# IMPROVING VEGETATION AND MOWING MANAGEMENT IN HIGHWAY CORRIDORS

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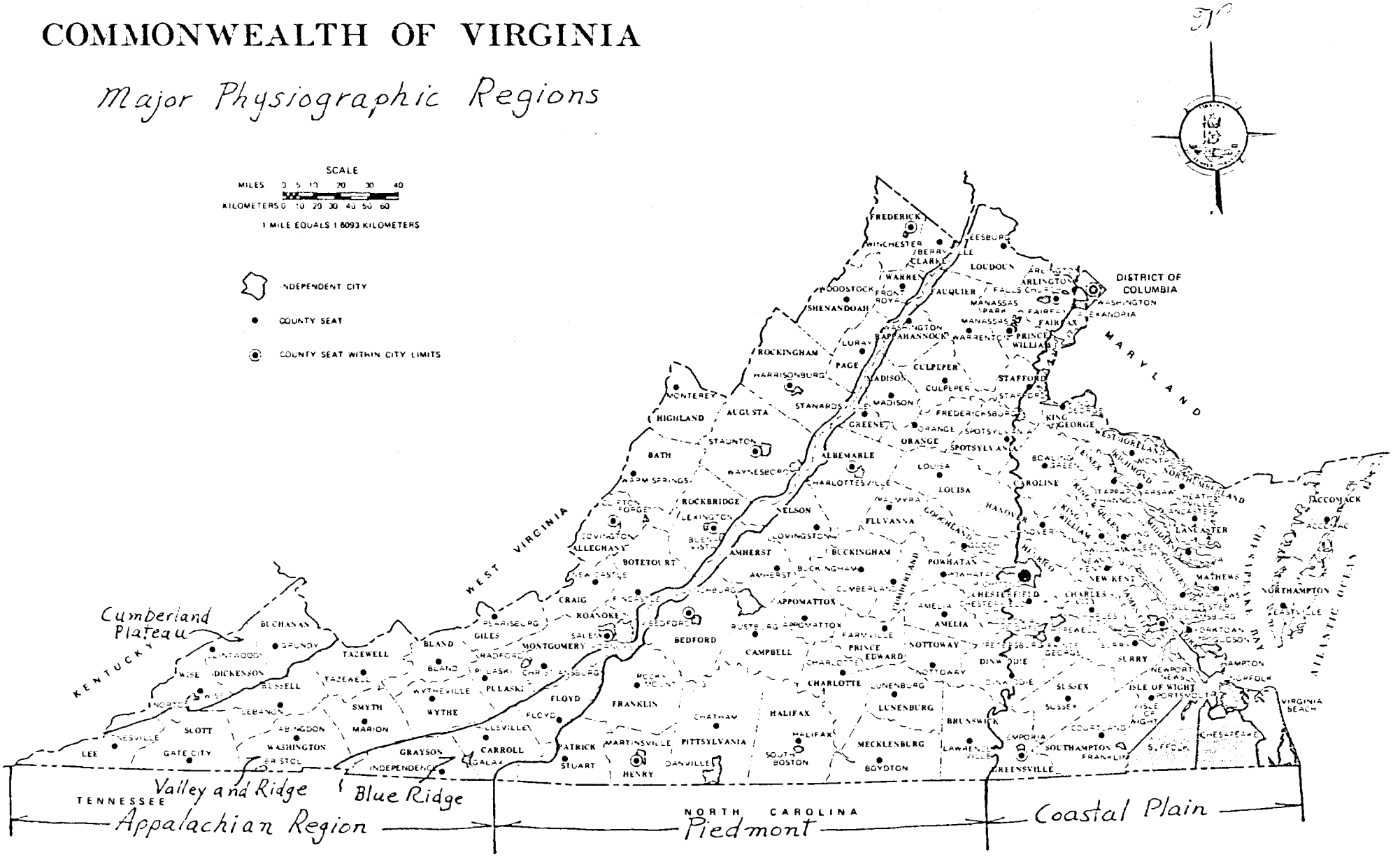
## ABSTRACT

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 cut slopes and medians with degenerating grass sods. Late winter seedings in medians were highly successful where seedbeds were prepared with a field cultivator. 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. German millet plus tall fescue were found to be the best associates for summer establishment of sericea lespedeza. Weeping lovegrass reduced sericea establishment by competing strongly in the summer, but was the best associate for establishment of crownvetch because lovegrass grows poorly when crownvetch grows vigorously. Lehmann lovegrass is not adapted to Virginia. Successful seedings of velvet bentgrass as a perennial companion 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. Limestone gravel filled trenches successfully moderated extreme acid conditions on a cut slope where sulfides had been exposed.

