable, vigorous plant cover. Numerous annual legumes (hop clover, partridge pea, annual lespedeza, hairy vetch) provide ground cover for a part of the year but die and leave bare ground that is subject to erosion or invasion by weeds. Red clover, a biennial leguminous plant, is frequently found in highway turf. The inevitable elimination of a given red clover plant by disease after about two years may lead to a weakening of the vegetative cover similar to that caused by annual legumes. A persistent cover is obtainable by growing perennial legumes.

Perennial legumes are desirable as components of turfs both in highway medians and on slopes. They shed root nodules and leaf litter; thus nitrogen is recycled and may be increased in highway soil materials. Because perennial legumes such as crownvetch, flatpea and perennial sweetpea persist through all seasons and from year to year, openings in the plant cover subject to erosion or weed invasion are minimal. Such legumes give effective plant cover and at the same time increase the vigor of associated perennial grasses by increasing the nitrogen status of the soil. In addition, many perennial legumes such as crownvetch and perennial sweetpea have conspicuous, attractive flowers.

2. Legume Species

Data from experiments previous to this project and from additional experimental legume seedings from the present project were obtained to evaluate the adaptation and cultural requirements of a number of species of perennial legumes in highway corridors of Virginia.

Sericea lespedeza has been used along Virginia's highways for about two decades. Observations during the current contract confirm

its adaptation to many acid soil and climatic environments of Virginia. At an extremely acid site in Patrick County seeded to sericea, crownvetch and flatpea in 1974, sericea gave the best vegetative cover where lime was applied and gave the only significant cover where lime was not applied. In 1978 at this site sericea was persisting on limed plots but with reduced vigor; numerous shoots with pale green foliage were observed.

Sericea is best adapted to the Piedmont region, less so west of the Blue Ridge and in the Coastal Plain region. However, at numerous sites in the state a weakening of old persisting stands of sericea on cut slopes was observed. Along Route 460 in the vicinity of Pearisburg, along I-81 south of the New River and in the vicinity of Christiansburg and along I-64 between Charlottesville and Richmond stands of sericea in spotted areas have thinned or died out completely. Evidence of gnawing at crowns was observed at a site south of the New River along I-81. At other sites winter killing and, possibly, natural senescence may have been the causal factors. The longevity of sericea is unknown but young stands appear more vigorous than old stands.

Along I-81 between exits for Christiansburg and Ironto crownvetch cover is making yearly advancement into areas where sericea lespedeza has died out. Despite evidence of weakening of stands of sericea with age, this species has stabilized freshly constructed highway slopes along many miles of highway a sufficient number of years to permit encroachment by a diverse and aesthetically pleasing population of woody species. This process is especially noticable along Route 58 and I-64 in the Piedmont region. Seedings of sericea in medians during the present project have been limited because evidence from mowed strips at the base of cut slopes having sericea covers suggests that this legume will not be well adapted where mowing is practiced

Persistent stands of crownvetch have become established in all three physiographic regions of Virginia. However, crownvetch is best adapted where soil acidity is not severe. Sampling of soils under stands of crownvetch in the Piedmont region have all shown pH values above 5.0.

Mildly acid or alkaline soil conditions occur naturally and frequently in the limestone valley area west of the Blue Ridge where vigorous stands of corwnvetch are common. However, the outward spreading from crownvetch"islands" into surrounding tall fescue stands has been observed to be relatively slow at some sites. Micronutrient and inoculant additions are being investigated as factors in a rate of spread experiment established on an alkaline soil in fall 1978.

Where acid soils are well limed, crownvetch has become estab lished at numerous sites in the Piedmont and Coastal Plain regions,

though with greater difficulty in the latter region. Highway personnel in all areas in central, northern and western regions of Virginia are using crownvetch in contract and renovation seedings. In the Lynchburg district crownvetch is being used to renovate stands of weeping lovegrass weakened by winterkill. Along Route 29 such seedings have resulted in vigorous, persistent stands of crownvetch which are spreading rapidly into the lovegrass which does not compete strongly during the cool spring and fall seasons when crownvetch grows best.

Nodules from roots of crownvetch were obtained in the Piedmont region at an acid soil site and in the Coastal Plain at a sandy, west facing, hot slope site. Strains of bacteria obtained thereby are being cultured and tested by a commercial producer of inoculant. Inoculant of bacteria well adapted to adverse soil conditions in these two regions may result in better success with seedings of crownvetch in these two regions in the future.

The best perennial leguminous stands in medians during the current project have been obtained by seedings of crownvetch. These successful seedings of crownvetch have all been confined to the Piedmont region. It appears that the warm season vegetation dominating the weak turf in medians has not been strongly competitive toward crownvetch seeded in these areas. This is attributed to crownvetch growing vigorously during spring and fall as compared to the warm season species, especially legumes. Crownvetch seedings made during the last two years in medians with varying degrees of vegetative cover have not been as successful west of the Blue Ridge and in the Coastal Plain as in the Piedmont region. However, crownvetch is growing vigorously in several medians in the limestone valley area west of the Blue Ridge where it was seeded when turf was initially established. This suggests that crownvetch will prove well adapted for medians west of the Blue Ridge when seeded in late winter-early spring of years having better rainfall than that of the last few years. The dry spring and fall seasons when crownvetch normally grows vigorously have caused seedling mortality.

Seedings of flatpea have been made relatively recently in Virginia as compared with sericea lespedeza and crownvetch. Seed of flatpea is much larger and germinates more slowly than that of crownvetch. On sloping areas methods of seedbed preparation which favor good soil seed contact (rough grading or stairstep construction) greatly aid its establishment. However, the numerous sites along highways throughout the state where flatpea has been seeded show excellent adaptation of this species to conditions in Virginia. Vigorous, persistent stands are growing at numerous sites in all three physiographic regions of the state. Flatpea has a deep tap root and rhizomes, giving better drought resistance than for crownvetch as well as vigorous spread vegetatively, especially in coarse textured soils of the Coastal Plain.

Flatpea seedings in medians have been successful in all three physiographic regions. In the Piedmont region its cover is not as vigorous as that of crownvetch one and a half years after seeding, but this legume has persisted at a Coastal Plain site where crownvetch failed.

Perennial sweetpea belongs to the same genus and in many respects resembles flatpea. It generally lacks rhizomes but has a very large and deep tap root; also it produces many attractive flowers over a long season. Seed, like those of flatpea, are quite large and, thus, seedbed requirements are similar. Where unmowed, tops of sweetpea die back in winter similarly to flatpea. At a variety trial in Blacksburg mowed in mid August, the most cold tolerant variety of sweetpea had 70% of its foliage remaining green in late December 1978 while flatpea had died back to less than 5% green cover. Perennial sweetpea is well adapted to climatic conditions in all regions of the state. Volunteer stands occur in all regions including several sites in Rockbridge County on mowed shoulders. Soil samples from volunteer stands have revealed moderately acid conditions and moderate to good fertility.

Seedings of perennial sweetpea from previous highway research projects have persisted throughout the state and in many cases have developed complete cover by spread from dehisced seed from a few sparsly spaced plants established from the initial seeding.

Successful establishment of perennial sweetpea has been obtained in highway medians west of the Blue Ridge and in the Piedmont region. Preliminary results from a late winter 1978 seeding at Newport News show perennial sweetpea to be less well adapted to that region than flatpea. With effective cultural practices it is possible to grow perennial sweetpea throughout the state both in medians and on slopes.

Birdsfoot trefoil and milkvetch have proved to be poorly adapted to conditions in Virginia. These legumes are perennials in regions where they are adapted.

3. Cultural Practices for Establishing Perennial Legumes

a. Soil Amendments

On freshly constructed slopes in Virginia highway corridors liming is a very necessary practice. Responses to lime were marked for seedings of crownvetch with the current project. Standard rates of fertilizer (1000 lbs./A of 10 - 20 - 10 or 667 lbs./A of 15 - 30 - 15) were used and proved effective where lime or other factors were not limiting.

For legume seeding made in medians with sparse to good vegetative cover, the medians had been initially limed and fertilized when seedings were made by contractors; hence, responses to lime and fertilizer were not pronounced for seedings in medians. At several acid sites lime was found to enhance establishment of legumes in medians. At one site a detrimental effect of overliming (3T/A) was observed. Responses to phosphorus and potassium have not as yet been detected.

Several experiments were conducted in the Coastal Plain region with micronutrients to find whether they enhance establishing and persistance of perennial legumes on coarse textured soil materials characteristic of that area. No response to molybdenum was observed for an experiment established near Suffolk. However, the low soil moisture caused poor growth of all seeded spcies, including the grasses.

At another site near Saluda in Gloucester County several rates of molybdenum, copper, zinc, iron, manganese and boron were applied in September 1977 when seeding a mixture of four legumes and several grasses. Establishment of both grasses and legumes has been poor with or without micronutrients.

It is notable that for an adjacent mulch experiment, seeded at the same date without micronutrients, crownvetch cover averaged 75% by fall 1978. The two experimental sites differed in two ways: the mulch site developed a dense stand of rye from seed in the straw in the fall of 1977 and spring of 1978. In addition, a liberal application of loose inoculant was applied by hydroseeder rather than as a seed coating as for the micronutrient site.

Thus, it appears that micronutrients will not aid the establishment of legumes in the Coastal Plain region.

b. Inoculation

Infection of roots by highly efficient strains of nitrogen fixing bacteria is essential for successful nodulation and growth for establishment and persistence of legumes. In numerous experiments bacterial inoculant was coated onto legume seeds with gum accacia and lime, as this technique has been reported to improve the nodulation of legumes (Holland and Sweet, 1963; Jones et al., 1978). However, under Virginia roadside conditions this technique did not give results superior to liberal applications of loose inoculant. In one instance (the micronutrient experiment at Saluda), where coated seed were applied by hydroseeder rather than by hand broadcasting, poor establishment of legumes may have been due to inefficient inoculation.

As noted earlier, bacterial nodules of crownvetch collected at sites in the Piedmont and Coastal Plain are being propagated by a

commercial producer of inoculant. Better adapted bacterial strains may aid establishment and spread of crownvetch.

c. Associate Species

i. Annual Associate Species

Several experiments were initiated with buckwheat, a summer annual companion species, to determine whether it might substitute for other summer annual companion species (German and Japanese millets) presently used. Other annuals are needed as the seed supply of German millet is scarce.

Results from these experiments indicate that buckwheat may be as suitable as the millets for establishing persistent vegetative covers of perennial plants on newly constructed highway slopes. Buckwheat permitted much better grass growth beneath its canopy than the two millets, rate of crownvetch establishment being similar. When the annual companion species died in fall, there was less mulch from buckwheat than for the litter from the millets. The mulching effect of millet is important both in improving water status as well as in moderating temperature. The effect of frost is moderated, thereby lengthening the period favorable for growth of cool season perennial grasses and legumes. Thus, buckwheat has proven superior to the millets during the warm part of the growing season, but the situation is reversed in the fall. A desirable seeding rate for buckwheat is from 40 to 50 lbs/A.

ii. Perennial Associate Species

Several perennial grasses were tested for establishing perennial legumes on highway slopes. Lehmann lovegrass was included to find if it would provide a more dense, spreading cover than weeping lovegrass which is used in summer seedings. In the year of seeding, Lehmann lovegrass proved much inferior to a mixture of German millet and tall fescue in providing a vegetative cover at one site. At all experimental sites Lehmann lovegrass was eliminated by winter kill by the spring the year after seeding. This species is not adapted and will not be recommended for Virginia.

Velvet bentgrass was tested because research demonstrated its superior acid tolerance, a desirable characteristic for many soils in Virginia highway corridors. At two sites in the Blue Ridge area velvet bentgrass provided adequate ground cover when seeded in early spring. Good sods were established which permitted vigorous crownvetch spread during the next year. However, seedings in the Piedmont and Coastal Plain regions during the summer resulted in very poor velvet bentgrass stands. This grass appears to be best adapted for cool season seedings; however, its susceptibility to disease needs to be observed over a long period of time.

At a site seeded in June 1977, weeping lovegrass provided more rapid and complete cover than Koket chewings fescue, Manhattan perennial ryegrass or Ky-31 tall fescue. Effects of grass companion species on establishment of flatpea were negligible during this very dry growing season.

The concentration of flatpea seedings at basal areas of slopes suggests that many seed had been washed downward from the upper portions of cut slopes. As at other experimental seeding sites of perennial sweetpea, the creation of favorable micro-sites by rough or stairstep grading appears to be of even greater importance than grass companion species for germination and establishment of legumes.

d. Seedbed Preparation

The abnormally low rainfall during the growing seasons of 1977 and 1978 accentuated the importance of seedbed preparation on freshly constructed slopes. At many sites legume seedlings were entirely confined to scarce, favorable microenvironments of haphazardly distributed rough places on predominantly smooth graded slopes. At several sites the dense seedling growth of perennial sweet and flatpea at the base of cut slopes shows that these relatively large legume seeds eroded off of smooth slopes. Rough and stairstep grading of slopes are very desirable practices for establishment of legumes as well as associate species.

Seedbed preparation is an important factor for establishing perennial legumes into highway medians with established vegetation. Broadcasting of seed into turf without reducing the competition from existing vegetation has given very poor results with crownvetch during periods of low rainfall. Responses from seedbed preparation with flatpea and perennial sweetpea are uncertain. After two years of growth, a median seeded with these species in August 1976 gave as good a stand with broadcasting of seed without seedbed treatment as when the sods were tilled or sprayed with paraquat. However, incorporation of perennial sweetpea seed into the soil for an experiment established in August 1977, improved seedling establishment during the fall as compared to surface seedings with either tilled or untilled soil. All of the late winter-early spring seedings with various seedbed treatments during 1978 failed to give covers by crownvetch, flat or perennial sweetpea by fall 1978 due to drought. The seedbed treatments were surface broadcast, disking and seed incorporation.

Results of seeding legumes in a median at the junction of Routes 29 and 903 in Pittsylvania County show the importance of differences in soil materials as they affect the ease of establishing a perennial legume in highway turf. Half of this experiment lies in a median area where the roadway passes through a cut; the balance is a fill area. Soil material in the road cut portion was very hard packed while the fill area had friable material.

Seeded legumes developed stands only in the fill portion of the median due to the more favorable physical properties of the soil materials. As germination of legume seeds starts, the emerging and elongating radicle (root) must penetrate into the soil to initiate a root system for uptake of water and nutrients for canopy growth. Legume radicles are relatively large, especially for flat and perennial sweetpea; mechanical impedance to their penetration of the soil causes seedling failures (Campbell and Swain, 1973). Mechanical constraint by hard packed soils, as for the cut portion of this median, was detrimental to legume establishment. Though other factors may have affected legume establishment, it is notable that some leguminous cover developed by fall for a site seeded in April, 1977 in Pittsylvania County having loose, micacous soil material. For a site in Charlotte County, having a hard packed surface, no legumes were detected by late fall for a March 1978 seeding. However, extremely dry, late summer-early fall weather in 1978 may have been the limiting growth factor. Fairly thorough tillage to provide a friable seedbed may be necessary for establishing perennial legumes in medians with hard packed soil materials.

e. Season of Seeding

Season of seeding has not been treated as a variable for legume seedings on freshly graded slopes. Rather, tests have been carried out with associate species appropriate for the different seeding seasons. Extention of the use of crownvetch into the winter season is being investigated with the use of unhulled crownvetch seed.

Data from the current project show that the seeding of legumes into medians in the late winter-early spring season is better than late summer-early fall seeding. Fall seedings have tended to be failures for crownvetch. This legume has very weak seedling vigor and is usually eliminated by competition from the aggressive existing vegetation in the fall. Also, fall developing seedlings will likely be winter killed, unless they reach heights of more than two inches (Woodruff and Blaser, 1969). Young seedlings of crownvetch were particularly attractive to grasshoppers during 1977 when that insect population was large.

Late winter-early spring seedings of crownvetch in 1977 were made in the Southern Piedmont region. At one of the three experimental sites a good crownvetch cover was obtained during the first year of seeding. This site was the earliest seeding (March 9) and the existing vegetation was retarded by vigorous disking. At the other two sites, the establishment of crownvetch was slow, but began to be prominent in spring 1978 at one site and in fall 1978 at the other site. At all three sites warm season species were the most prominent competitors. Thus, competition is not strong with the late winter seeding when crownvetch is better adapted to cool temperatures than warm season species. Where cool season species

form a large portion of the existing vegetation, medians to be renovated with crownvetch will require fairly drastic methods of seedbed preparation to reduce competition. Competition for moisture from any vegetation is more serious with late summer and fall than for spring seedings.

Date of seeding appears to be more flexible for perennial sweetpea and flatpea than for crownvetch; however, late winter-early spring seedings appear most desirable. The best covers by these two legumes in medians developed at a site in the Piedmont region seeded in early March. Poor stands and growth occurred at sites seeded in late summer or fall.

B. PERENNIAL GRASSES FOR MOWED AREAS

Disease resistance and tolerance to acid soils have been claimed for some new varieties and species of perennial grasses. Lesser mowing requirements for some of these as compared with tall fescue make them attractive for use in some highway environments. Experiments were established to evaluate their adaptation in Virginia highway corridors.

Data from both the area west of the Blue Ridge (Wythe County, I-77 experiment) and the Piedmont region (Prince Edward County, Rt. 360 experiment) suggest that the alternatives to Ky-31 tall fescue will probably not perform as well as the latter cultivar. The conditions at both sites were adverse (soil was very gravelly and hard packed at the Wythe County site and water was severely limiting at the Prince Edward County site); however, such extremes may be common in the environments of Virginia highways. Tall fescue eventually died at the Prince Edward County site due to the dry conditions which apparently favored the warm season grasses that became dominant. However, Ky-31 tall fescue provided the strongest cover showing that it is the best adapted of the species seeded.

At the Wythe County site vigorous stands of grass were attained in 1977 but were severely attacked by disease in 1978. Biljart hard fescue which performed fairly well at the Wythe County site did poorly at the Prince Edward County site. These findings support the conclusion that Ky-31 tall fescue remains the best adapted of cool season perennial grasses for use in Virginia highway environments.

It is worth noting that leguminous cover on nearly identical soil material to that at the Greenbay Grass Trial was initiated successfully at another site in Prince Edward County (a median of Rt. 460, west of Farmville) in an experiment established three

weeks before the perennial grass trial at Greenbay. At both sites the soil material is highly micaceous, of low fertility and resists compaction. (Massive and persistent slumping has occurred in the fill material immediately adjacent to the Greenbay grass trial site due to the resistance to compaction.) This loose, loamy material high in mica appears to be particularly inhospitable for perennial cool season grasses but has permitted the most successful establishment of legumes in a median of all such experiments of the present project. It seems likely that fertilizer nitrogen is rapidly leached from the loose soil material precipitating a swift decline of perennial grass species. Leguminous species, by contrast, are able to supply their nitrogen needs continously by means of nitrogen fixing root bacteria and benefit from the looseness of the soil which permits more intimate soil-seed contact for rapid germination and allows root systems to proliferate readily.

C. MOWING MANAGEMENT

1. Grass Turf

Observation of mowing demonstration sites were made in 1977 with personnel of the Virginia Highway and Transportation Department and Research Council. The demonstration mowing regime was an 8-inch stubble height, cut on June 15. This regime was very effective in removing seed heads of tall fescue, which flowers early only once in a year. However, greasegrass, which heads out in mid summer, was observed to be a significant component of highway median and shoulders especially west of the Blue Ridge. Seed heads of this species as well as growth of many weeds were conspicuous in some of the demonstration areas in late summer and fall. Dense grass canopies would undoubtedly have depressed many of the undesirable weeds.

An experiment was initiated in 1978 in Fairfield to examine if two close mowings at a 4-inch height, one in mid May and one at the beginning of September, would: 1) encourage tillering during the cooler parts of the growing season by opening the canopy to more light, 2) permit regrowth in advance of the hottest part of the growing season to shade weed seedlings and the soil, favoring cool soil temperatures advantageous for new tiller growth, and 3) remove greasegrass seed heads and top growth of any weeds in late summer. Tiller counts were made in permanently stationed quadrats on mowed plots of the mowing regimes previously mentioned as well as for numerous other comparison regimes. Some of these quadrat areas were accidently mowed by highway personnel at the beginning of June thereby confounding part of the experiment. Tiller counts will be made in unaffected quadrats in spring 1979 to determine if mowing regimes have differentially affected tillering density.

2. Grass-Legume Turf

a. Crownvetch

Experimental mowing of a crownvetch-tall fescue turf in 1977 and 1978 at Lexington has documented the ability of crownvetch to persist under fairly severe mowing. Date of first mowing is very important and frequency and height of mowing are additional factors which determine the vigor of crownvetch growth in association with tall fescue. A single mowing of crownvetch at an 8-inch stubble on June 15 appears to be the most economical management and would ensure that woody species would not become established in median areas. With this management crownvetch grows about as vigorously as unmowed crownvetch.

b. Perennial Sweetpea

Perennial sweetpea, growing in a median of I-81 near Salem and in a shoulder of I-81 near Steeles Tavern has been mowed by highway department personnel at least once each year for two or more years. Perennial sweetpea is persisting under this management. Mowing of perennial sweetpea appears to favor persistence of green foliage color during winter as compared to unmowed areas.

c. Flatpea

A dense cover of flatpea along the entrance ramp to the Rt. 360 bypass at Farmville is persisting under a standard highway mowing management which has included at least two mowings in a growing season.

II. NEW EXPERIMENTS

This section gives the objectives and preliminary results of new experiments established for this project. Diagrams are given in the appendix. The drought stress during the past two years when new experiments were established, often caused seeding failures or partial success. Because of changes in plant succession, the observations to be obtained in 1979 will make results more meaningful.

A. PERENNIAL GRASSES FOR MOWED AREA

1. Grass and legume experiment in a median, I-77, South of New River Bridge, established 15 October, 1976.

Experimental Methods

Objectives of this experiment were to evaluate several perennial legume and grass species and varieties for use in highway medians. The site was a freshly graded median composed of hard packed, mostly gravelly material. Two varieties of perennial ryegrass, Manhattan and Pennfine, and three fine leaved fescues, Koket Chewings fescue, Jamestown Chewings fescue and Biljart hard fescue, were seeded individually @ 30 lbs/A. The grasses were replicated in randomized blocks, four times for the fescue species and twice for the perennial ryegrasses. The grasses were broadcast seeded in strips on each side of a central strip. There were two randomized complete blocks for perennial legumes(flatpea, perennial sweetpea, milkvetch and birdsfoot trefoil were seeded), each at 10 and 20 lbs/A rates.

Results and Discussion

No growth by any of the species occurred in 1976, since severely cold weather began at about the date of establishing the experiment and persisted through the late fall and winter. By fall, 1977, dense grass stands were attained by all grass species. By October 27, 1978, the perennial ryegrass species had almost completely died and only Biljart, of the fine leaved fescues,maintained a substantial cover. (Table 1).

Only flatpea and birdsfoot trefoil at 20 lbs/A succeeded in establishing a significant legume cover. Flatpea, which spreads vigorously by rhizomes, promises to develop into a legume cover to improve the appearance of the vegetative cover of this median as growth appears vigorous and healthy.

Table 1
Grass and Legume Experiment in a Median
I-77, South of New River
Established 15 October 1976
Data, 27 October 1978

% Grass Cover

Chewings Fescue		Hard Fescue	Perennial Ryegrass	
Koket	Jamestown	Biljart	Manhattan	Pennfine
32	41	74	2.0	2.3

% Legume Cover

Flatpea		Sweetpea		Milkvetch		Trefoil	
@		@		@		@	
10 lbs/A	20 lbs/A	10 lbs/A	20 lbs/A	10 lbs/A	20 lbs/A	10 lbs/A	20 lbs/A
5.1	18	0.30	0.75	3.5	5.7	5.0	17

2. Grass experiment in a median, Rt. 360, Greenbay
Established 29 Mar., 1977.

Experimental Methods

This experiment was designed to test several varieties and species of grasses for highway medians in the Virginia Piedmont. The site of the experiment was a median having poor vegetative cover and a very micaceous, coarse textured soil material. Chemical characteristics of the soil material were: pH 4.8 to 5.2; calcium, low - low; magnesium, low to medium-; phosphorous, low to low +; potassium, low to low +.

After a thorough disking of the site, the following grasses were seeded @ 80 lbs/A: Koket chewings fescue, Biljart hard fescue; Banner chewings fescue, Jamestown chewings fescue, Yorktown perennial ryegrass, Manhattan perennial ryegrass, Ky-31 tall fescue and a 50-50 mix of Adelphi and Kenblue Kentucky bluegrass. Two nitrogen (N) rates, 50 and 100 lbs/A, were broadcast seeded within each N rate. Treatments were randomized in blocks. Over the entire site 2 T/A lime, 500 lbs/A of a 10-20-10 fertilizer and 1 lb/A annual ryegrass were applied by hydroseeder.

Results and Discussion

Establishment of grass at this site was poor on 27 October, 1977, (Table 2). The two perennial ryegrass varieties performed very poorly at both rates of nitrogen. Response to nitrogen by the fine leaved fescues (Koket, Biljart, Banner and Jamestown) was not marked, grass cover at both N rates being poor. Bluegrass and tall fescue showed strong responses to N rates; however, for species seeded only tall fescue at the high nitrogen rate gave a substantial vegetative cover. Encroachment by warm season annuals was severe with all treatments.

By late summer, 1978, there was virtually no cover from the seeded species. Warm season annual grasses and seeds predominated.

B. PERENNIAL LEGUMES IN MEDIANS

1. Legume experiment in a median, I-81, Salem, north of Exit 40,
Established 11 Aug., 1976.

Experimental Methods

This experiment was planned to evaluate several species of legumes and methods of seeding for improving vigor and appearance of the vegetation in highway medians. Several of the legume species tested have attractive flowers and all have the capacity to improve the nitrogen status of soil.

Table 2
Median Grass Seeding Experiment
Rt. 360, Greenbay
Established 29 March 1977

% Grass Cover, 27 March 1977

	N @ 50 lbs/A	N @ 100 lbs/A	Mean
Perennial Ryegrass			
Manhattan	6.7c	10d	8.5de
Yorktown	5.7c	4.0d	4.8e
Kentucky Bluegrass			
Adelphi + Kenblue	6.7c	30cd	18cd
Chewings Fescue			
Koket	30ab	33bc	31ab
Banner	35a	24c	30abc
Jamestown	23ab	38b	31ab
Hard Fescue			
Biljart	13bc	12bc	23bc
Tall Fescue			
Ky-31	16bc	60a	38a

The treatments were laid out in strips three feet wide and four feet apart paralleling the direction of the highway. All treatments were replicated three times in randomized blocks. Three treatments of seedbed preparation(rototilling, paraquating of grass, and a check(no treatment) formed the main plots within blocks. Within each main plot, six species of legumes were broadcast seeded as randomized subplots: birdsfoot trefoil @ 20 lbs/A, milk vetch @ 15 lbs/A, crownvetch @ 15 lbs/A, perennial sweetpea @ 25 lbs./A, flatpea @ 25 lbs/A, and sericea lespedeza @ 35 lbs/A. Phosphorus @ 200 lbs/A was applied over the entire area.

Results and Discussion

This site was subjected to the same maintenance regime as surrounding median areas, including herbicide applications and mowing. Successful establishment was most conspicuous in the case of perennial sweetpea which produced prominent, attractive flowers in 1977 and 1978. Stand counts on November 11, 1978, are given in Table 3. Milkvetch, birdsfoot trefoil and sericea failed to establish stands; crownvetch stands were little better. The two pea species have become significant components of the median turf with little or no advantage gained from the special seed bed preparation methods.

Table 3. Legume experiment in a median, I-81, Salem, Established Aug. 17, 1976, Data November 11, 1978

Seedbed Preparation	Crownvetch		Flatpea		Perennial Sweetpea	
	plants/plot	G. I.*	plants/plot	G.I.	plants/plot	G. I.
Check	0	0	10	159	20	294
Rototilled	0	0	7.3	127	17	230
Sprayed with Paraquat	0.3	4	10	156	32	492

* G. I. = plant/plot x average height

2. Legume experiment in a median, Rt. 460, West of Farmville, Established 9 Mar., 1977.

Experimental Methods

The principle objective of this experiment was to evaluate flatpea, perennial sweetpea and crownvetch for renovating poorly vegetated medians. The site of the experiment was an area of very highly micaceous, substratum material of silt loam texture having a weak stand of weeping lovegrass. Chemical characteristics of the site were somewhat variable, pH having a range from 5.1 to 6.0, calcium from low

- to medium, potassium from low to medium.

Four passes over the site with a light disk sufficed to loosen the light textured soil material and weaken competition from existing lovegrass. Each of three legume species was hand seeded @ 20 lbs/A on separate plots which were replicated three times in randomized blocks. Over the entire site nitrogen was applied @ 50 lbs/A, phosphorus (P_2O_5) @ 200 lbs/A, potassium (K_2O) @ 50 lbs/A, lime @ 1 T/A, and fine leaved fescue @ 30 lbs/A.

Results and Discussion

By fall 1977 crownvetch had become well established at this site, two plots having 70% cover by crown vetch and the other 30% (average 57% cover) (Table 4). Cover for the two pea species was much less than crownvetch. The large pea seeds are much slower to germinate than those of crownvetch and may have been more severely affected by the dry conditions which began to prevail in April, 1977.

Table 4. Legume experiment in a median, Rt. 460, West of Farmville Established 9 Mar., 1977.

	% Cover by Legumes		
	Crownvetch	Sweetpea	Flatpea
11 October 1977	57	15	20
28 October 1978	73	40	60

Soil samples were taken from plots having 70% and 30% covers of crownvetch in 1978 in order to investigate the factors that may have affected growth differentially. Since the 1977 growing season was very dry, differences in soil texture might have affected water availability so the soil texture was analyzed. Results showed virtually no difference in texture (Table 5). Chemical analysis of the samples revealed that phosphorous was the most probable factor causing the variable plant growth.

Fine leaved fescue showed negligible growth in 1977. By fall, 1978, stands of crownvetch and flatpea were very good at this site. Crownvetch had increased from 30% to 50% on the plot having lesser growth in 1977. Perennial sweetpea had many vigorous plants established; however, the vegetative cover was not as good as for the flatpea and crownvetch.

Table 5. Soil Characteristics of crownvetch plots with poor and good vegetative cover.

	70% Crownvetch Plot	30% Crownvetch Plot
Sand	57.0	58.9
Silt	32.7	32.0
Clay	10.3	9.1
Textural Class	Sandy Loam	Sandy Loam
pH	7.0	6.4
Calcium	1142 lbs/A	839 lbs/A
Magnesium	398 lbs/A	393 lbs/A
Phosphorus	250 lbs/A	121 lbs/A
Potassium	146 lbs/A	127 lbs/A

3. Legume, lime experiment in a median, Rt. 29 South of Gretna, Established 31 Mar., 1977.

Experimental Methods

This experiment was laid out on a median area of Rt. 29, Pittsylvania County, in a section on a long hill north of intersection Rt. 903. The southern, uphill half of the site lies in a road cut area, the northern, downhill area in a fill area. Chemical characteristics of the site were: pH, 5.3; calcium, low; magnesium, low +; phosphorus, low +; potassium, medium. Many weeds and warm season annual grasses dominated the vegetation at this site.

The experiment was designed to study the establishment of crownvetch, perennial sweetpea, flatpea, and milkvetch to improve the vegetative cover in median areas. Three lime rates (0, 1.5, and 3.0 T/A) were used to evaluate the effect of lime on legume establishment. A 10-20-10 fertilizer @ 300 lbs/A and creeping red fescue @ 30 lbs/A were applied over the whole experiment.

The design of the experiment was a split plot, randomized complete block with lime rates as main plots and all treatments were replicated four times.

Results and Discussion

This site was treated with herbicides by highway personnel not long after seeding. Because of the dryness of the spring, it is likely that legume seedlings were not affected by the herbicide. The dry weather prevailing in the 1977 season led to a failure in legume establishment as only a few scattered crownvetch plants appeared in the fall of 1977 and the spring of 1978. However, by fall 1978 plants of three of the seeded legume species were beginning to form a vegetative cover on the two downhill replicates. Data from these two replicated are listed in Table 6. No milkvetch plants were found. Crownvetch had the best cover, followed by flatpea, both species spread strongly by rhizomes. Perennial sweetpea stands are given as plants per plot (900 ft^2). Although sweetpea stands were not large, many of the plants were quite vigorous. On several plots sweetpea was flowering and had set seed.

Legume growth tended to be better where lime was applied at 1.5 T/A than at the 0 or 3.0 T/A rate. Apparently, over-liming may adversely affect leguminous growth, perhaps by reducing phosphorus or micronutrient availability.

The complete failure of the seeded legumes on two replicates lying in the road cut area requires an explanation. In this area, the soil material was very compact and more droughty than the down slope replicates. Possible differences in chemical characteristics are being investigated.

Table 6. Legume stands on two replicates on September 14, 1978, of seedings in a median of Rt. 29, Gretna. Established Mar. 31, 1977.

Lime Rate	Perennial Sweetpea		Flatpea		Crownvetch	
	plants/plot*	G.I.+	% cover	G.I.+	% cover	G.I.+
0 T/A	52	767	11	139	1.1	11
1.5 T/A	67	1327	14	184	14	225
3.0 T/A	40	600	7.4	36	1.3	12
Mean	53	898	11	120	5.5	83

*Plots = 900 ft^2

+ G.I. = growth index, average plant height x plants/plot or % cover

4. Legume, lime, and phosphorus experiment in a median, Rt. 29, near Hurt. Established 1 Apr., 1977.

The experimental site was a wide, graded median just south of the southern Hurt exit on Rt. 29 in Pittsylvania County. The median area slopes from the inner margins of a divided highway toward a mid-ditch and is inclined shallowly toward the north. Soil material was fairly coarse textured, micaceous substratum material with an enactic partial vegetative cover composed of diverse volunteer species, mainly annuals and biennials.

The objectives of the experiment were to compare the effectiveness of crownvetch and flatpea as ground covers in poorly vegetated median areas and to assess the effects of phosphorus, lime and their interaction on rate of establishment and vigor of the two leguminous species.

Three lime treatments, 0, 1.5 and 3.0 tons/A, were combined factorially with three phosphorus rates of 0, 100 and 200 lbs/A. These nine treatments were combined again factorially with the two legume species, giving 18 treatments. Lime rates were the main plots within a block, phosphorus rates were subplots, and the two legume species, sub-subplots. The treatments were replicated in four, randomized blocks. The lime, phosphorus and seed treatments were applied by hand. Additional fertilizer (50 lbs/A N and 100 lbs/A K_2O) and grass seed common to all plots were applied by cyclone seeder. After applying these treatments, the site was disked lightly with one pass over the area.

Results and Discussion

The site was routinely sprayed with herbicide by highway personnel shortly after establishment. Some seedlings may have been killed at this time; however, the prolonged dry weather affecting much of Virginia in 1977 commenced in early April and it is likely few seed had germinated by the time herbicide was applied. The kill of weeds was minimal; thus, competition for water due to their presence remained a factor. Scattered emergence of legume seedlings and establishment became observable in fall 1977 after more favorable soil water conditions began to prevail. Ground cover by crownvetch and flatpea by June 1978 are presented in Table 7.

Significant responses to lime and phosphate are not exhibited by the data. However, cover by crownvetch proved significantly better than that by flatpea. The slow but fair establishment of the two legumes during the very adverse moisture conditions for this experiment indicate that the vegetative cover might have been rapid and complete under favorable moisture. The two species spread very vigorously by vegetative means and, despite at least two mowings during 1977, these legumes show promise of giving decided improvements to the vegetative cover in this median.

Table 7
Hurt Median Legume Experiment
Rt. 29, South Hurt Exit
Established 1 April 1977
Data, 9 June 1978

Lime Rate (Tons/A)																		
0						1.5						3.0						
P_2O_5, lbs/A						P_2O_5, lbs/A						P_2O_5, lbs/A						
0		100		200		0		100		200		0		100		200		
Ground Cover %						Ground Cover %						Ground Cover %						
P*	V**	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	
16	40	24	53	15	26	17	27	13	27	24	20	24	27	19	36	10	35	

*F - Flatpea

**V - Crownvetch

5. Seedings of legumes in medians in fall, 1977, at Salem and Chesapeake and in Pittsylvania and Botetout counties.

Four experiments were established in fall, 1977 to assess methods of establishing crownvetch in medians. Experiments were established at Salem and Chesapeake and in Pittsylvania and Botetout counties. Treatment plots received either inoculant coated seed or seed with inoculant applied loose. Seed were broadcast @ 10 lbs/A by hand on untilled plots and on plots disked with a light disk two times. Further treatments employed a "zip seeder" which has five coulters mounted rigidly on a very heavy frame to cut through existing sod allowing incorporation of seed in the soil. Zip seeded plots were sprayed or not sprayed with paraquat by means of a sprayer mounted on the zip seeder in a strip approximately four inches wide along the row in which seed had been incorporated. The experiments at Salem, Botetourt, and Pittsylvania Counties had nitrogen, phosphorus and potassium levels as subtreatments randomized within the treatment plots described above. At the Chesapeake site, lime levels (0 or 2 T/A) were treatments randomized within seeding method plots. All experiments were replicated four times in blocks.

Results and Discussion

At all four sites, establishment of crownvetch was minimal in fall 1977. No seedlings became established on plots where seed was broadcast without disking or incorporation by means of zip seeder. Seedling establishment on disked plots was also negligible. Zip seeded plots, especially those having plant competition reduced by parquat spraying in the row seeded, had the best establishment of crownvetch. However, establishment was very erratic, with rows of seedlings encountered at intervals of several inches for a stretch of several feet followed by complete lack of crownvetch seedlings. This erraticness was attributed to the difficulty in maintaining a consistent, optimal depth of seeding; at times seed was left on the surface, at times, too deeply incorporated. No significant response to seed coating was noted. A response to lime was noticeable at the Chesapeake site, but no pattern of response to fertility treatments was discernable at the other three sites.

Insect depredation was also severe on emerging crownvetch seedlings. Numerous instances were observed of very young seedlings which had some or all of the cotyledons or first true leaves eaten. Seedlings completely defoliated at such an early stage of growth undoubtedly died.

By spring 1978 crownvetch seedlings were virtually eliminated from all sites, except Chesapeake. At the Salem and Botetourt County sites spring application of herbicides by highway department personnel was an additional detrimental factor. However, establishment was no better at the Pittsylvania County site. Though no vigorous crownvetch seedlings were observable at the Chesapeake site, some seedlings had survived the winter or became established. Later during the 1978 growing season, half of the plots at this site were mowed by highway

department personnel and half were left unmowed. Crownvetch was completely eliminated from mowed plots. On October 28, 1978, the number of crownvetch plants on unmowed plots (275 ft^2) ranged from 0 to 44. A very marked response to lime was observable despite the very small number of plants. A pattern of response to the other treatment variables was not distinguishable.