# COMMONWEALTH OF VIRGINIA

## Major Physiographic Regions

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# SUMMARY OF RESEARCH

## 1.1 PERENNIAL LEGUMES

### 1.1.1 Introduction

Because soil materials in highway corridors initially have negligible quantities of nitrogen supplying organic matter and because nitrogen applied as a 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.

### 1.1.2 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 winterkilling 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 advances into areas where sericea lespedeza has died. 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 noticeable 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 has 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 crownvetch 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 established 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. At the west end of the Farmville bypass of Route 460 crownvetch seeded in March 1977 has achieved 100 per cent cover where seeded and has begun to spread into the thin median grass adjacent to the experiment. In a very wide median of Route 29 near Hurt, seeded in April 1977, crownvetch had achieved an average cover of 63 per cent by June 1979. It appears that the warm season vegetation dominating the weak median turf in medians of these Piedmont sites has not been strongly competitive toward crownvetch. This is attributed to crownvetch growing vigorously during spring and fall as compared to warm season species, especially legumes. Crownvetch seedings in 1977 and 1978 in medians with varying degrees of vegetative growth 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 wide medians of I-64 in the limestone valley area west of the Blue Ridge where it was seeded when turf was initally 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 spring rainfall than 1977 and 1978. Demonstration seedings of crownvetch in wide medians in late winter 1979 in the Coastal Plain and in the Piedmont, where seedbeds were prepared by tillage with a field cultivator, in all cases show strong seedling establishment.

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 stair step 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. This species may also be better adapted in poorly drained areas.

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 1-1/2 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 and 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 sweet pea 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 sparsely 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 proven to be poorly adapted to conditions in Virginia. These legumes are perennials in regions where they are adapted.

### 1.1.3 Cultural Practices for Establishing Perennial Legumes

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 seedings 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 these seedings. 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, residual nutrients from previous fertilizer being adequate.

Several experiments were conducted in the Coastal Plain region with micronutrients nutrients to find whether they enhance establishing and persistence 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 species, 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.

It appears that micronutrients will not aid the establishment of legumes in the Coastal Plain region.

## 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 legumes seeds with gum accacia and lime, as this technique has been reported to improve the nodulation of legumes (Holland and Sweet, 1968; 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.

An experiment has been established to determine if lack of inoculant may retard spread of crownvetch.

## 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.

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 (Clarkson, 1966). 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, observations in spring 1979 of stands seeded in 1977 revealed relatively rapid decline in vigor as compared with Ky-31 tall fescue.

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.

Findings from a summer companion species experiment of 1978 in Floyd County suggest that weeping lovegrass is

superior to German millet plus tall fescue as a plant associate for establishment of crownvetch. This warm season grass does not compete with crownvetch in early spring and fall when crownvetch growth is most vigorous.

By contrast, data collected from experiments initiated in 1974 and 1975 demonstrate that German millet plus tall fescue are more desirable than lovegrass as companion species for sericea establishment in summer seedings. Sericea is a warm season species which is harmed by the strong competition of lovegrass during the summer. Growth of tall fescue is poor during the high temperatures of summer and, thus, it competes weakly when sericea growth is strong.

Crownvetch has proved capable of much more rapid spread than flatpea, sweetpea and sericea lespedeza on experiments established under the current and the previous contract. Inclusion of crownvetch in seedings of flatpea and sweetpea is recommended since crownvetch is able to establish more quickly a strong cover to exclude weeds and retard woody species invasion. In many regions of the state pea species will later, slowly succeed crownvetch as the pea species appear better adapted in the long term, though capable of less rapid spread.

## 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 the few 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 demonstrated that these relatively large legume seeds had 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 2 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.

Seedbed preparation by field cultivation in late winter 1979 has proved completely successful for introduction of crownvetch and perennial pea species at demonstration seeding sites in the Piedmont and Coastal Plain.

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. Such tillage by field cultivator on the hard packed portion of the Route 29 x 903 site permitted establishment of a strong stand of crownvetch seedlings by June 1979 from seedings made in early March.

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. Extension of the use of crownvetch into the winter season was investigated with the use of unhulled crownvetch seed.