C. MOWING OF A MIXED STAND OF CROWNVETCH AND TALL FESCUE IN A MEDIAN

1. Lexington Grass-Legume Mowing Experiment

Persistent leguminous covers show promise as a means of lowering maintenance costs and enhancing vigor and beauty of median vegetation in Virginia highway corridors. However, in the environment of Virginia, leguminous plants can only retard and not eliminate the encroachment of volunteer woody species if areas are left unmowed (Sharp, 1978; Blaser and McKee, 1967). Thus, as with grass turf, infrequent mowing would be necessary in medians with leguminous vegetation when woody species need be excluded. Work by Woodruff (1971) indicates that under mowing regimes commonly used in Virginia highway districts, pure stands of crownvetch would not be eliminated by mowing. However, in Virginia highway medians crownvetch would generally be growing in association with grass. Forage experiments where mixed crownvetch-grass stands have been mowed, have given contradictory responses on the persistence of crownvetch in mixed stands (Mays and Evans, 1972; Dobson et al., 1976).

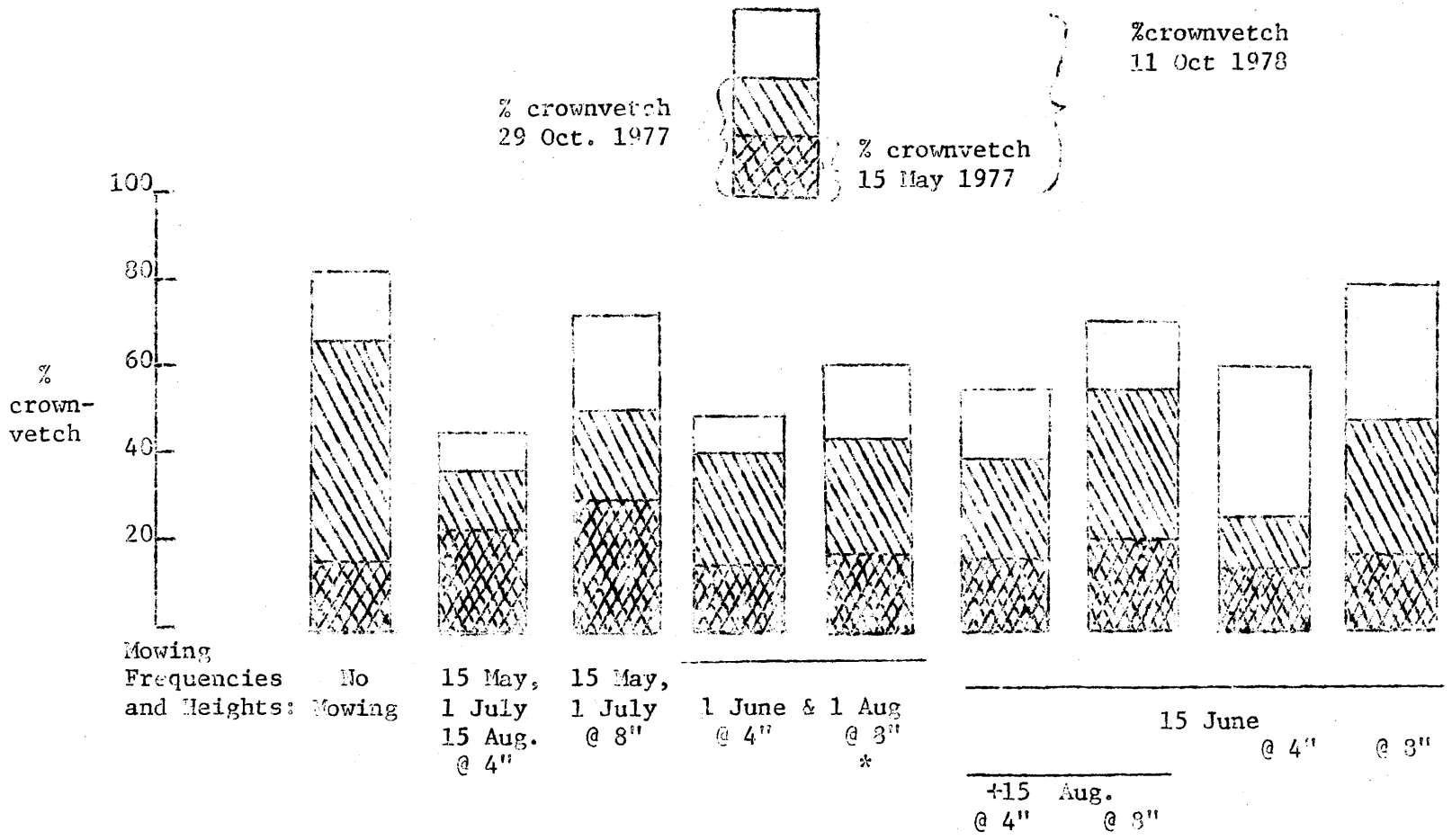
Experimental Methods

In spring, 1977, an experiment was begun to determine the impact of mowing on a mixed crownvetch-Ky 31 fescue canopy in a median of I-64 just west of Rt. 11 near Lexington. In May, 1977, the experimental site had an initial crownvetch cover ranging from 4.5 to 50%. Tall fescue made up most of the other vegetative cover; weeping lovegrass contributed to the grass cover on a few plots and several plots had bare, eroded areas toward the mid ditch. Mowing regimes were various dates for first mowing, number of mowings in a year, and heights of mowing as listed in Figure 1. The plot sizes were 25 feet by 60 feet; the large size was used to reduce border effects due to the strongly rhizomatous growth habit of crownvetch and to facilitate evaluation of the aesthetic values of mowing managements. In 1977, each treatment was replicated in six randomized complete blocks. In 1978, the treatments were as in 1977, except that, for one mowing regime, the June 15 mowing was shifted to June 1. Plots were mowed with rotary lawn mowers in 1977 and at the earliest mowing date in 1978 (May 15). By June 1, 1978, some of the growths of crownvetch were too profuse for mowing with a hand propelled lawn mower. Therefore, June 1 and June 15 mowings were accomplished with a tractor and bush hog. Lawn mowers were used again for the later mowing dates. Visual estimates of percent crownvetch were made on May 15 and Oct. 29, 1977 and Oct. 11, 1978.

Results and Discussion

Figure 1 presents the mean crownvetch cover for the various mowing treatments before mowing began and in fall 1977 and 1978. Note that even the most severe mowing regime, three times in a season at four inches, permitted crownvetch to spread very significantly.

Figure 1 Mowing experiment on mixed grass crownvetch stand, I-64, Lexington



*These plots were moved in 1977 on 15 June rather than 1 June.

After two years of mowing, the mean cover of crownvetch for this mowing treatment had approximately doubled. Spread of crownvetch for a mowing regime of a single, 8 inch high cut on June 15 had developed a crownvetch cover similar to the control, no mowing treatment, more than a four-fold increase occurring over the two year period.

In 1977, the rate of spread of crownvetch tended to be greater where plots were mowed at eight inches than at four inches. This trend did not occur in 1978, except for the plots first mowed on June 1. The moisture during the spring of 1978 was better than that of 1977, causing much more growth of crownvetch. Mowing of crownvetch to the specified heights became increasingly more difficult as date of first mowing was delayed (June 1 and 15). Where crownvetch growth was very luxuriant, the bush hog mower tended to push down the canopy rather than cut it cleanly at a given height. The lack of precision in height of cut for June 1 and 15 (first mowing dates) likely obscured effects of the height of mowing for these mowing regimes.

For both 1977 and 1978 the second, August 15, mowing of plots first mowed on June 15 reduced the rate of spread of crownvetch as compared with plots mowed only once.

Plots with an 8 inch mowing regime on May 15 and July 1 had the largest initial mean percent crownvetch cover of any of the treatments. Spread of crownvetch on these plots was moderate but consistent during 1977 and 1978. This mowing regime appears to be compatible with vigorous growth of crownvetch in a mixed grass-legume stand and provides a pleasing, groomed appearance during the growing season.

The high nitrogen residues of clipped crownvetch provide a continuous fertilizer supplement to soil. This is very desirable as soils in highway environments are generally so low in nitrogen that grasses degenerate, making it necessary to use periodic nitrogen refertilization and reseeding of degenerated median vegetation.

A factor which may have affected competition between crownvetch and grass was the presence of numerous grasshoppers in 1977 and 1978. Virginia has experienced a gradual build up of grasshopper populations over the last three years due to the trend of dry weather which favors proliferation of grasshoppers (Parker and Connin, 1964). At the experimental site in 1978, grasshoppers were observed to feed on tall fescue throughout the warm part of the growing season. However, crownvetch was not severely attacked until about the time of seed set, after which there was severe infestation. It appears that grasshoppers may have conferred on crownvetch a competitive advantage by selectively depressing growth of tall fescue.

D. COATING OF BACTERIAL INOCULANT ON LEGUME SEED

1. Seed coating experiments at Cloyd's Mountain Rt. 100, Pulaski County. Established 14 Apr., 1977.

Experimental Methods

Two experiments were laid out on south facing cut slopes along Rt. 100 just west of Back Creek in Pulaski County. The soil material at the more westerly cut was partially decomposed, calcareous, red shale having the following chemical characteristics: pH, 7 (H_2O), 6.3 (0.01 M $CaCl_2$), calcium, very high; magnesium, very high; phosphorus, very high and potassium, high -. The more easterly site was several hundred yards from the first on a cut through very loose substratum material, probably derived from shaly limestone and had the following chemical characteristics: pH, 5.2 (H_2O), 4.1 (0.01 M $CaCl_2$); calcium, low; magnesium, high +; phosphorus, medium; potassium, medium +. On both sites previously seeded by a contractor, the vegetation was variable to poor or had degenerated to a 50 to 75% soil cover.

Experiments at both sites were planned to assess the value of coating flatpea seed with bacterial inoculant as a means of enhancing vigor and establishment of legume seedlings when reseeding or renovating cut slopes that have a poor vegetative cover. On the easterly, acid site, lime and no lime treatments were combined factorially with inoculation treatments. We "coated" or "pelletted" seed using a method described by California workers (Holland and Street, 1963). The bacterial inoculant was mixed with a paste prepared from gum accacia. The mix was added to seed which were then agitated until well covered. Addition of lime with further shaking served to separate the seeds from each other. The technique assumes that inoculant in intimate contact with the seed in the presence of the lime on the seed aids in creating a limed soil microenvironment which favors the proliferation of the bacterial symbiont for vigorous nodulation to stimulate growth of legume seedlings. Coated and uncoated seed were applied by hand to plots. Remaining treatments of inoculation, lime, fertilizer and seed were applied with a hydroseeder; coated seed plots received inoculant both from coating and by hydroseeder slurry. At both sites treatments were replicated three times in blocks.

Results and Discussion

On the westerly, calcareous site seedlings of flatpea have failed to become established. The extreme dryness of the 1977 growing season was compounded at this site by the inherently droughty nature of the partially consolidated soil material.

Some ungerminated seed remained on the surface of the acid site through most of the 1977 growing season. During late summer, with the break in the drought, some seedlings began to emerge. Data collected on 7 October, 1977, are listed in Table 8, and are given as

total number of seedlings per plot for the treatments since seedling densities were low. Establishment of annual rye and tall fescue was negligible. As might be expected with such low numbers of seedlings, the pattern of response to treatments was erractic; however, lime-treated plots showed better seedling establishment without coating and unlimed plots showed no difference. Estimates of percent grass cover were made to determine if an interaction with grass cover might have affected seedling stands. Paterns of interrelationships were not discernible.

By October 1978 at the more acid site, several treatments had attained percent cover by flatpea of as high as 25%, but most plots had much less than this with no pattern of response to treatments exhibited (Table 8). Seedling establishment at the calcareous site was negligible.

Table 8. Legume seed coating and lime experiment, Rt. 100, Pulaski County, established 14 April, 1977.

	Flatpea Seedlings/Plot 7 October 1977	% Grass Cover 7 October 1977	% Flatpea Cover 27 October, 1978
Lime: 2 Tons/A			
Seed: Not Coated	21	72	10
Lime: 2 Tons/A			
Seed: Coated	6	77	6.7
Lime: None			
Seed: Not Coated	14	70	10
Lime: None			
Seed: Coated	14	62	8.8

2. Perennial Sweetpea renovation experiment, Rt. 29, Greene County. Established 11 August, 1977.

Experimental Methods

The principle objective of this experiment was to assess the value of different methods of seed placement and soil preparation for perennial sweetpea to renovate a poorly vegetated highway slope. A secondary objective was to test the effectiveness of coating legume seeds with bacterial inoculant and lime. The site of the experiment was a 2.5:1 sloping median just south of the Rapidan River along Rt. 29. The soil material was dark red clay with the following properties: pH, 5.6; calcium, medium +; magnesium, medium +; phosphorus, medium, and potassium, medium. The site was poorly vegetated and actively eroding.

The treatments were replicated three times in randomized blocks with seed treatment of coated and uncoated perennial sweetpea seed being main plots within blocks. Five treatments were randomized within each main plot: broadcast seeding of perennial sweetpea @ 20 lbs/A; surface seeded at one foot intervals in a 10-foot rototilled strip; seed incorporated to 1 1/4" depth at one foot intervals in a 10 foot rototilled strip; seed surface seeded at one foot intervals in a 10 foot strip not rototilled; seed incorporated to 1 1/4" depth one foot apart in a 10-foot strip not rototilled. Perennial pea seed treatments were applied and the site was then covered with a hydroseeder slurry containing materials at the following rates of application: woodfiber mulch, 1500 lbs/A; Ky-31 tall fescue, 50 lbs/A, German millet, 20 lbs/A, 15-30-15 fertilizer, 333 lbs/A, lime 1 T/A.

Results and Discussion

Data were collected at the site on 29 September 1977. Establishment of millet and fescue were nil due to the extremely dry weather. We noted some increased vigor in the existing, patchy stand of weeping lovegrass, probably due to the fertilizer applied. Table 9 reports findings on seedling establishment of perennial sweetpea.

Coating of pea seed with bacterial inoculant and lime produced no significant differences in seedling establishment as compared to seed having inoculant associated only by slight dampening of the seed with subsequent agitation with the loose inoculant. Seedling establishment of peas when surface applied was very poor, strip seeded peas having negligible establishment. Plots having pea seed broadcast @ 20 lbs/A received roughly 14 times as many seed per plot as plots with pea seed incorporated in strips but attained similar seedling emergence.

Seedlings on broadcast plots were found almost entirely in rills where water relations were probably improved by partial shading and concentration of any precipitation that occurred during the period

after establishing the experiment. Seed which were incorporated in strips gave superior seedling establishment, despite the extremely dry weather. Methods for establishing perennial sweetpea which place the seed of this large seeded legume in good contact with the soil promise to achieve superior results.

Table 9
Perennial sweetpea renovation experiment
Established 11 August 1977

	Pea Broadcast @ 20 lbs/A		Pea Seeded in rototilled strip				Pea Seeded untilled strip			
	Surface		Surface		1 1/4" deep		Surface		1 1/4" deep	
	coat	not coat	coat	not coat	coat	not coat	coat	not coat	coat	not coat
Seedling Emergence per Plot	3.3	5.3	0	1.0	6.3	5.3	0	0	5.0	3.0
Mean Emergence	4.3a		0.5b		5.8a		0.b		4.0a	

3. Mulch and seed coating experiment, Rt. 17, Saluda, September 7, 1977.

Experimental Methods

Objectives of this experiment were twofold: first, evaluate a new shredded waste paper mulch produced by Rumose Corporation for controlling erosion and enhancing the establishment of vegetation; second, compare crownvetch seedling growth where seed had and had not been coated with bacterial inoculant and lime. The site of the experiment was a 1.5:1, east facing cut slope in a sandy, coastal sediment material. Chemical properties were: pH, 5.1; calcium, low -; magnesium, medium; phosphorus, low -; potassium, low.

Mulch treatments were the main plots, the crownvetch seed inoculation treatments being assigned randomly to one-half of each mulch treatment. The crownvetch seeds at 20 lbs/A were applied by hand to appropriate plots along with tall fescue and annual ryegrass seed sufficient for 50 and 7 lbs/A rates, respectively. Woodfiber mulch was employed in the experiment as a standard of comparison. Woodfiber and paper mulches were applied by hydroseeder at 1500 and 2500 lbs/A and at 750 lbs/A as a tacking agent for straw applied by straw blower. In each of the three replications of the experiment, one plot received seed, lime and fertilizer but no mulch.

Results and Discussion

The three weeks after establishment of the experiment dry weather prevailed interspersed with several gentle showers. At this date, the plots with straw had the best grass cover; plots with woodfiber and paper mulch alone had a significantly poorer cover than straw (Table 10)

Table 10. Mulch and seed coating experiment, Rt. 17, Saluda, September 7, 1977*

	Straw, 3000						
Mulch rates in lbs/A	Woodfiber 750	Paperfiber 750	Woodfiber 1500	Woodfiber 2500	Paperfiber 1500	Paperfiber 2500	No mulch
Grass % Cover 28 Sept. 1977	75a	69a	30cd	23cd	40c	19d	21d
Crownvetch: seedlings/ft^2 28 Sept. 1977	2.7a	3.9a	7.7a	7.9a	6.0a	6.6a	6.1a
% Cover 29 Oct. 1978	90	93	60	63	68	67	93

*Values in a row followed by different letters are significantly different at the 5% level of probability.

The grass cover obtained with wood or paperfiber did not differ significantly, except that the low rate of paper mulch (1500 lbs/A) had significantly better cover than the higher rate (2500 lbs/A) and the no-mulch treatment. Crownvetch seedling stands were not affected significantly by mulch or seed treatment. No plots had encountered erosion to an extent quantifiable visually. The lack of any distinct plant growth responses to mulch treatments other than straw as compared to no-mulch treatments leaves in doubt the efficiency of the paper mulch. However, no significant, deleterious effects on plant growth were exhibited. The relative erosion control potential of the mulch materials per se was untested because no hard rains fell during establishment. Later in the fall vigorous, complete stands of grass had become established on all treatments. By spring, 1978, part of the experiment had been disturbed by installation of a drainage way, but complete erosion control was provided by the plant covers with all mulch treatments. Crownvetch growth on straw plots was severely depressed relative to that for wood or paperfiber treatments, apparently because of severe competition from cereal rye plants from seed in the straw. However, by fall, 1978, crownvetch had become established more strongly where straw had been applied.

By the end of October, 1978, strong stands of crownvetch had become established on all plots. Crownvetch cover was greatly superior to that on a micronutrient experiment immediately adjacent. The mulch site had been contaminated with cereal rye seed which had come from straw used to mulch an area above the experimental site. Straw mulch plots had the best crownvetch cover. It appears that, despite the heavy competition for crownvetch, the cereal rye serves to keep fertilizer nutrients from being leached away in the very sandy soils of this site (which is typical of many coastal plains soils). Rye plants absorb nutrients rapidly and then release them when they die later.

E. MICRONUTRIENT ADDITIONS FOR LEGUMES ESTABLISHMENT IN THE COASTAL PLAIN REGION.

1. Lovegrass and molybdenum experiment, Rt. 604, Suffolk. Established 3 August, 1977.

This experiment in the Coastal Plain region was designed to study the establishment of sericea lespedeza as influenced by three factors: species of lovegrass (Lehmann and weeping lovegrass), molybdenum application and coating of bacterial inoculant on seeds.

The experimental site was a freshly graded 1:1 cut slope through very sandy, Coastal Plains sedimentary material, having several clay lenses toward the base of the cut. Chemical characteristics of the material were: pH, 4.4; calcium, low; magnesium, low; phosphorus, medium -, and potassium, medium -. The experiment was a split plot design and was replicated three times. The two lovegrass species were main plots randomized within blocks. The four factorial treatments (coated seed plus molybdenum, coated seed minus molybdenum, uncoated seed plus molybdenum, uncoated seed minus molybdenum) were assigned randomly within each lovegrass treatment. The lovegrass @ 10 lbs/A and sericea @ 30 lbs/A were applied by hand broadcasting onto appropriate plots, with loose bacterial inoculant for uncoated sericea seed being applied concurrently with seed. Molybdenum @ 2 ounces/A was applied in a dissolved form sprayed onto plots with a backpack sprayer. Straw @ 3000 lbs/A was applied over the entire experimental site by a strawblower. Woodfiber tack @ 750 lbs/A, containing a slurry of Ky-31 fescue sufficient for a 50 lbs/A rate, as well as 15-30-15 fertilizer @ 667 lbs/A and lime @ 1 T/A, was then applied with a hydroseeder.

Results and Discussion

Data were collected on 27 September, 1977, at which date the growth of grass species was very scant. Growth indices (products of average height X average density) for sericea lespedeza are presented in Table 11 and exhibit no significant patterns of response to treatment variables.

The Lehmann lovegrass established in 1977 winterkilled. By fall, 1978, erratic stands of weeping lovegrass and sericea were established on the site with patterns of development primarily attributable to differential water status in the experiment. No response to seed treatment or molybdenum application was detectable. The moisture conditions were very unfavorable after establishing this experiment. However, sweetgum, which had a seed source from several nearby trees, volunteered on 13 of the 24 plots of the experiment.

Table 11. Lovegrass, molybdenum and seed coating experiment, Rt. 604, Suffolk, established 3 August, 1977.

	Legume Seed Coated With Bacterial Inoculant				Legume Seed Not Coated With Bacterial Inoculant			
	Molybdenum		No Molybdenum		Molybdenum		No Molybdenum	
	*L.lg.	w.lg.	L.lg.	w.lg.	L.lg.	w.lg.	L.lg.	w.lg.
Sericea growth Ht. (in.) X_2 den. (plants /ft^2)	3.5	1.0	2.7	1.3	2.9	4.4	2.9	1.3

*L. lg. = Lehmann lovegrass
w. lg. = weeping lovegrass

2. Experiment on Rt. 17, south of Saluda, established 7 September, 1977.

Experimental Methods

The primary objective of this experiment was to investigate whether additions of micronutrients to substratum Coastal Plain soil materials exposed in a fresh road cut in Middlesex County might aid in establishment and growth of perennial legumes. As at many sites in the Coastal Plain region, the texture of the soil material was very coarse and, thus, subject to much leaching. Responses to micronutrients have been found for soybeans, peanuts, corn and small grains growing in coarse textured surface soils of the Coastal Plain . Some micronutrients are maintained by soil organic in forms more available to plants (Stevenson & Ardakani, 1972) and since organic matter is very low in freshly exposed substratum material, it was thought that under these conditions addition of micronutrients might aid in establishment of vigorous, persistent stands of legumes. Molydenum by itself was selected as one treatment since it is a necessary element for nitrogen fixation in legume-rhizobia associations (Anderson, 1956). Additional treatments were a low, "shotgun" treatment containing molybdenum, copper, zinc, iron, manganese and boron at low rates, a high, "shotgun" treatment containing these elements at higher rates and a check, no micronutrient treatment.

An additional objective of the experiment was to compare seedling establishment of legumes when seeded with velvet bentgrass as compared to seeding with tall fescue plus straw at 3000 lbs/A. Though previous experiments with bentgrass had shown good emergence, followed by decline in crownvetch, it was thought that the large seeded legumes, sweet and flatpea, might have germination enhanced by bentgrass and, thereafter, due to their plentiful reserves for seedling growth, resist suppression by the companion grass.

The site of the experiment was a 1.5:1, east facing cut slope along Rt. 17 south of Saluda. The soil material was coarse textured, a loamy sand or sandy loam, having the following chemical characteristics: pH, 5.1; calcium, low -, magnesium, low +; phosphorus, low -; potassium, low.

Micronutrient treatments were mixed in clean sand and distributed by hand over the appropriate treatment plots. Tall fescue and bentgrass were seeded by hand. Lime, fertilizer and seed (sericea lespedeza @ 30 lbs/A, crownvetch @ 20 lbs/A, flatpea @ 10 lbs/A, perennial sweetpea @ 10 lbs/A and annual ryegrass @ 7 lbs/A) were applied by hydroseeder over the entire experiment. Woodfiber was then applied by hydroseeder @ 750 lbs/A to straw/tall fescue plots and @ 1500 lbs/A to bentgrass plots. Inoculant for legumes was applied by coating the appropriate rhizobial strain onto the seed of each species of legume in the manner previously described. The experiment was replicated twice in blocks with straw/tall fescue and velvet bentgrass as main treatment plots.

Table 12
Micronutrient Experiment
Rt. 17, Saluda
Established 7 September 1977

	No Micronutrients		Molybdenum		Low Micronutrients		High Micronutrients	
	K-31	Bentgrass	K-31	Bentgrass	K-31	Bentgrass	K-31	Bentgrass
% Grass cover 28 Sept 1977	57	18	63	10	53	8	42	5
Sericea/ft^2 28 Sept 1977	3.4	22	2.5	22	5.8	22	2.0	13
Sericea/ft^2 27 May 1978	0.30	1.0	0.60	2.5	0.60	2.9	0.07	0.75
Sericea growth index (density x ht) 27 May 1978	0.30	1.0	0.60	3.5	0.60	5.4	0.70	0.75
Crown vetch/ft^2 27 May 1978	0.63	1.0	0.75	2.0	0.63	3.5	0.43	0.63
Crown vetch growth index (density x ht) 27 May 1978	1.0	1.7	1.5	4.5	1.3	13	0.80	2.0
Sweet pea/plot 27 May 1978	21	40	25	28	17	41	17	29
Flat pea/plot 27 May 1978	29	57	39	49	37	61	31	49

Results and Discussion

Three weeks after establishing the experiment, cover by tall fescue on straw plots was very significantly better than on bentgrass plots (Table 12). Emergence of sericea lespedeza was the most prominent among the four legume species used, with very few seedlings of the other three species being evident. Growth of sericea was significantly enhanced in association with bentgrass as compared with straw/fescue, the difference being attributable to much more grass competition with the tall fescue as compared with bentgrass. However, neither grass cover nor sericea growth manifested any significant response from the micronutrient treatments.

By late May, 1978, cover by grass was about 40% for both tall fescue and bentgrass associates with no micronutrient response noted. Table 12 presents data for growth and stands of the four legume species. Seedling establishment was consistently better with bentgrass than with tall fescue but was not significantly different at the 5% level. Stands of sericea had declined as compared with the previous fall and were being surpassed in seedling establishment and vigor by crownvetch. Establishment of sweet and flatpea was meager: seedlings were counted for entire plots and are reported on that basis. Somewhat higher numbers of flatpea than of sweetpea seedlings occurred. The two species were seeded at the same rate and are approximately equal on a seed/lb basis. Flatpea, however, spreads vigorously by rhizomes even at a fairly young stage and somewhat higher numbers of plants counted for flatpea than for sweetpea may be due to such spreading.

No responses to micronutrient treatments significant at the 5% level were recorded for any of the legumes either in density of emergence or in growth index. This lack of response may imply a sufficiency of micronutrients in the soil, a growth stage of the leguminous species too early to manifest symptoms of deficiency, or a loss of availability of the applied micronutrients before the legumes had achieved appreciable growth.

F. SUMMER ANNUAL ASSOCIATES OF LEGUMES

1. Summer annual companion species experiment, Rt. 644, Floyd County, established 26 May, 1977.

Experimental Methods

This experiment was established on a 1.5:1 south facing cut through schist saprolite during road widening operations. Chemical properties of the soil materials were: pH, 4.9; calcium, high; magnesium, high; phosphorus, high; potassium, medium.

The objectives of the experiment were to compare the effectiveness of buckwheat and German millet for developing vegetative cover quickly on bare slopes in the summer season. These two annuals were also tested as a companion species for establishing crownvetch and persistent grass covers. Buckwheat, which germinates quickly, has a large seed (15,000 per lb) as compared to small seed for German millet (220,235 per lb.). Germination trials of buckwheat on wet filter paper in petri dishes at room temperature showed a mean 92% germination within 48 hours. Like German millet, buckwheat is a summer annual that is killed by light frosts. Buckwheat is very tolerant of acid, low fertility soils (Kipps, 1970).

Buckwheat was applied at three rates (20, 40 and 60 lbs/A and German millet at two rates (20 and 30 lbs/A) by hand broadcasting. Tall fescue (Ky 31), annual ryegrass and crownvetch were applied uniformly over the site with the fertilizer and woodfiber mulch slurry by a hydroseeder. Treatments were randomized in blocks with three replications.

Results and Discussion

Seedings of German millet gave a complete vegetative cover more rapidly than those of buckwheat. The latter had fewer seeds per square foot (101 and 152 seed/ft^2 for German millet @ 20 and 30 lbs/A and 7, 14 and 21 seed/ft^2 for buckwheat @ 20, 40 and 60 lbs/A) . However, buckwheat plants branched repeatedly to form a protective canopy with large, horizontally positioned leaves. By summer, the canopies of buckwheat permitted better growth of annual ryegrass and tall fescue in the understory than did German millet; growth of crownvetch was similar for the two summer annuals and for the varying seeding rates. Since by late summer-early fall both annual companion species became senescent, the differing growth of the cool season grasses in the understories is a factor to consider from the point of view of potential for erosion and its control. Since 1977 had a very dry growing season, greater water competition by German millet might be cited as a cause of reduced grass growth. Such an effect ought to have acted on growth of crownvetch similarly. This was not the case. Analyses of the stands of annual companion species and grass for protein content tend to preclude differential nitrogen competition between the two annual species (Table 13). At all three rates, buckwheat accumulated more nitrogen (or protein) per unit area than did German millet at the lower rate, yet, nitrogen uptake by grass was greater in association with buckwheat than with millet.

Drooping of leaves of buckwheat on hot afternoons was observed numerous times and permitted light to penetrate more readily to the understory than for millet, which maintained a relatively constant canopy structure under stress conditions. It is likely that the more extreme light competition with German millet may be the causative factor in the suppression of understory grass. Crownvetch, by contrast, is relatively shade tolerant. The better growth of grass in association with buckwheat is fortunate as the <u>in situ</u> mulch by this species in the fall is much less dense than for millet. Such a mulch is a factor in reducing water run off and enhancing the establishment of crownvetch.

Table 13. Summer annual companion species experiment, data of 30 August, 1977.

Seeding rate (lbs/A)	German Millet, lbs/A 20	30	Buckwheat, lbs/A 20	40	60
Crownvetch/ft^2	1.8	2.3	3.3	.2	2.8
% cover by annual companion species:	97	89	70	00	92
% cover by annual ryegrass and tall fescue:	7.7	3.7	45	65	37
Grass growth (average height x % cover)	20	11	360	30	228
Density of annual companion species* (Stems/ft^2)	47	65	4.3	.0	13
Seeding density of annual companion species (seed/ft^2)	101	152	7	14	21
Grass dry weight (g/ft^2)	2.9	1.6	11	8.2	6.3
% protein grass:	12	9.5	13	13	13
Grass protein (g/ft^2)	0.33	0.18	1.4	1.0	0.83
Companion species dry weight (g/ft^2):	26	40	20	22	19
% protein, companion species:	6.3	6.9	8.9	9.5	8.7
Companion species protein (g/ft^2)	1.5	2.8	1.8	2.1	1.7
Total protein (g/ft^2)	1.8	3.0	3.2	3.1	2.5

*For Millet counts are for total number of stems, not plants

By fall, 1978, strong vegetative covers had become established on almost all plots, with no significant differences in crownvetch or tall fescue stands being attributable to previous summer companion species treatments (Table 14).

Table 14: Summer annual companion species experiment, data 18 October, 1978.

	Buckwheat, lbs/A			German Millet, lbs/A	
Seeding rate (lbs/A)	20	40	60	20	30
Grass cover, %	27	20	25	23	17
Crownvetch cover. %	62	76	67	70	66

2. Summer annual companion species experiment, Rt. 735, Galax, established 20 June, 1977.

Experimental Methods

This experiment was laid out on a freshly graded 1.5:1 cut slope, having a west aspect. Soil material was coarse textured phyllite and mica-schist saprolite fairly compact at the bottom portion of the cut. Chemical properties were: pH, 5.3; calcium, low; magnesium, very high; phosphorus, low -; potassium, medium.

The objective of the experiment was to assess the effect of buckwheat as compared to Japanese millet. Seeding rates and method of establishing the experiment were similar to the experiment with buckwheat in Floyd County with Japanese substituting for German millet.

Results and Discussion

Establishment of a complete cover by buckwheat was somewhat slower than for Japanese millet, due to the much lower number of seeds applied per unit area. As it matured, buckwheat branched repeatedly and provided a complete vegetative cover with its broad, horizontally disposed leaves. Densities of the two annual companion species at the varying rates observed on 23 September, 1977, are reported in Table 15. The data clearly show the lesser plant density of buckwheat as compared to Japanese millet. Buckwheat at the higher two seeding rates and Japanese millet at both seeding rates provided good vegetative covers during the warm summer season to protect the slope from possible loss of seed, fertilizer and soil occasioned by hard, summer cloud bursts.

The density of Japanese millet appeared to have been severe enough to inhibit growth of the other grass species seeded (tall fescue and annual ryegrass) as compared to buckwheat (Table 15). As with buckwheat in Floyd County, the fact that growth of crownvetch, which is relatively shade tolerant, was not significantly different for the compion species and seeding rates suggests that low light intensity rather than water competition was primarily responsible for the poor grass growth under Japanese millet. Here again it was noted that drooping of the leaves of buckwheat occurred during hot afternoons. However, the canopy form of Japanese millet showed little effect from transient water stresses.

Growth of crownvetch and tall fescue at this site was much less in 1978 than at the Floyd site where buckwheat was tested (Table 14). No effects of summer annual companion species were exhibited on growth of tall fescue at this site. Within one of the replications of the experiment, markedly better growth of crownvetch was found to correlate with a change in soil material from phyllite to schist saprolite. Soil materials in this replication appeared to be stronger determinants of plant growth than treatments. With this replication excluded in calculating treatment means for crownvetch coverwith Japanese

millet at the 20 lbs/A rate proved superior to buckwheat at any of the three rates as a summer annual companion species. Litter of millet continued to be conspicuous on the soil surface of the millet plots, whereas, on buckwheat plots where neither tall fescue nor crownvetch was growing, bare soil was exposed. Water appears to have been a limiting factor again in 1978 at this site. Better conservation of fertilizer by means of in situ mulch such as dead millet, may prove to aid in plant growth under good water relations.

Table 15. Buckwheat and Japanese millet experiment, Rt. 735, Galax, established 20 June, 1977.

	Buckwheat, lbs/A			Japanese Millet, lbs/A	
	20	40	60	20	30
	Data for 23 Sept. 1977				
Density of annual companion species (plants/ft^2)	3.0b	4.2b	8.5b	44a	40a
Density of crownvetch (plants/ft^2)	4.1a	3.0a	2.7a	3.2a	3.3a
Dry weight of grass tall fescue and annual ryegrass (g/ft^2)	7.8a	4.6ab	3.1b	0.33c	0.44c
	Data for 27 Oct. 1978				
% tall fescue cover	11a	6.7a	11a	12a	14a
% crownvetch cover (means of three replications)	30a	14a	22a	30a	20a
% crownvetch cover (means of two replications)	20b	8c	13c	28a	25ab

G. PERENNIAL GRASS ASSOCIATES OF LEGUMES

1. Lehman lovegrass and velvet bentgrass experiment, Floyd County, established 26 May, 1977.

Experimental Methods

Objectives of this experiment were to assess the value for slope stabilization and establishment of crownvetch of several perennial grass species that had not been previously used in roadside vegetation research. Weeping lovegrass has proved to be a highly successful species for vegetating slopes during the warm part of the growing season; however, this grass often thins out during a period of years in many parts of the state. Lehmann lovegrass has been

Table 16

Lehmann lovegrass, Velvet bentgrass Experiment
Floyd County
Established 26 May 77

Seeding rate (lbs/A)	No Lime						1.5 T/A Lime						3.0 T/A Lime					
	Leh. Lovegrass			Velvet Bentgrass			Leh. Lovegrass			Velvet Bentgrass			Leh. Lovegrass			Velvet Bentgrass		
	5	10	15	10	30	60	5	10	15	10	30	60	5	10	15	10	30	60
%grass cover 26 Aug 1977	78	80	88	68	66	63	79	85	92	62	55	64	75	90	82	70	68	69
% grass cover 18 Oct 1977	80	90	88	83	70	75	95	95	98	83	78	85	78	98	93	85	83	83
Crownvetch density (Plants/ft^2) 18 Oct 1977	0.25	0.67	1.0	0.17	0.00	0.17	1.8	0.92	0.67	1.3	0.33	0.33	0.83	3.2	1.3	1.0	0.25	0.83
% grass cover* 18 Oct 1978	25	14	3	11	33	34	7.5	7.5	10	31	36	46	0	13	10	33	13	36
% crownvetch cover 18 Oct 1978	34cd	30d	50abcd	80a	43bcd	43bcd	81a	75ab	84a	65abc	55abcd	51abcd	79a	84a	78ab	64abc	55abcd	56abcd

*Values for Lehmann lovegrass are for cover by winterkilled canopies remaining on plots.

reported to spread vegetatively by rooting at nodes (Heath, et al, 1973) and it was thought that a more persistent, dense growth of lovegrass might be obtained with this species than with the bunchgrass growth of weeping lovegrass. Velvet bentgrass was considered to be of interest because of reports of its superior tolerance of soil acidity (Clarkson, 1966).

The site of this experiment was a fresh road cut slope with a west-curving to southwest aspect along Rt. 644 near Copper Hill in Floyd County. The soil tests for this mica schist saprolite were: pH, 5.0, calcium, low -; magnesium, medium -; phosphorus, low and potassium, low. Velvet bentgrass and Lehmann lovegrass were hand seeded onto designated plots at rates of 10, 30, and 60 and 5, 10 and 15 lbs/A, respectively. Crownvetch @ 20 lbs/A, woodfiber, a complete fertilizer and lime @ 0, 1.5 and 3.0 T/A were applied by hydroseeder to appropriate plots. The experiment was replicated twice in randomized blocks.

Results and Discussion

Data on grass cover on 26 August, 1977, and 18 October, 1978, indicated that neither seeding rates nor lime rates significantly affected the establishment of cover by the two grass species. Lehmann lovegrass appears to resemble weeping lovegrass in acid tolerance and tended to give more complete vegetative covers than velvet bentgrass. Lehmann lovegrass proved to have somewhat more open canopies than weeping lovegrass; bentgrass canopies were short (less than six inches high) and extremely dense. Data of 18 October, 1977, indicate very significant responses to both lime and grass species by crownvetch. Responses to seeding rates were not pronounced. With bentgrass, through the course of the summer, many crownvetch seedlings initiated growth and then died before growing beyond the first or second true leaf stage. Competition for water or nutrients may have been factors in suppressing crownvetch as well as plant diseases, which may have proliferated more readily in the extremely dense canopy of bentgrass as compared with lovegrass.