Counts of crownvetch seedlings in spring 1979 following a January 1978 seeding revealed insignificant differences between seedings of hulled and unhulled crownvetch seed. At the same site effectiveness of rye in winter seedings and interactions with emerging crownvetch was assessed. Of 200 lbs/A rye seeded in January, 18 per cent had established plants by spring though with few tillers; mean plant density of 14/ft$^2$ afforded an adequate plant cover which did not significantly suppress emerging crownvetch seedlings.

Data from the experiments of the current as well as the previous project show that the seeding of legumes into medians and cut slopes 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 weak seedling vigor and is usually eliminated by competition from the aggressive existing vegetation in the fall. Also, fall developing seedlings will likely be winterkilled, unless they reach heights of more than 2 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.

## 1.2 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, Route 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, initially 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 on Route 460 west of Farmville) in an experiment established 3 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 continuously 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. A demonstration seeding at the Greenbay site of crownvetch, flatpea and perennial sweetpea established in March 1979 with seedbed prepared by field cultivator has developed a vigorous and dense stand of legume seedings which promises to rapidly develop a persistent and attractive plant cover to suppress weeds at this problem site.

## 1.3 MOWING MANAGEMENT

### 1.3.1 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 seedheads 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 quadrant areas were accidently mowed by highway personnel at the beginning of June, thereby confounding part of the experiment. For quadrats not accidentally mowed, tiller counts made in spring 1979 did not show tillering density to be differentially affected by mowing regimes.

### 1.3.2 Grass-Legume Turf

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 height 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.

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 personnel at least once each year for 2 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.

Flatpea

A dense cover of flatpea along the Route 15 entrance ramp to the Route 460 bypass at Farmville is persisting under a standard highway mowing management which has included at least two mowings in a growing season.

## 1.4 RENOVATION OF CUT SLOPE VEGETATION

Where perennial legumes are not well established on cut slopes, grass covers inevitably decline due to insufficient available nitrogen. Species which often invade degenerating grass covers are noxious weeds whose removal may be mandated by law. Thus, in Augusta and Madison Counties, for example, considerable expense is entailed in the herbicidal control of thistles (*Cirsium* spp.) whose infestation in tall fescue serves as a seed source which may contaminate agricultural areas adjacent to highways. Degenerated grass covers also increase the probability of erosion with ensuing costs for spring cleaning of ditches and sedimentary pollution of water sources. Among woody species which invade weak grass stands

black locust, a leguminous tree, is prominent because its nitrogen needs are met by nitrogen fixing bacteria in root nodules and because of rapid vegetative propagation from proliferating roots. Herbicidal control or mechanical removal of such woody species is costly and leaves unsightly patches of dead saplings and grass in the case of herbicidal control.

Observations of excellent covers of crownvetch, flatpea and sweetpea throughout Virginia support and amplify the findings of Sharp and Ross (1978) who reported that crownvetch greatly retarded encroachment of woody species in highway corridors of Pennsylvania. Further, in Virginia, these three legumes develop dense canopies that almost totally exclude weedy species including thistles. It follows that seeding perennial legumes into degenerating vegetation in areas where weeds and woody species need to be excluded is a very desirable practice.

However, the task of legume introduction into weak cut slope vegetation is often difficult. Of six renovation experiments one shows promise of rapid legume establishment; this at Williamsburg along I-64 was seeded in late winter 1979 into a partial stand of weeping lovegrass and supports the principal of late winter seeding for renovation as well as illustrating the desirability of lovegrass over other grass companion species. By spring 1979, crownvetch has begun to be prominent at a legume renovation cite in Madison County seeded in August 1977; however, rate of establishment appears to be much more strongly controlled by variation in existing vegetation than by treatments applied which included N, P, K, lime, Ky-31 tall fescue and herbicide as variables. Renovation experimnets in Charlottesville and in New Kent, Prince Edward and Rockbridge Counties have failed to produce strong leguminous covers by any of the methods assayed. In the first three cases less than optimal timing of seeding combined with abnormally dry conditions probably adequately explains lack of success. Thus, a late winter date for renovation seedings is recommended to maximize favorable moisture conditions for establishment.

At the Fancy Hill, Rockbridge County site, season of seeding was controlled with both fall and late winter seedings of crownvetch and perennial pea species. Failure to establish legumes is notable at this site because the total vegetative cover by knapweed is representative of a significant portion of the vegetative covers encountered adjacent to I-81 in the limestone valley region. The Fancy Hill site had begun by spring 1979 to yield to encroachment by the annual legume, hop clover, indicating that the nitrogen status had declined to the point where the deep rooted perennial, knapweed itself was weakened by poor fertility. Though knapweed may succumb to invasion by the

legume, hop clover, this latter species is unlikely to adequately stabilize slopes since it dies back in summer.