2. Lehmann lovegrass and velvet bentgrass experiment, Rt. 735, Galax, established 20 June, 1977.

Experimental Methods

Objectives and method of establishment were similar to those of the previous experiment in Floyd County. The experimental site was a 1.5:1 cut slope with a western aspect through schist saprolite. Chemical characteristics were pH, 5.6; calcium, low -; magnesium, medium; phosphorus, medium - and potassium, low.

Table 17

Lehmann lovegrass, Velvet bentgrass Experiment
Rt. 735, Galax

Established 23 September 1977

Seeding rate	No Lime						1.5 T/A Lime						3.0 T/A Lime					
	Leh. Lovegrass			Velvet Bentgrass			Leh. Lovegrass			Velvet Bentgrass			Leh. Lovegrass			Velvet Bentgrass		
	5	10	15	10	30	60	5	10	15	10	30	60	5	10	15	10	30	60
% grass cover 23 Sept. 1977	87	98	95	75	76	79	99	94	98	72	80	88	95	95	98	88	87	90
Crownvetch density (Plants/ft^2) 23 Sept 1977	4.2	7.1	4.2	2.3	1.3	1.0	6.5	8.0	7.8	3.4	4.6	3.6	6.3	6.0	6.8	4.5	3.8	5..
Crownvetch growth index (Average ht. x density) 23 Sept 1977	8.0	10	4.9	2.3	1.5	1.7	14	14	9.8	8.2	6.7	8.3	9.8	9.4	11	9.0	8.8	8.(
% grass cover* 27 Oct 1977	79a	100a	87a	95a	85a	83a	93a	97a	93a	96a	97a	97a	89a	100a	97a	100a	97a	10(
% crownvetch cover 27 Oct 1977	57ab	80a	67ab	52ab	45b	35b	80a	77a	81a	56ab	47b	50b	81a	85a	80a	77a	37b	41b

*Values for Lehmann lovegrass are for cover by dead canopies of winterkilled grasses.

Results and Discussion

Seedling establishment and vigor of crownvetch were positively affected by lime application and association with Lehmann lovegrass. Lehmann lovegrass attained significantly better plant covers than did velvet bentgrass. Rate of seeding the two grasses had little effect on stands of either crownvetch or the grass species. Response to lime was minor for the grasses but significant with crownvetch.

Lehmann lovegrass winter killed at this site but cover by dead canopies persisted. Crownvetch developed much more strongly in association with lovegrass than with bentgrass and showed increased vigor with liming. Crownvetch growth was retarded by bentgrass as compared with lovegrass, especially at the two higher seeding rates. Crownvetch growth at this site was better than on the buckwheat experiment nearby, established at the same date and similar to the bentgrass-lovegrass experiment in Floyd County established somewhat earlier(May 26, 1977).

3. Lehmann lovegrass, velvet bentgrass experiment, Rt. 640, Pittsylvania County, established 8 July, 1977.

Experimental Methods

Objectives in this experiment were similar to previous trials with Lehmann lovegrass and velvet bentgrass, except that the establishing of perennial sweetpea rather than crownvetch was investigated. The site of the experiment was a 1.5:1, west facing bare cut through schist saprolite, which was compact after grading; later the soil material became very loose. The coarse textured, micaceous material had much erosion potential after prolonged exposure to atmospheric conditions. Lehmann lovegrass was applied at rates of 10 and 20 lbs/A, velvet bentgrass at rates of 10 and 30 lbs/A and lime at rates of 0, 1.5 and 3.0 T/A, all by hydroseeding. A fertilizer, pea seed and woodfiber mulch slurry was applied uniformly over the experiment by a hydroseeder.

Results and Discussion

Establishment of grass covers by each species was strongly affected by the severe 1977 summer drought, being very slow and incomplete, especially by bentgrass (Table 18). There was more contamination of grass species across the plots in this experiment where applications were made by hydroseeder than in previous trials with hand broadcasting. Both of these grass species have extremely small seed, easily dispersed by wind. In the 1977 growing season, the taller growing Lehmann lovegrass was much more conspicuous as a contaminant in bentgrass than the reverse. As in previous experiments, the two grasses were not significantly affected by lime or seeding rate. Perennial sweetpea which has a very large seed (10,022/lb) had extremely sparse stands on this site. Toward the top of the slope on the experimental area, a very small bench parallel to the slope had fair stands of perennial

Table 13
Lehmann lovegrass, Velvet bentgrass Experiment
Rt. 640, Pittsylvania County
Established 8 July 1977

	No Lime				1.5 T/A Lime				3.0 T/A Lime			
Seeding rate (lbs/A)	Lehmann lovegrass 10	20	Velvet bentgrass 10	30	Lehmann lovegrass 10	20	Velvet bentgrass 10	30	Lehmann lovegrass 10	20	Velvet bentgrass 10	30
% Grass cover 12 Oct 1977	45	53	23	28	32	55	25	28	37	53	20	27
Sweetpea seedlings per plot 12 Oct 1977	4.0	5.7	5.0	6.3	5.7	6.7	7.7	9.7	3.7	3.2	6.0	8.3
% Grass cover 2 June 1978*	57	53	65	55	38	42	87	72	40	20	50	77
Sweetpea seedlings per plot 2 June 1978	5.3	11	15	11	11	19	25	17	15	15	16	16

*Under Lehmann lovegrass treatment, percentages are for velvet bentgrass cover.

sweetpea seedlings. Elsewhere, the contour of the slope with a smooth graded surface had very few sweetpea plants. The plentiful growth of seedlings in the ditch at the base of the slope showed that many of the large, roundish perennial pea seeds had rolled off the slope. The scant numbers of seedlings reported in Table 18, given as numbers per plot should be compared to the initial density of seed (4.6 per ft^2 or 414 per plot). The fact that good stands of perennial sweetpea occurred on roughened microenvironments on the slope during this droughty 1977 season shows that rough or stair-step contours should be fully endorsed and implemented on cut slopes by the Virginia Highway and Transportation Department. No discernible pattern of responses to lime or companion grass treatment existed for sweetpea emergence or establishing seedlings.

By spring 1978, cover by the two companion grass species were altered drastically. Lehmann lovegrass was almost totally eliminated by winter kill, whereas, velvet bentgrass stands were excellent. The bentgrass contaminant in lovegrass plots developed covers of varying degrees of completeness. Bentgrass plots had good grass covers, without significant responses to lime or seeding rates. Seedling stands of sweetpea also increased during the second year, with no differential responses to lime or companion species.

4. Lehmann lovegrass, velvet bentgrass, German millet experiment Rt. 640, Pittsylvania County, established 19 July, 1977.

Experimental Methods

This experiment was designed to assess the performance of velvet bentgrass and Lehmann lovegrass as compared to German millet plus tall fescue for developing vegetative covers for slope stabilization during mid-summer and also to evaluate the effect of the vegetative cover on the establishment of crownvetch. The experiment was laid out on a very sandy 1:1 bare cut slope, having an eastern aspect. Lime (1.5 and 3.0 T/A) in three randomized blocks was applied by hydroseeder to the experimental site first. Straw at 1.5 T/A was applied by straw blower, and tacked with 750 lbs/A of woodfiber mulch by hydroseeder; the companion species being applied concurrently. Velvet bentgrass was seeded @ 30 lbs/A, Lehmann lovegrass @ 10 lbs/A; tall fescue, @ 60 lbs/A and German millet @ 20 lbs/A, being randomized within lime rate plots. Crownvetch at 20 lbs/A and fertilizer were applied over all plots.

Results and Discussion

German millet developed a cover much more rapidly and completely than the other two grass companion species, the cover by bentgrass being poor (Table 19). Differential responses to lime rates were not significant for establishing the grass covers. Seedling emergence of crownvetch was enhanced at the higher rate of lime when grown in

association with Lehmann lovegrass which had stronger stands at the higher lime rate. Crownvetch stands did not significantly differ for the companion species. However, sloughing from the poorly vegetated lovegrass and bentgrass plots had begun by fall, 1977, and became severe by spring, 1978. Plots seeded to German millet had minimal sloughing.

As with other experiments with Lehmann lovegrass, this species winter killed. Cover by bentgrass was poor in part due to severe sloughing; tall fescue growth, while not vigorous, was sufficient to inhibit sloughing. Differential responses to lime or companion species in crownvetch density or vigor were not significant. The considerable amount of sloughing on bentgrass and lovegrass plots undoubtedly resulted in loss of lime and fertilizer, thereby retarding the spread of crownvetch. Sloughing threatened or caused losses in existing crownvetch cover.

Table 19. Lehmann lovegrass, velvet bentgrass, German millet experiment, Rt. 640, Pittsylvania County, established 19 July, 1977.

	1.5 T/A Lime			3.0 T/A Lime		
	German millet	Velvet bentgrass	Lehmann lovegrass	German millet	Velvet bentgrass	Lehmann lovegrass
% cover * 10 Oct. 1977	77	5	25	90	5	43
Crownvetch Density (Plants/ft^2)	5.5	12	13	11	11	8.0
% cover* 2 June 1978	46	27	0	33	3	0
Crownvetch Density, 2 June, 1978 (plants/ft^2)	.11	.24	.16	.14	.10	.09
Vetch Growth Index, 2 June 1978 (Vetch Density x average height)	.45	1.3	.38	.39	.29	.26

*Value for % cover of areas seeded with German millet-tall fescue mix are for millet in Oct. 1977 and for tall fescue in June, 1978.

5. Flatpea companion species experiment, Rt. 644, Floyd County, established 10 June, 1977.

Experimental Methods

This experiment was established to asses the effect of various perennial grass companion species on the establishing of flatpea. The experiment was laid out on a newly graded, 1.5:1, west facing cut slope. Koket chewings fescue, Manhattan perennial ryegrass, weeping lovegrass, each at three seeding rates, and Ky-31 tall fescue @ 60 lbs/A were hand broadcast onto appropriate plots. Lime, fertilizer, woodfiber mulch, flatpea @ 20 lbs/A and annual ryegrass @ 3 lbs/A were applied in a slurry by hydroseeder over the experimental site. The experiment was replicated three times in blocks.

Results and Discussion

Establishment of grass cover in 1977 was very slow and incomplete due to the dry weather (Table 2C). Only weeping lovegrass gave a good protective vegetative cover to prevent erosion during the first summer. Flatpea seedlings were very few over the whole site in 1977. By fall, 1978, near complete grass covers had developed on most of the treatments. However, on a number of plots, Manhattan perennial ryegrass had begun to die. Sparce stands of flatpea began to appear but seedlings were almost entirely confined to the bottom five feet of the slope.

Table 20
Flatpea Companion Species Experiment
Rt. 644, Floyd County
Established 10 June 1977

	Koket Chewings Fescue			Manhattan Perennial Ryegrass			Weeping Lovegrass			Ky-31 Tall Fescue
(lbs/A)	15	50	90	25	60	90	5	10	15	60
% Grass Cover 26 Aug 1977	12e	18de	33cde	29cde	33cde	34cd	49bc	71ab	90a	15de
% Grass Cover 2 Oct 1978	87	87	85	83	73	77	85	90	87	85
% Flatpea Cover 2 Oct 1978	3.7	7.0	4.3	2.0	15	3.7	9.3	2.0	8.3	8.7

H. AMERICAN BEACHGRASS

1. American beachgrass experiment, I-77, Bland County, established 5 April, 1977.

Experimental Methods

This experiment was planned to assess the value of American beachgrass for stabilizing a bare, sloughing slope of partially decomposed shale. The pH of the most weathered material was 4.1. Beachgrass was planted in rows, at 18 to 24 inch intervals; 5 culms of grass were placed in a slit opened by a spade. In one block of plantings, a half a handful each of a 10-20-10 fertilizer and lime were placed in the slit along with the beachgrass. In another block, beachgrass was planted with only fertilizer added.

Results and Discussion

By 27 October, 1978, all plantings of beachgrass receiving only fertilizer had died out. Twenty of 120 hills of beachgrass planted survived in the block receiving lime as well as fertilizer. Rhizome spreading of beachgrass was confined to 18 inches or less of the site of planting, apparently because the acidity of the surrounding, unlimed soil adversely affected this species. Though beachgrass shows some promise for stabilizing loose, mobile, shaley slopes, it would be best adapted to calcareous shales.

III. WORK IN PROGRESS

Data have been collected on experiments initiated under previous projects; further data will be collected in spring 1979 and findings presented in the final report.

In the winter of 1977-8 a liming experiment on a highly acid, pyrite bearing cut slope was started. Extremely dry spring conditions have caused poor plant growth responses to treatments. Soil samples will be obtained to determine effects of treatments on soil acidity; further data on plant growth will be collected.

In late winter-early spring 1978 seedings of perennial legumes in medians were made in all three physiographic regions of Virginia. Abnormally dry spring and late summer-early fall weather adversely affected seedling establishment and growth in these trials. Further observations are planned at these sites since delayed developement of legume stands occurred in several medians seeded in the dry spring of 1977.

Additional seedings of legumes in medians in late winter-early spring 1979 are planned.

A number of hydro-mulch materials were tested on slopes in highway environments in summer and fall of 1978. Further data will be collected from these sites as well as from further tests projected for spring 1979. Laboratory tests of mulch materials are being conducted.

A test of plant associates for summer seedings of crownvetch was carried out in Floyd County in summer 1978 and data obtained. Species included buckwheat and sprangletop, a promising warm season perennial. Additional observations will be obtained in spring 1979.

Experiments to test methods of renovating degenerated cut slopes were initiated in New Kent and Prince Edward Counties in spring 1978. These seedings appear to be failures due to dry weather; further observations will be made. A renovation experiment on a cut slope dominated by star thistle was initiated in Rockbridge County in fall 1978. This experiment includes a date of seeding as a variable and will receive the other treatments in late winter 1979.

Laboratory experiments on effects of herbicides on legume seeds have been started to determine the feasibility of co-spraying legume seeds and herbicides by hydroseeder.

An experiment was initiated in Montgomery County in fall 1978 to test additions of boron and bacterial inoculant on the growth of crownvetch at an alkaline site.

Unhulled seed of crownvetch and of a number of Alaskan perennial grass species have been obtained for a dormant seeding trial in the winter of 1979.

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Appendix - 1

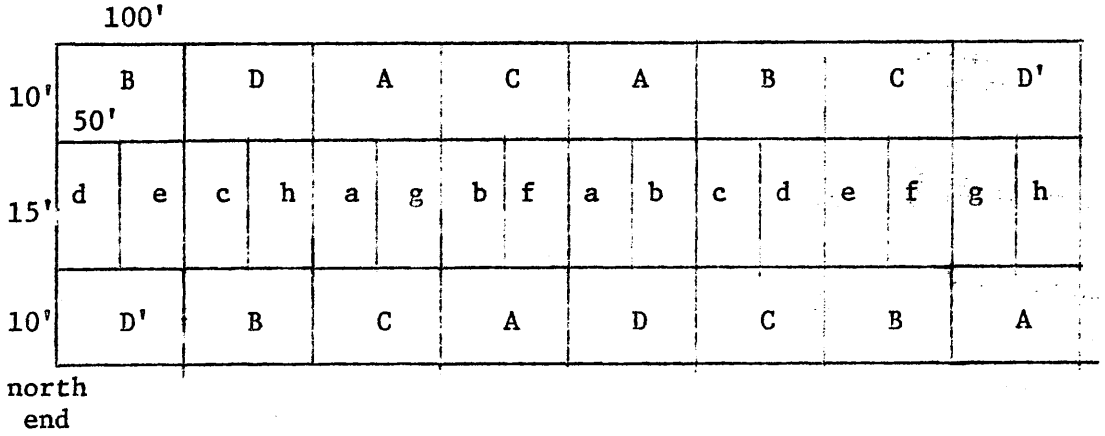
Species Cited

Common Names	Scientific Names
American beachgrass	*Ammophila breviligulata* Fernald.
Birdsfoot trefoil	*Lotus corniculatus* L.
Buckwheat	*Fagopyrum esculentum* L.
Cicr milkvetch	*Astragalus cicer* L.
Crownvetch	*Coronilla varia* L.
Deer tongue	*Panicum clandestinum*
Fescue	*Festuca* L.
Chewings	*rubra* var. *commutata* Gaud.
varieties used	Banner
	Jamestown
	Koket
Hard	*ovinina* var. *duriuscula* (L.) Koch
variety used	Biljart
Tall	*arundinacea* Schreb.
variety used	Ky-31
Flatpea	*Lathyrus sylvestris* L.
Foxtail (German) millet	*Setaria ilalica* (L.) Beauv.
Greasegrass (purpletop)	*Tridens flavus* Hitchc.
green sprangletop	*Leptochloa dubia* (H.B.K.) Nees.
Hairy vetch	*Vicia villosa* Roth
Japanese Millet	*Echinochloa crusgalli* var. *frumentacea* (Roxb.) Wright
Kentucky bluegrass	*Poa pratensis* L.
varieties used	Adelphi
	Kenblue
Lovegrass	*Evagrostis* Beauv.
Lehmann	*lehmanniana* Nees.
Weeping	*curvula* (Schrad.) Nees.
Partridge pea	*Cassia fasciculata* Michx.
Perennial sweetpea	*Lathyrus latifolius* L.
Red clover	*Trifolium pratense* L.
Rye	*Secale cereale* L.
Ryegrass	*Lolium* L.
Annual	*multiflorum* Lam.
Perennial	*perenne* L.
varieties used	Manhattan
	Pennfine
	Yorktown
Star Thistle	*Centaurea Maculosa* Lam.
Sericea lespedeza	*Lespedeza Cuneata* (*Sericea*) (Dumont) G. Dons
Velvet Bentgrass	*Agrostis canina* L.

APPENDIX - 2

Diagrams of Experiments

Title: Grass and Legume Experiment
Objectives: Assess use of grasses requiring reduced mowing and use of legume in a median.
Location: I-77 median experiment near old "Shot Tower" on New River.
Established: 10/15/76



A - Koket @ 80
B - Bilgart @ 80
C - Jamestown @ 80
D - Manhattan @ 80
D'- Pennfine @ 80

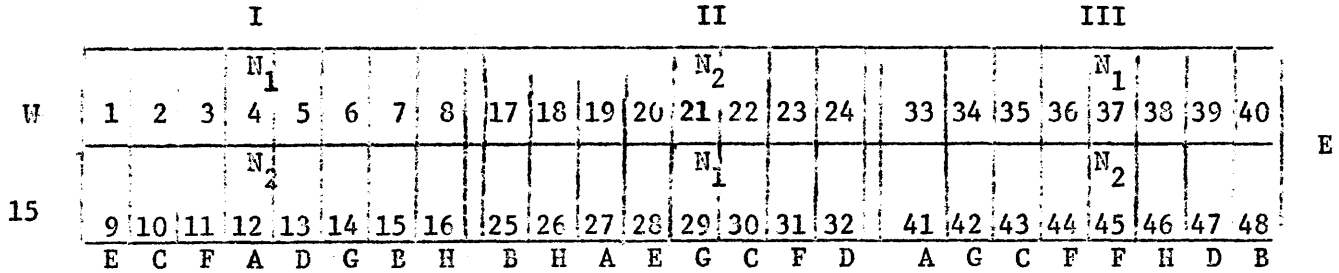
a. Flat pea @ 20
b. Sweet pea @ 20
c. Milk vetch @ 20
d. Trefoil @ 20
e. Flat pea @ 10
f. Sweet pea @ 10
g. Milk vetch @ 10
h. Trefoil @ 10

To entire experiment:

Annual ryegrass @ 7
10-20-10 @ 1000
lime @ 2 tons
woodfiber @ 15000

Title: Grass Experiment in a Median

Location: Median, U. S. 360, 3 miles E of Greenbay, W of industrial intersection for Union Camp Lumber Co.
Objectives: Test for growth habit and response to N of grasses with potential along guardrails and in medians near cities.
Established: March 29, 1977

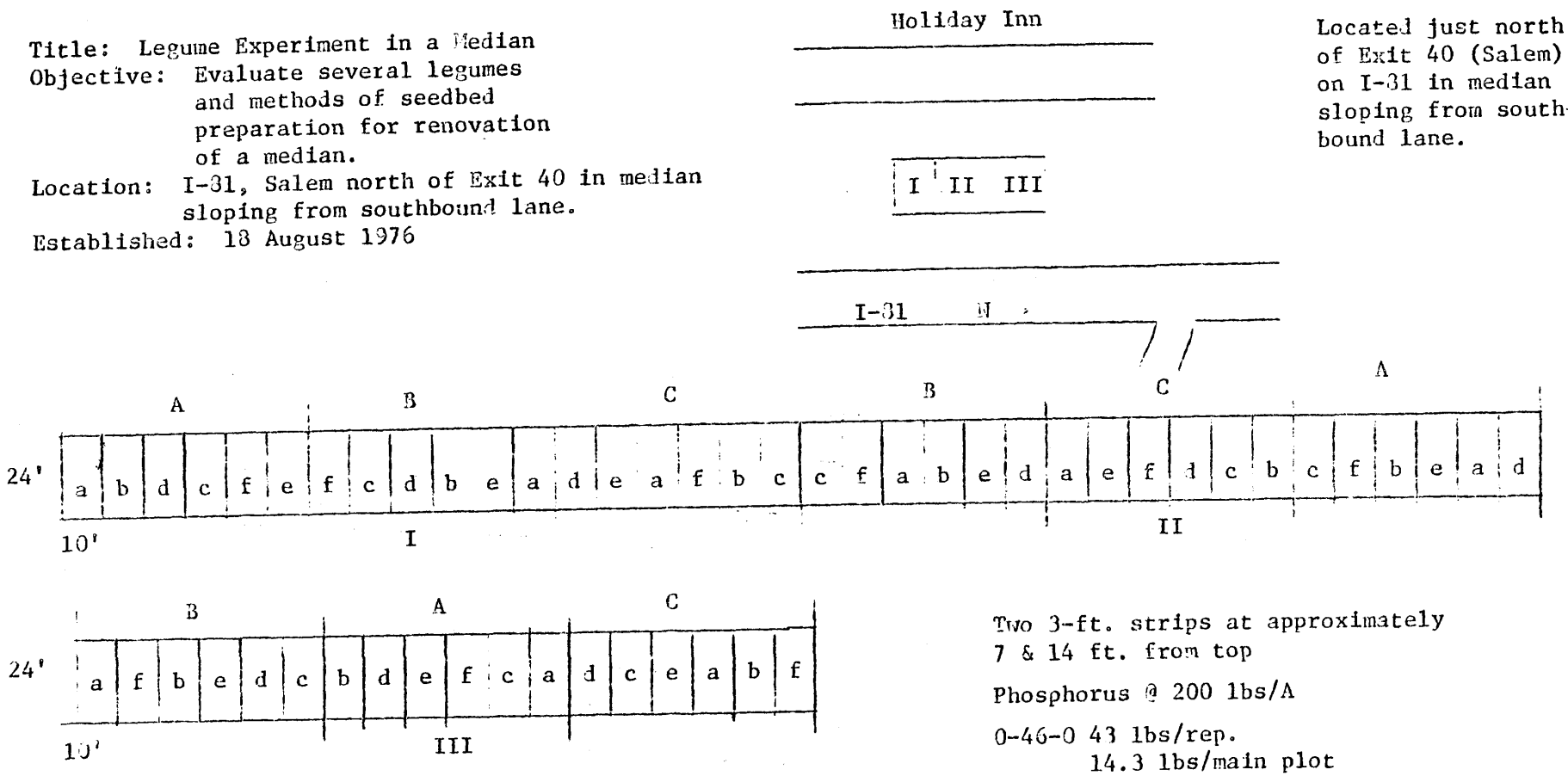


Plot size: 15' x 12.5'
Treatments: All plots: 2 Tons/A dolomitic lime
500 lbs/A 10-20-10

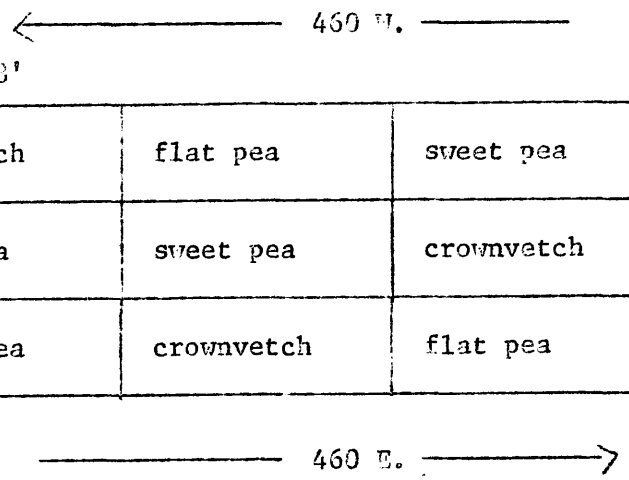
N_1 = 50 lbs/A N
N_2 = 100 lbs/A N

A = 80 lb/A Koket, chewings fescue
B = " Biljart, hard fescue
C = " Banner, chewings fescue
D = " Jamestown, chewings fescue
E = " Yorktown, perennial rye grass
F = " Manhattan, perennial rye grass
G = " Mixture 50-50 Adelphi-Kenblue, Kentucky bluegrass
H = " Ky-31 tall fescue

Title: Legume Experiment in a Median
Objective: Evaluate several legumes and methods of seedbed preparation for renovation of a median.
Location: I-81, Salem north of Exit 40 in median sloping from southbound lane.
Established: 18 August 1976



Title: Legume Experiment in a Median
Objective: Assess several legume species for renovation of a median
Location: Route 460, 0.7 miles west of western intersection of route 460 with route 15 and about 100 yards west of yellow highway shed. West of Farmville
Established: 9 March 1977

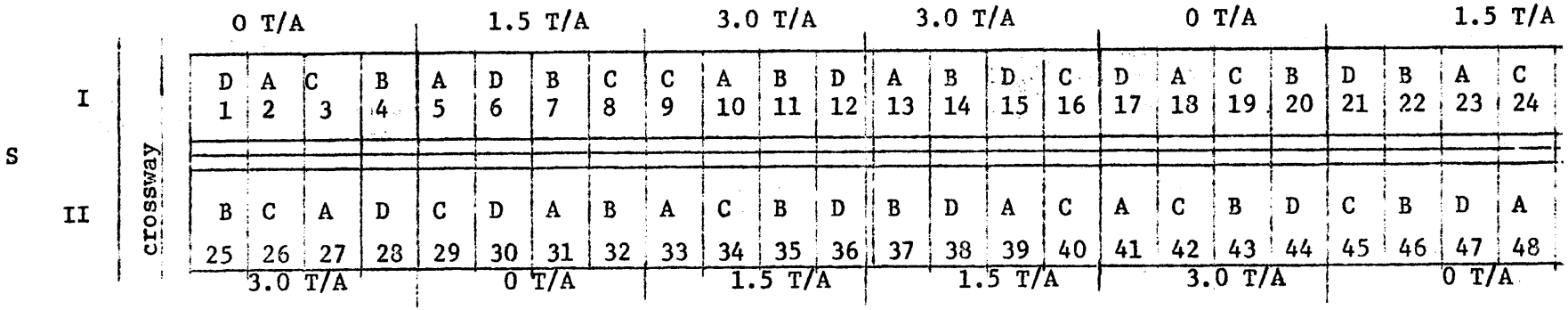


Treatments:
crownvetch @ 20 lbs. 1A
flat pea @ 20 lbs. 1A
sweet pea @ 20 lbs. 1A

All plots:
50 lbs. 1A N as NH_4NO_3
200 lbs. 1A P_2O_5 as triple superphosphate
50 lbs. 1A K_2O as KCl
15 lbs. 1A Koket chewings fescue
15 lbs. 1A Biljart hard fescue

Title: Legume, Lime Experiment in a Median.
Location: Route 29 median just north of Route 903, Pittsylvania County (approximately 3 miles south of Gretna).
Objective: Assess effects of differential lime application on establishment of legumes for renovating medians.
Established: March 31, 1977

LIME RATES



North bound Route 29

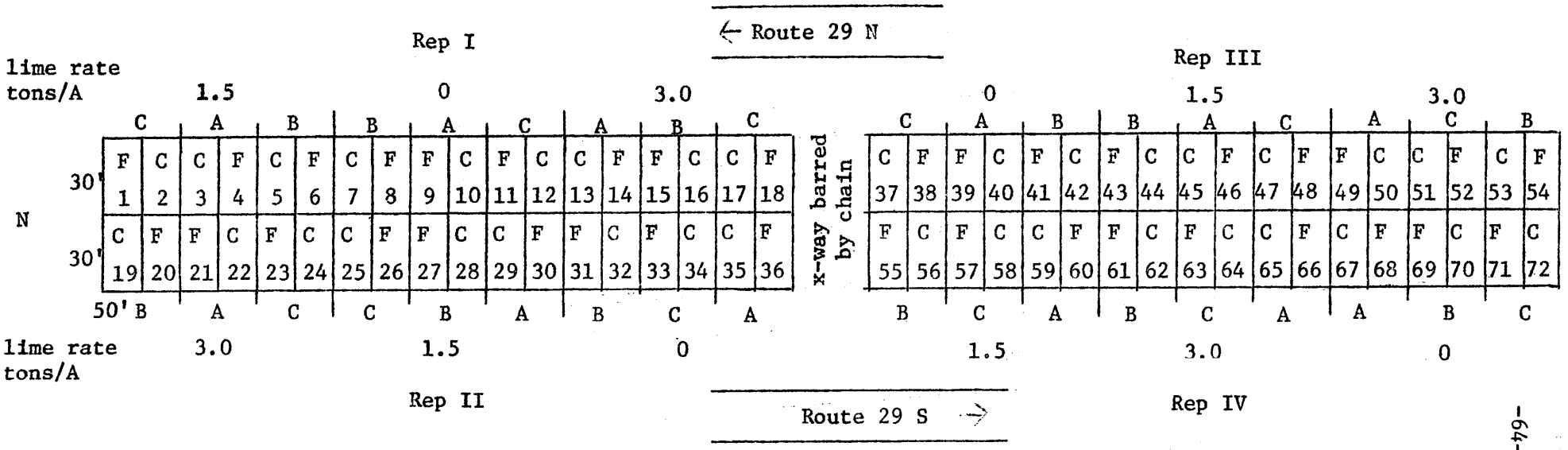
Treatments: A-Crownvetch @ 20 lbs/A
B-Milk vetch @ 20 lbs/A
C-Sweet pea @ 20 lbs/A
D-Flat pea @ 20 lbs/A

Lime as on map.
All plots: 300 lbs/A 10-20-10
30 lbs/A Jamestown creeping red fescue

Subplots: 15' x 60'

Soil: (0-6") pH (H_2O), 5.3; Ca - L; Mg - L+; P - L+; K - M.

Title: Legume, Lime and Phosphorus Experiment in a Median
Objective: Assess importance of lime and phosphorus on renovation of median with legumes.
Location: Route 29, immediately south of Hurt exit by Ambassador Motel (Route 988).
Established: April 1, 1977.



Treatments:

A - 0 lbs/A P_2O_5 as con super
B - 100 lbs/A P_2O_5 as con super
C - 200 lbs/A P_2O_5 as con super

F - flat pea @ 20 lbs/A
C - crownvetch @ 20 lbs/A

All plots: 50 lbs/A N as NH_4NO_3
100 lbs K_2O/A as KCl
4 lbs/A annual ryegrass
30 lbs/A Jamestown creeping red fescue

Plot Size: 30' x 50'

Location: South two replications have southern limit approximately 38' north of reflector post which is second north of sign for "Gretna - 9 miles" in south bound lane. North end of south replications is approximately 60' south of south post holding chain barring crossway.

South end of north replications approximately 18' north of north post holding chain barring crossway. North end is approximately 30' south of north end of concrete triangle by south bound entrance ramp.

Treatments: B = no treatment of existing sod (broadcast)
Z = zip seeding of seed of crownvetch into sod
D = disking of existing sod
p = paraquat applied to sod behind zip seeder rows at 1 qt. per acre of 4" swaths
$\bar{p}$ = no paraquat applied behind zip seed
g = crownvetch seeds coated with gum, innoculant and lime
$\bar{g}$ = no coating on crownvetch seed

	N lbs/A	P_2O_5 lbs/A	K_2O lbs/A
1 =	0	100	50
2 =	50	100	50
3 =	50	200	50

Title: Legume Experiment in a Median

Objectives: Determine effective methods for establishing crownvetch in existing grass sods of highway medians; compare methods of seedbed preparation, seed treatment (coated or not coated with inoculant and lime) and fertilizer rates. Later, assess value of crownvetch as aid in long term low maintenance vigorous median vegetation.

Location: South of mile post 140 in Salem on Route 81 median.

Established: 24-25 August 1977

N

	I	II		III	IV	
20'	1	3		1	3	
$Zp\bar{g}$	3	2	$B\bar{g}$	2	2	Zpg
	2	1		3	1	
	3	2		3	2	
$Z\bar{p}g$	1	3	Zpg	2	3	$Z\bar{p}\bar{g}$
	2	1		1	1	
	3	2		2	3	
Bg	2	1	Dg	1	2	$D\bar{g}$
	1	3		3	1	
	2	1		1	3	
Zpg	1	2	$D\bar{g}$	3	1	Dg
	3	3		2	2	
	1	2		3	2	
$D\bar{g}$	2	3	$Z\bar{p}\bar{g}$	2	1	$B\bar{g}$
	3	1		1	3	
	3	2		2	1	
$Z\bar{p}\bar{g}$	1	1	$Z\bar{p}g$	1	3	$Z\bar{p}\bar{g}$
	2	3		3	2	
	3	1		1	2	
Dg	2	3	Bg	3	1	Bg
	1	2		2	3	
	2	1		3	1	
$B\bar{g}$	3	2	$Zp\bar{g}$	1	2	$Zp\bar{g}$
	1	3		2	3	

S

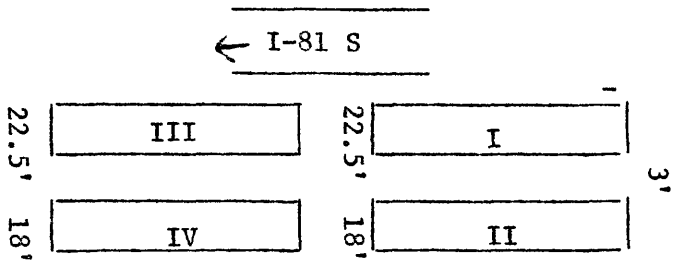
Treatments

B = no treatment of existing sod (broadcast)
Z = zip seeding of seed of crownvetch into sod
D = disking of existing sod
p = paraquat applied to sod behind zip seeder rows @ 1 qt./A of 4" swaths
$\bar{p}$ = no paraquat applied behind zip seeder
g = crownvetch seeds coated with gum, inoculant, and lime
$\bar{g}$ = no coating on crownvetch seed

Fertilizer rates (lbs/A)

1 = 0 N, 100 P_2O_5, 50 K_2O
2 = 50 N, 200 P_2O_5, 50 K_2O
3 = 50 N, 100 P_2O_5, 50 K_2O

Crownvetch @ 10 lbs/A on all plots.



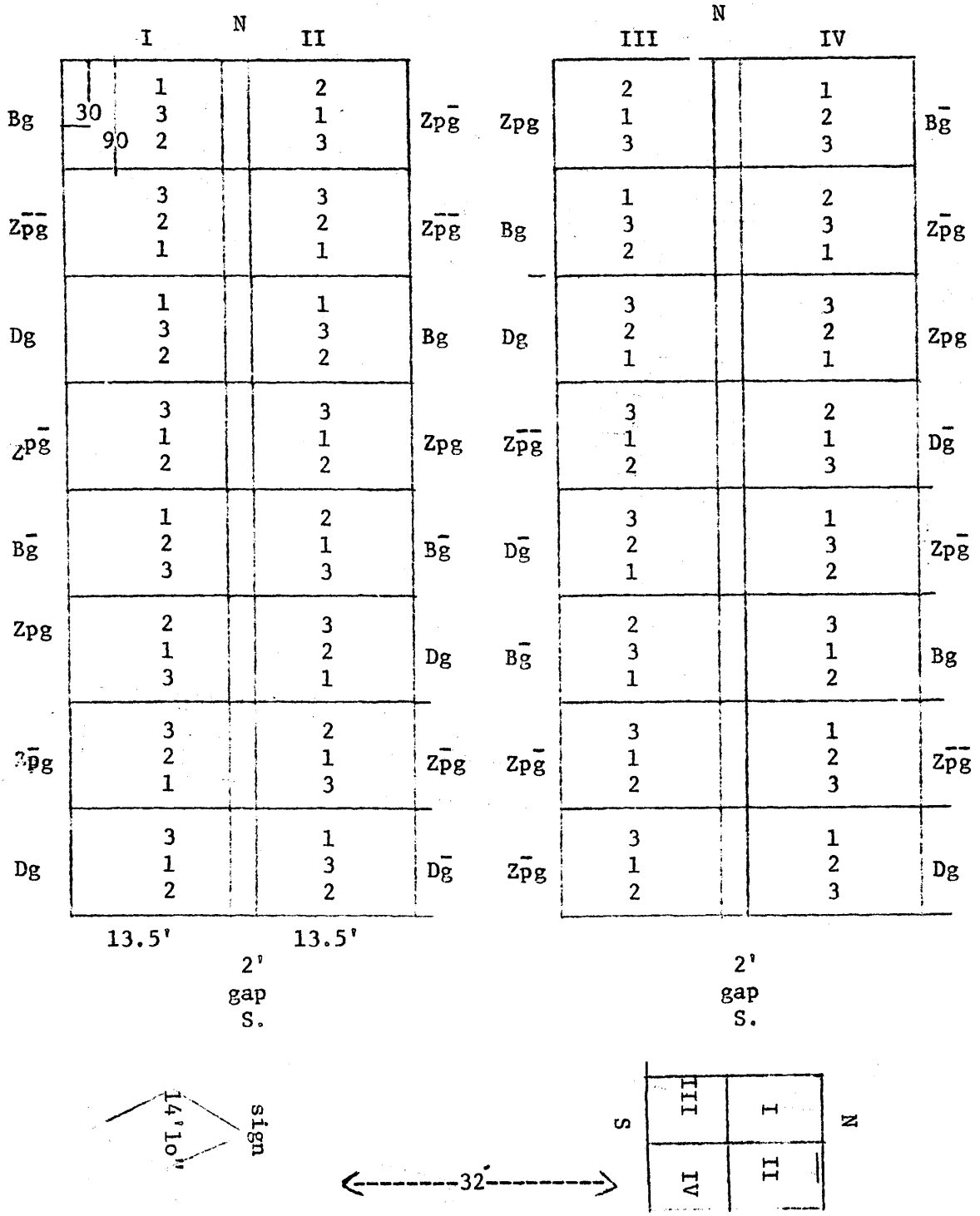
Title: Legume Experiment in a Median

Objectives: Determine effective methods for establishing crownvetch in existing grass sods of highway medians; compare methods of seed bed preparation, seed treatment (coated or not coated with innoculant and lime) and fertilizer rates. In future, assess value of crownvetch as aid in long term, low maintenance, vigorous median vegetation.