Subsurface seeding of perennial pea species, tested for renovation purposes, has improved rate of seedling establishment as compared to surface application of seed. However, methods of subsurface seeding of crownvetch should be investigated as this legume spreads more rapidly than either of the two perennial pea species. Subsurface seeding of crownvetch for knapweed dominated slopes is likely to prove more successful than surface seedings as it is postulated that a large population of seed eating insects is attracted by the profuse seeding of knapweed.

## 1.5 HYDROMULCHING MATERIALS

Many new products claiming to be suitable for application by hydroseeder are being offered for sale for use in highway contracts and by the Virginia Department of Highways and Transportation. Several of these materials were tested under the current contract.

Cellin Fiber Mulch appears to be composed principally of waste magazine paper. Three different grades of this material had been ground to pass 1/4, 3/8, or 1/2 in. screens of a hammermill. The three grades of mulch were applied alone @ 1500 and @ 2500 lbs/A and @ 750 lbs/A as a tacking agent for straw on a fresh cut slope in Blacksburg. Comparison treatments were no mulch and woodfiber mulch. Cellin Fiber Mulches were satisfactory for erosion control and as a tacking agent for straw. However, the largest grind of mulch had an adverse effect on plant emergence, while the two smaller grinds enhanced plant establishment but not as well as woodfiber mulch.

A second experiment in Halifax County assessed the value of the Cellin mulches and Astro-Mulch of United International Chemical Company, Inc. Performance of Cellin mulches was very similar to that observed for the Blacksburg experiment. Astro-Mulch, which is composed of both waste paper and waste cardboard, performed as well or better than woodfiber mulch. However, this test was conducted during the fall seeding season when moisture was more favorable and seed mixes different than for the Blacksburg seeding. Astro-Mulch needs to be tested during the summer season to determine if the papier mache like crust which it forms will prevent emergence of the relatively large sized, emerging shoots of German millet, as was the case for the largest grind of Cellin Fiber Mulch in the Blacksburg test.

## 1.6 LIMING OF ACID SULFATE SITES

At scattered sites throughout the state, extreme acid conditions caused by exposure of sulfidic materials during road constructions have completely thwarted efforts to establish vegetation. The problem material at these sites is principally the iron sulfide, pyrite, which generates four moles of acidity per mole of pyrite as it undergoes oxidation. Sulfides may be concentrated in several kinds of environments: 1) boggy coastal areas where low oxygen, reducing conditions have favored accumulation in recent geological time; 2) consolidated or metamorphosed sediments of Paleozoic age which originally were laid down in circumstances similar to 1). The incomplete section of Bypass 13 in Suffolk illustrates the first type; the acid cuts along I-64 in the Clifton Forge area the second type.

An experiment was initiated on an acid cut slope along I-64 east, near Clifton Forge, to test several methods for moderating extreme acid conditions due to exposure of sulfides. Surface applications of lime at very heavy rates proved incapable of modifying sufficiently the acid conditions. Trenches which had been cut across the slope at 15-foot intervals and filled with limestone gravel raised the pH of the exposed material to values permitting plant growth. Construction and filling of such trenches after completing highway construction is difficult and costly. However, with adequate prediciton of the occurrence of high sulfide material, cut slopes may be constructed in stairstep fashion with filling of the steps with limestone gravel carried out as cuts are constructed. Further, prior identification of sulfidic materials in highway sections will permit specifying the burial in the interior of fill slopes of high sulfur material excavated from cuts, thereby avoiding extreme acid conditions on fill slopes and in medians. Adequate prediction will necessitate identification of geological strata which frequently contain sulfides and the sampling of cores for sulfur content. pH measurements of freshly obtained cores will not indicate the presence of acid producing materials as these remain neutral or alkaline in reaction until oxidized.

## Section 2

## EXPERIMENTS OF THE CURRENT PROJECT

This section gives the objectives and results of new experiments established for this project as well as results for some experiments of previous projects. Diagrams are given in the appendix.

### 2.1 PERENNIAL GRASSES FOR MOWED AREAS

#### 2.1.1 Grass and legume experiment in a median, I-77

Location: I-77, south of New River Bridge. Establishment Date: 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 at 80 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.