Site: South of M. P. 172, in Botetourt County on Route 8 median.

Established: 1-2 Sept. 1977

I-81, S. of M.P. 172

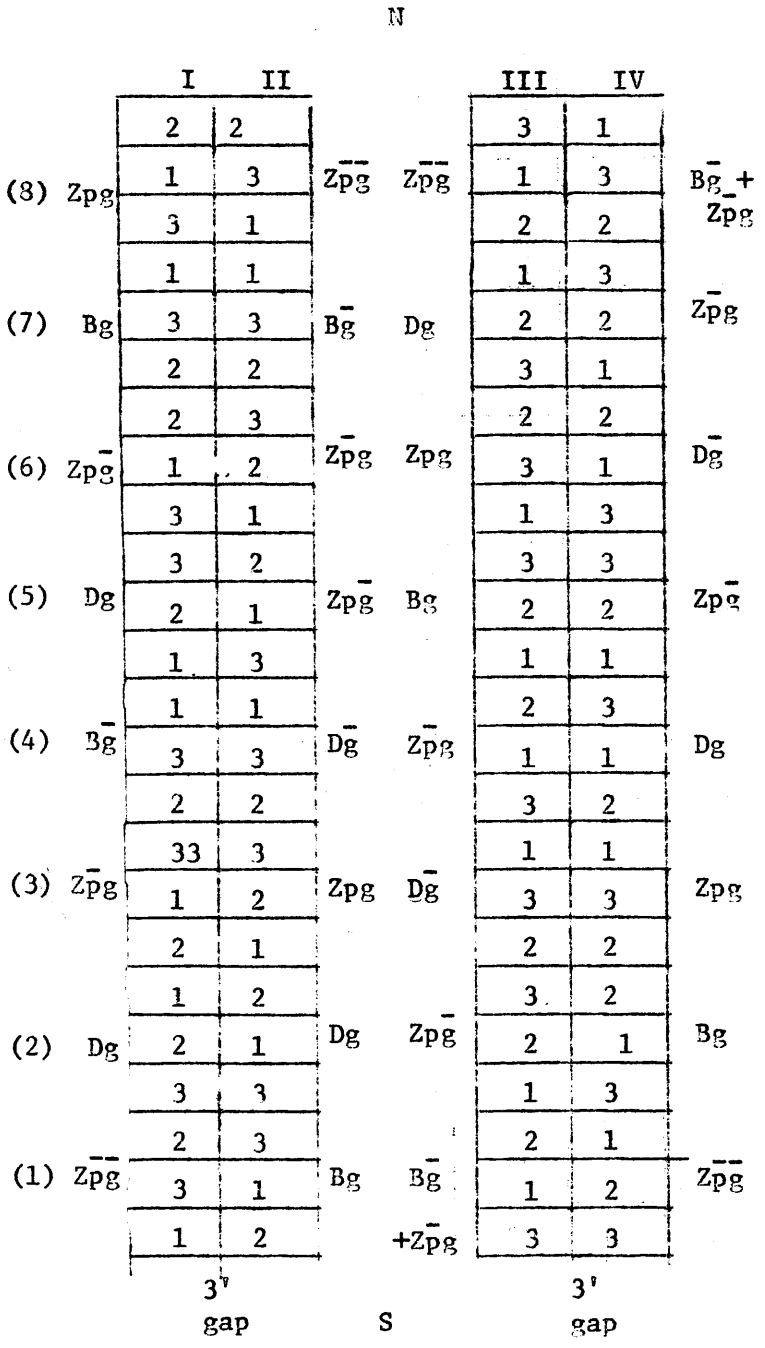


Title: Legume Experiment in Median

Objectives: Determine effective methods for establishing crownvetch in in existing grass sods of highway medians; compare methods of seed bed preparation, seed treatment and fertilizer rates. Later, assess value of crownvetch as an aid in long term low maintenance vigorous median vegetation.

Site: Median, Route 29, on either side of overpass of south Hurt exit.

Established: 18-19 September 1977



Treatments:

B = no treatment of existing sod (broadcast)

Z = zip seeding of seed of crownvetch into sod

D = disking of existing sod

P = paraquat applied to sod behind zip seeder rows at 1 qt./A of 4" swaths

p̄ = no paraquat applied behind zip seeder

g = crownvetch seeds coated with gum, inoculant, and lime

ḡ = no coating on crownvetch seed

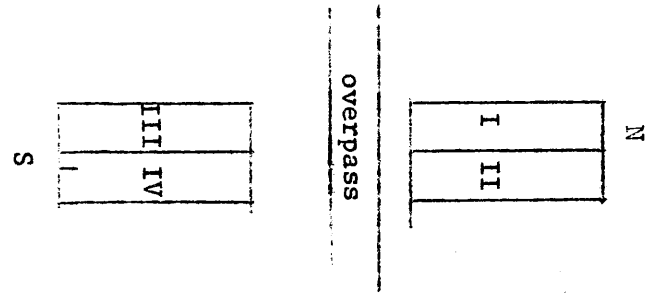
Fertilizer rates (lbs/A)

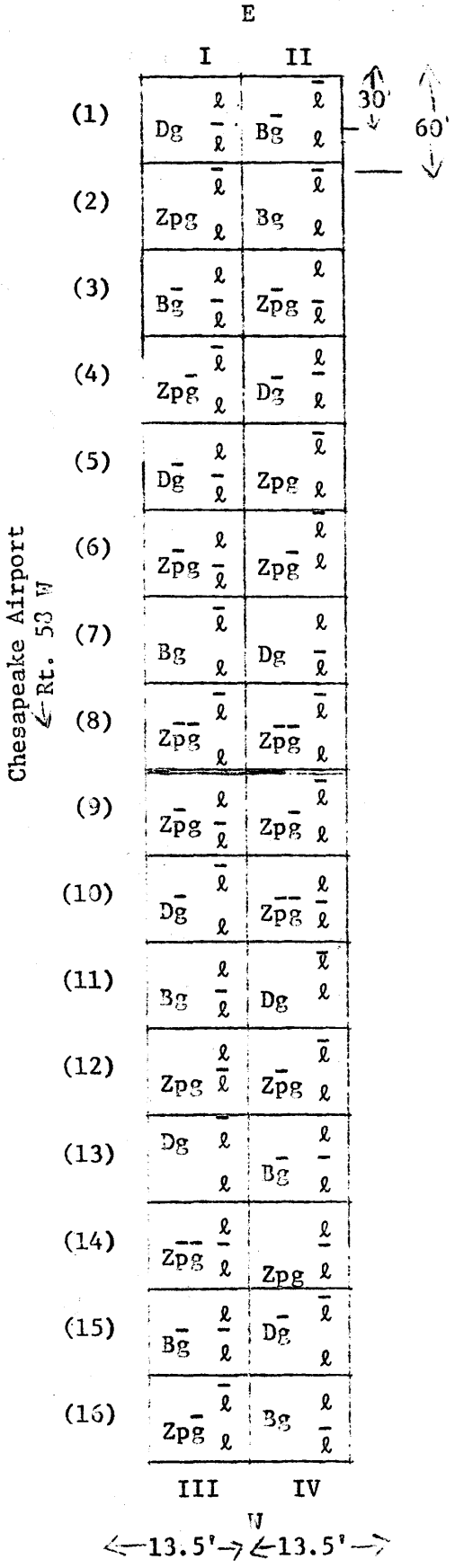
1 = 0 N, 100 P_2O_5, 50 K_2O

2 = 50 N, 100 P_2O_5, 50 K_2O

3 = 50 N, 200 P_2O_5, 50 K_2O

Crownvetch @ 10 lbs/A on all plots.





Title: Legume Experiment in a Median

Objective: Assess methods for establishment of crownvetch in median strip in Coastal Plain with bermudagrass sod.

Site: Median strip adjacent to Rt. 58 west bound just to west from Chesapeake Airport, Chesapeake.

Established: 27-28 September 1977.

Treatments:

B = no treatment of existing sod (broadcast)
Z = zip seeding of seed of crownvetch into sod
D = Disking of existing sod
p = paraquat applied to sod behind zip seeder rows at 1 qt./A of 4" swaths
$\bar{p}$ = no paraquat applied behind zip seeder
g = crownvetch seeds coated with gum, inoculand, and lime
$\bar{g}$ = no coating on crownvetch seed

ℓ = lime at 1 ton/A
$\bar{\ell}$ = no lime

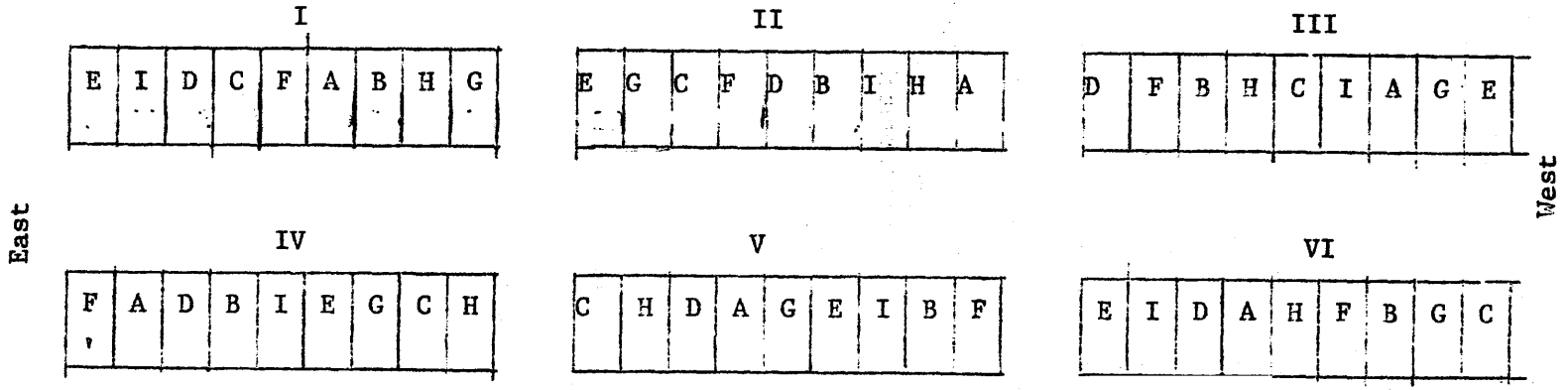
All plots

P_2O_5 at 100 lbs/A

K_2O at 50 lbs/A

Crownvetch at lbs/a

Title: Mowing Management of Crownvetch and Tall Fescue in a Median
Objective: Determine mowing regime which will maintain compositional balance in legume-grass stand in medians.
Location: I-64, Lexington, immediately west of Route 11 crossover in median.



Plot sizes: I = 15' x 40' II-VII = 25' x 60'

Treatments (± 2 days)

A = no mosing

B = a) mow 15 May @ 4"
b) mow 1 July @ 4"
c) mow 15 Aug @ 4"

C = a) mow 15 May @ 8"
b) mow 1 July @ 8"

D = a) mow 1 June @ 4"
b) mow 1 Aug @ 4"

±E = a) mow 1 Jun @ 8"
b) Mow 1 Aug @ 8"

F = a) mow 15 Jun @ 4"
b) mow 15 Aug @ 4"

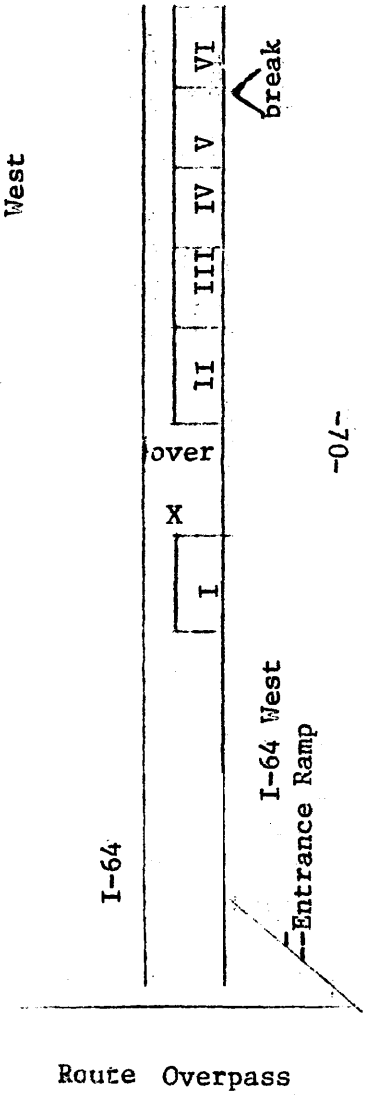
G = a) mow 15 Jun @ 8"
b) mow 15 Aug @ 8"

H = mow 15 Jun @ 8"

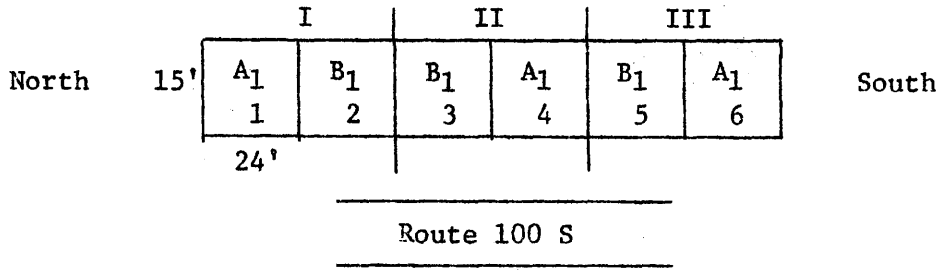
I = mow 15 Jun @ 4"

*This treatment in block VI left unmowed after May 15 mowing

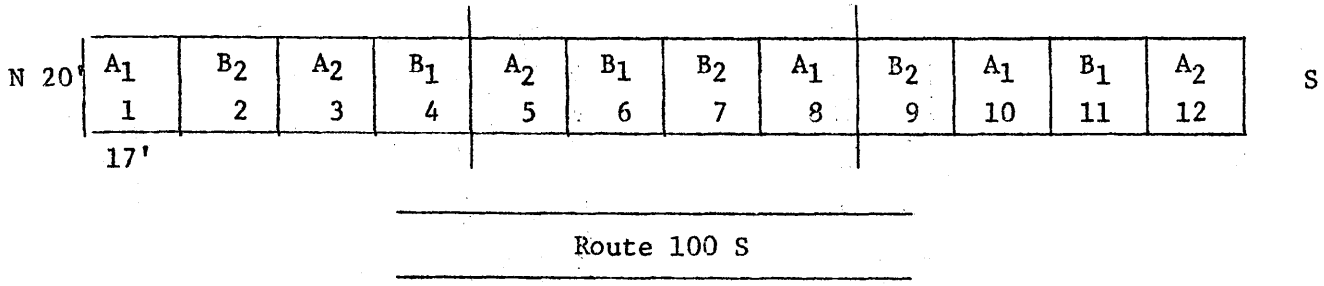
+E treatment had first mowing at 15 June in 1977 rather than June 1



Title: Seed Coating Experiments at Cloyd's Mountain
Objective: Evaluate practice of pelletting inoculant with legume seeds.
Location: West facing cut slope, Route 100, immediately south of Cloyds Mt. Truck Stop, Pulaski Co. Thin stand of tall fescue.
Soil: Red shale parent material. pH (H_2O) - 7; ($CaCl_2$) - 6.3; Ca - VH; Mg - VH; P - VH; K - H.
Established: 14 April 1977.



Objective: Assess use of pelletting of inoculant with legume seeds and use of lime for renovating failing cut slopes.
Location: West facing cut slope, Route 100 by 733 sign, Pulaski Co.
Soil: pH (H_2O) - 5.2, ($CaCl_2$) - 4.1; Ca - L; Mg - H+; P - M; K - M+.
Established: 14 April 1977.



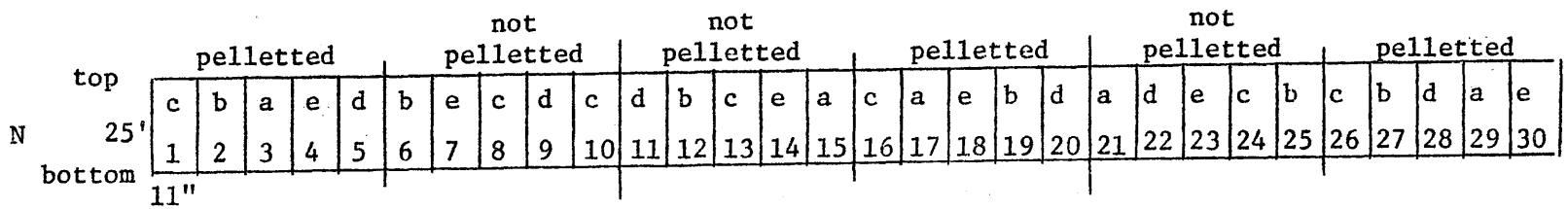
Treatments: All plots: 30 lbs N/A as NH_4NO_3
200 lbs P_2O_5/A as con super
100 lbs K_2O/A as KCl
6 lbs/A annual ryegrass
10 lbs/A Ky 31

A = flat pea @ 20 lbs/A, pelletted
B = flat pea @ 20 lbs/A, not pelletted

sub 1 = no lime
sub 2 = lime (dolomitic) @ 2 tons/A

Inoculant for non-pelletted subplots put on by hydroseeder.
Stakes at top of slope between and at ends of replications.
Woodfiber applied @ 750 lbs/A before hand seeding flat pea and 750 lbs/A thereafter.
Dry weather for 10 days previous.

Title: Perennial Sweetpea Renovation Experiment
Objective: Evaluate methods for establishment of sweet pea in patchy median slope
Location: Sloping median, just south of Rapidan River in Greene County
Established: 11 August 1977



Route 29 S →

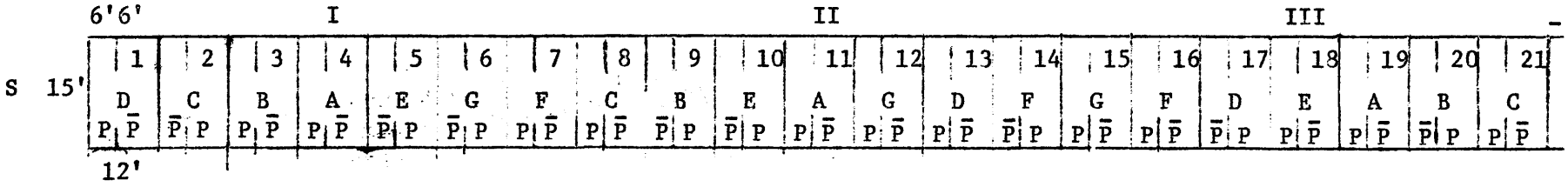
Treatments: seeding methods for sweet pea

a) broadcast on surface @ 20 lbs/A
b) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed on surface
c) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed at 1-1/4" depth
d) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed on surface in rototilled strip
e) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed at 1-1/4" depth in rototilled strip

pelletted: seed coated with gum, inoculant, lime
non pelletted: seed not coated, inoculant applied loose

All plots: Ky 31 @ 50 lbs/A
German millet @ 20 lbs/A
15-30-15 @ 333 lbs/A
straw @ 3000 lbs/A
woodfiber @ 750 lbs/A

Title: Mulch and Seed Coating Experiment.
Objective: Assess value of paper fiber as mulch for vegetation establishment
Site: Route 17, South of Saluda
Established: 7 Sept. 77

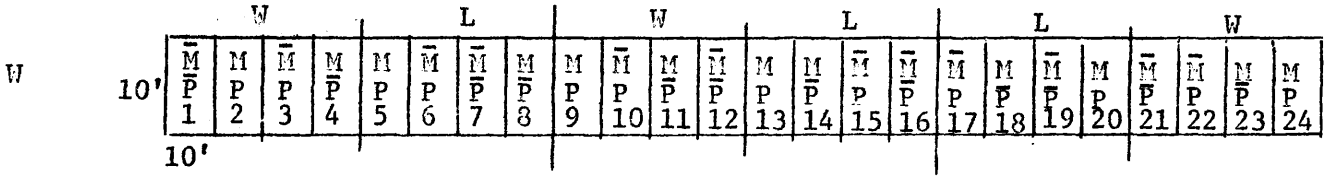


Route 17

A = straw @ 3000 lbs/A + woodfiber @ 750 lbs/A
B = straw @ 3000 lbs/A + paper fiber @ 750 lbs/A
C = woodfiber @ 1500 lbs/A
D = woodfiber @ 2500 lbs/A
E = paper fiber @ 1500 lbs/A
F = paper fiber @ 2500 lbs/A
G = no mulch

P = crownvetch @ 20 lbs/A, pelletted
P̄ = crownvetch @ 20 lbs/A, no pelletted

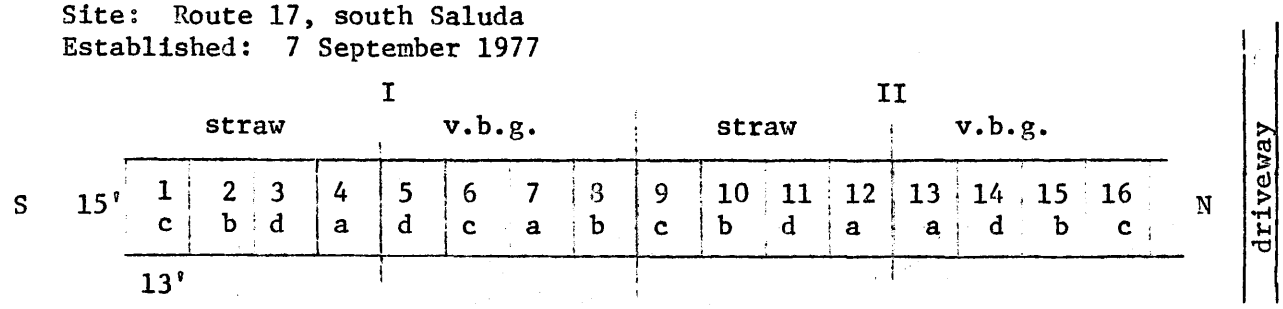
Title: Lovegrass and Molybolenum Experiment.
Objectives: Assess value for sericea lespedeza establishment in the Coastal Plain of: 1) pelletting inoculant with seed; 2) addition of molybdenum to soil; and 3) Lehmann lovegrass as companion species
Location: Route 604, north of Route 58 bypass, Suffolk; south facing cut slope
Established: 3 August 1977



Treatments: All plots: sericea @ 30 lbs/A
lime @ 1 ton/A
15-30-15 @ 667 lbs/A
straw @ 3000 lbs/A
woodfiber @ 750 lbs/A

P = sericea seed pelletted with inoculant
P̄ = sericea seed not pelletted
M = Mo @ 2 oz./A
M̄ = no Mo
W = weeping lovegrass @ 10 lbs/A
L = Lehmann lovegrass @ 10 lbs/A

Title: Micronutrient Experiment
Objectives: Determine if micronutrient deficiency may be limiting establishment of legumes in highway cut sites in the Coastal Plain.
Site: Route 17, south Saluda
Established: 7 September 1977



Route 17

Treatments: Main plots: straw @ 3000 lbs/A
Ky-31 @ 50 lbs/A
annual ryegrass @ 7 lbs/A
woodfiber @ 750 lbs/A
Straw

velvet bentgrass @ 15 lbs/A
annual ryegrass @ 7 lbs/A
woodfiber @ 1500 lbs/A
v.b.g.

Subplots: a = no micronutrients
b = Mo @ 2 oz/A
c = Mo @ 2 oz/A
Cu @ 2 lbs/A
Zn @ 3 lbs/A
Fe @ 5 lbs/A
Mn @ 5 lbs/A
B @.5 lbs/A
d = Mo @ 15 oz/A
Cu @ 6 lbs/A
Zn @ 9 lbs/A
Fe @ 15 lbs/A
Mn @ 15 lbs/A
B @ 1.5 lbs/A

All plots: sericea @ 30 lbs/A
crownvetch @ 20 lbs/A
flat pea @ 10 lbs/A
sweet pes @ 10 lbs/A

all seeds pelletted; weights based on unpelletted weight

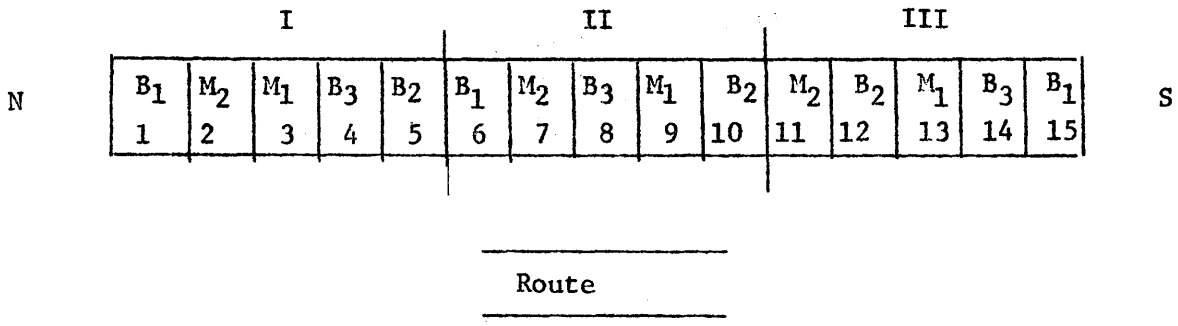
15-30-15 @ 667 lbs/A
lime @ 2 tons/A

Title: Summer Annual Companion Species Experiment

Objective: Evaluate use and rates of buckwheat and Japanese millet as summer annual companion species for establishment of crownvetch.

Location: Route 644, Floyd Co. Cut slope central of three experimental sites, next to orchard.

Established: 26 May 77



Treatments:
M_1 = 20 lbs/A German millet
M_2 = 30 lbs/A German millet
B_1 = 20 lbs/A Buckwheat
B_2 = 40 lbs/A Buckwheat
B_3 = 60 lbs/A Buckwheat

All plots:
15-30-15 @ 667 lbs/A
lime @ 2 tons/A
annual ryegrass @ 5 lbs/A
woodfiber @ 1500 lbs/A
Ky 31 fescue @ 60 lbs/A
crownvetch @ 20 lbs/A

Sweet pea planted approximately 1 inch deep at 1 foot intervals with hand planter across top of experiment.

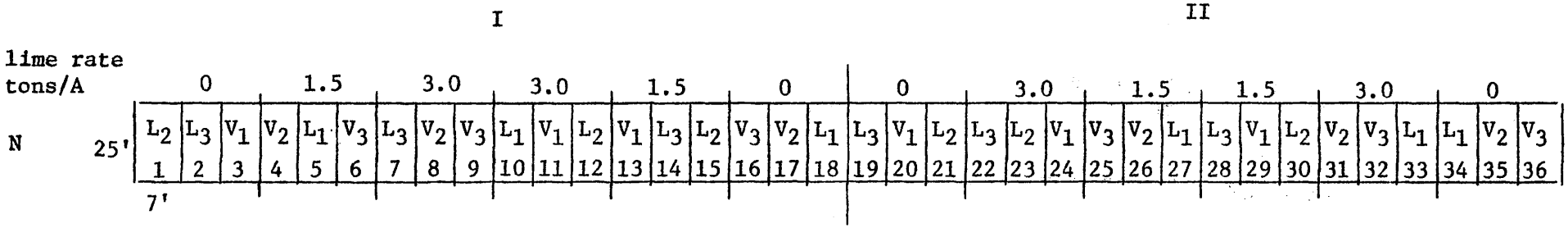
Title: Summer Annual Companion Species Experiment
Objective: Evaluate use and rates of buckwheat and Japanese millet as summer annual companion species for establishment of crownvetch.
Location: Route 735, Galax
Established: 20 June 1977

	I					II					III					
N	B_1	M_2	M_1	B_3	B_2	B_1	M_2	B_3	M_1	B_2	M_2	B_2	M_1	B_3	B_1	S
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

Treatments:
M_1 = Japanese millet @ 20 lbs/A
M_2 = Japanese millet @ 30 lbs/A
B_1 = Buckwheat @ 20 lbs/A
B_2 = Buckwheat @ 40 lbs/A
B_3 = Buckwheat @ 60 lbs/A

All plots:
15-30-15 @ 667 lbs/A
lime @ 2 tons/A
annual ryegrass @ 5 lbs/A
woodfiber @ 1500 lbs/A
Ky 31 fescue @ 60 lbs/A
crownvetch @ 20 lbs/A

Title: Lehmann Lovegrass and Velvet Bentgrass Experiment
Objective: Evaluate usefullness of velvet bentgrass and Lehmann lovegrass at several lime and seeding rates as companion species for establishment of crownvetch.
Location: Route 644, Floyd Co., most NW of three experimental sites.
Established: 26 May 77

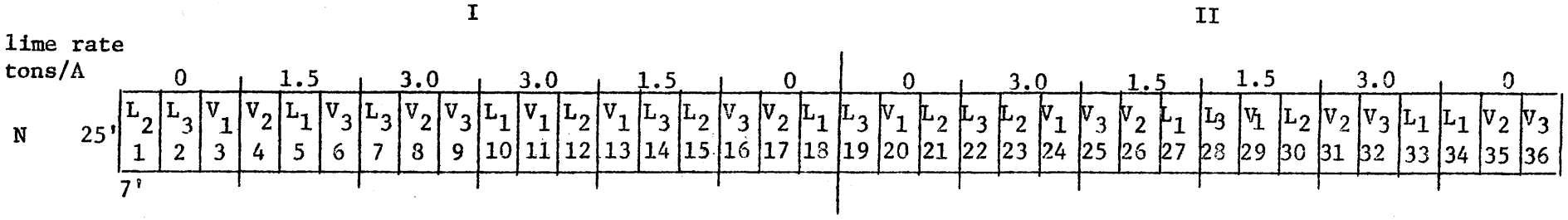


Treatments: lime @ 0, 1.5 and 3.0 tons/A

L_1 = Lehmann lovegrass @ 5 lbs/A
L_2 = Lehmann lovegrass @ 10 lbs/A
L_3 = Lehmann lovegrass @ 15 lbs/A
V_1 = Velvet bentgrass @ 10 lbs/A
V_2 = Velvet bentgrass @ 30 lbs/A
V_3 = Velvet bentgrass @ 60 lbs/A

All plots: 15-30-15 @ 667 lbs/A
woodfiber @ 1500 lbs/A
crownvetch @ 20 lbs/A

Title: Lehmann Lovegrass and Velvet Bentgrass Experiment
Objective: Evaluate usefullness of velvet bentgrass and Lehmann lovegrass at several lime and seeding rates as companion species for establishment of crownvetch.
Location: Route 735, Galax
Established: 20 June 1977

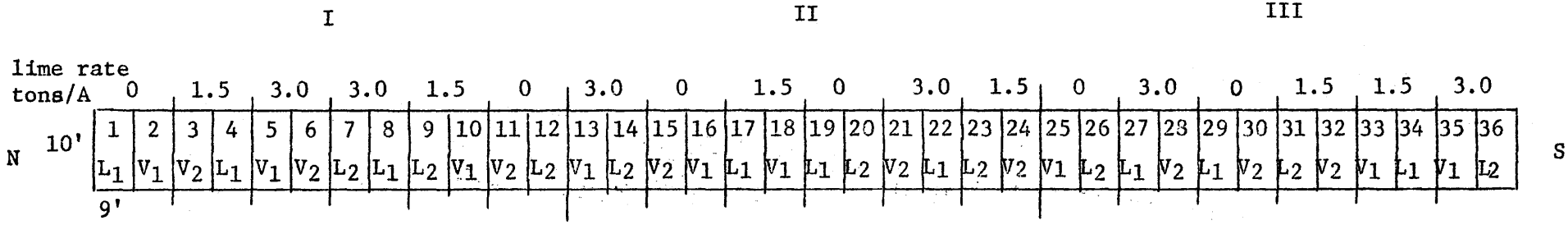


Treatments: lime @ 0, 1.5 and 3.0 tons/A

L_1 = Lehmann lovegrass @ 5 lbs/A
L_2 = Lehmann lovegrass @ 10 lbs/A
L_3 = Lehmann lovegrass @ 15 lbs/A
V_1 = Velvet bentgrass @ 10 lbs/A
V_2 = Velvet bentgrass @ 30 lbs/A
V_3 = Velvet bentgrass @ 60 lbs/A

All plots: 15-30-15 @ 667 lbs/A
woodfiber @ 1500 lbs/A
crownvetch @ 20 lbs/A

Title: Lehmann Lovegrass and Velvet Bentgrass Experiment.
Objective: Assess use of Lehmann lovegrass and velvet bentgrass for use as companion grass for establishment of perennial sweet pea.
Location: West facing slope, Route 460, Pittsylvania Co.
Established: 8 July 1977.

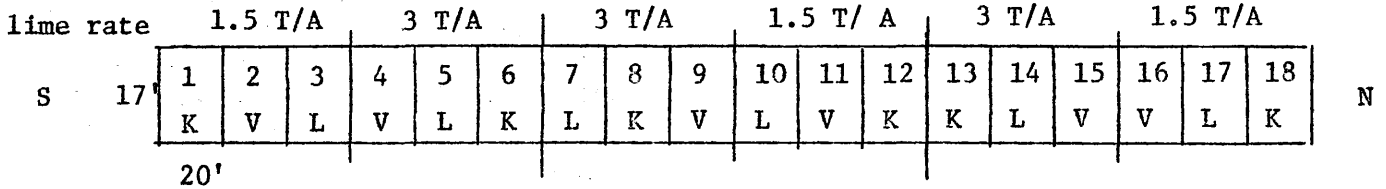


Treatments: dolomitic lime @ 0, 1.5, and 3.0 tons/A
V_1 = velvet bentgrass @ 10 lbs/A
V_2 = velvet bentgrass @ 30 lbs/A
L_1 = Lehmann lovegrass @ 10 lbs/A
L_2 = Lehmann lovegrass @ 20 lbs/A

All plots: perennial sweet pea @ 20 lbs/A
15-30-15 @ 667 lbs/A
woodfiber @ 1500 lbs/A

Title: Lehmann Lovegrass, Velvet Bentgrass, German Millet Experiment
Objective: Evaluate use of Lehmann lovegrass and velvet bentgrass as companion species for establishment of crownvetch in the Piedmont.
Location: Route 640, Pittsylvania County
Established: 19 July 1977

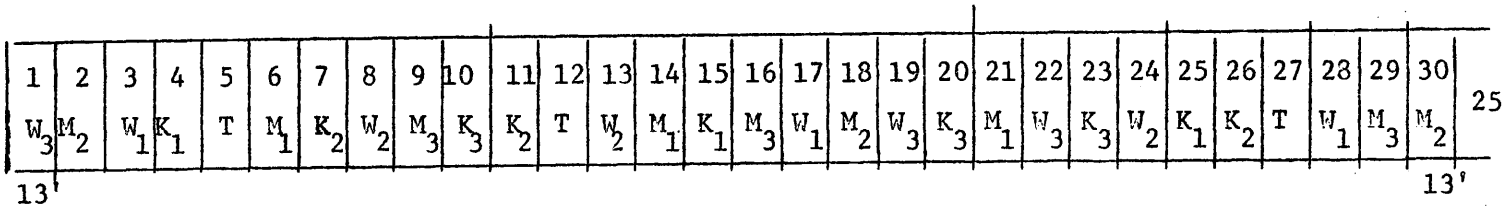
This is quite sandy material.



Treatments: lime: 1.5 or 3 tons/A
V = velvet bentgrass @ 30 lbs/A
L = Lehmann lovegrass @ 10 lbs/A
K = Ky 31 fescue @ 60 lbs/A + German millet @ 20 lbs/A

All plots: 667 lbs/A 15-30-15
1500 lbs/A woodfiber
20 lbs/A crownvetch
1.5 T/A lime
1.5 T/A straw

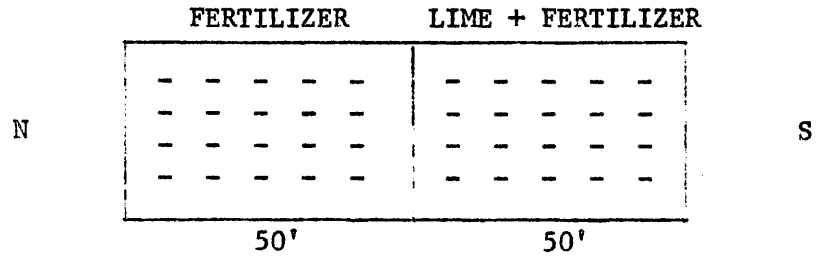
Title: Flatpea companion species experiment.
Objective: Evaluate several perennial grass companion species at several rates for effectiveness in establishment of flatpea.
Site: Route 644, Floyd County, just north of bridge
Established: 10 June 1977



Treatments:
K_1 = Koket chewings fescue @ 15 lbs/A
K_2 = Koket chewings fescue @ 50 lbs/A
K_3 = Koket chewings fescue @ 90 lbs/A
M_1 = Manhattan perennial ryegrass @ 25 lbs/A
M_2 = Manhattan perennial ryegrass @ 60 lbs/A
M_3 = Manhattan perennial ryegrass @ 90 lbs/A
W_1 = Weeping lovegrass @ 5 lbs/A
W_2 = Weeping lovegrass @ 10 lbs/A
W_3 = Weeping lovegrass @ 15 lbs/A
T = Ky 31 tall fescue @ 60 lbs/A

All plots: 15-30-15 @ 667 lbs/A
lime @ 2 tons/A
woodfiber @ 1500 lbs/A
annual ryegrass @ 3 lbs/A
flatpea @ 20 lbs/A

Title: American Beach Grass Experiment
Location: East cut slope immediately north of Bastian exit on Route 77, Bland County.
Objective: Assess use of American beach grass on very mobile, coarse textured slopes.
Established: April 5, 1977



Beach grass planted in hills, 5 culms per hill, 18-24" apart, in 4 rows. In each hole for a hil threw]/2 handfull of 10-20-10 fertilizer plus like of lime where applicable.

Soil: very fissile shale supporting very scant vegetation, none over greater part. pH in H_2O of some of more weathered material was 4.1