#### 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. Flat pea, 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.

### 2.1.2 Grass experiment in a median, Greenbay

Location: Route 360, Greenbay. Establishment Date: 29 March 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, 4.8-5.2; calcium, low- to low; magnesium, low to medium-; phosphorus, low to low+; potassium, low to low+.

After a thorough disking of the site, the following grasses were seeded at 80 lbs/A: Koket 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 applied broadcast 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 of annual ryegrass were applied by hydroseeder.

#### Results and Discussion

Establishment of grass at this site was poor on October 27, 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.

Table 1. Grass and legume experiment in a median; I-77, south of New River; established 15 Oct 76; data collected 27 Oct 78.

| % Grass cover | | | | |
|---|---|---|---|---|
| Chewings fescue | | Hard fescue | Perennial ryegrass | |
| Koket | Jamestown | Biljart | Manhattan | Pennfine |
| 32 | 41 | 74 | 2.0 | 2.3 |

| % Legume cover | | | | | | | |
|---|---|---|---|---|---|---|---|
| Flatpea (lbs/A) | | Sweetpea (lbs/A) | | Milkvetch (lbs/A) | | Trefoil (lbs/A) | |
| 10 | 20 | 10 | 20 | 10 | 20 | 10 | 20 |
| 5.1 | 18 | 0.30 | 0.75 | 3.5 | 5.7 | 5.0 | 17 |

Table 2. Median grass seeding experiment; Route 360, Greenbay; established 29 Mar 77; % grass cover 27 Mar 78.

| | 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 |

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

## 2.2 PERENNIAL LEGUMES IN MEDIANS

### 2.2.1 Legume experiment in a median, Salem

Location: I-81, Salem, north of Exit 40. Establishment date: 11 August 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.

The treatments were laid out in strips 3 feet wide and 4 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 at 20 lbs/A, milkvetch at 15 lbs/A, crownvetch at 15 lbs/A, perennial sweetpea at 25 lbs/A, flatpea at 25 lbs/A, and sericea lespedeza at 35 lbs/A. Phosphorus at 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 seedbed preparation methods.

## 2.2.2 Legume experiment in a median, Farmville

Location: Route 460 west of Farmville. Establishment Date: 9 March 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 sandy 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 at 20 lbs/A on separate plots which were replicated three times in randomized blocks. Over the entire site nitrogen was applied at 50 lbs/A, phosphorus ($P_2O_5$) at 200 lbs/A, potassium ($K_2O$) at 50 lbs/A, lime at 1 T/A, and fine leaved fescue at 30 lbs/A.

### Results and Discussion

By fall 1977 crownvetch had become well established at this site, two plots having 70% cover by crownvetch 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.

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 phosphorus 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.

### 2.2.3 Legume - lime experiment in a median, Gretna

Location: Route 29 south of Gretna. Establishment Date: 31 March 1977.

#### Experimental Methods

This experiment was laid out on a median area of Route 29, Pittsylvania County, in a section on a long hill north of intersection Route 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 at 300 lbs/A and creeping red fescue at 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 replicates 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 sq. ft.). Although sweetpea stands were not large, many of the plants were quite vigorous. On several plots sweetpea was flowering and had set seed.

Table 3. Legume experiment in a median; I-81, Salem; established 17 Aug 76; data collected 11 Nov 78.

| Seedbed preparation | Crownvetch plants/plot | Crownvetch GI* | Flatpea plants/plot | Flatpea GI | Perennial sweetpea plants/plot | Perennial sweetpea GI |
|---|---|---|---|---|---|---|
| Check | 0 | 0 | 10 | 159 | 20 | 294 |
| Rototilled | 0 | 0 | 7.3 | 127 | 17 | 230 |
| Sprayed w/ paraquat | 0.3 | 4 | 10 | 156 | 32 | 492 |

* GI = plants/plot x average height

Table 4. Legume experiment in a median; Route 460 west of Farmville; established 9 Mar 77.

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

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 | 398 lbs/A |
| Phosphorus | 250 lbs/A | 121 lbs/A |
| Potassium | 146 lbs/A | 127 lbs/A |

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.

### 2.2.4 Legume, lime and phosphorus experiment in a median, Hurt

Location: Route 29 near Hurt. Establishment Date: 1 April 1977.

Experimental Methods

The experimental site was a wide, graded median just south of the southern Hurt exit on Route 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 erratic 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 of $P_2O_5$. 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 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.

Table 6. Legume stands on two replicates on 14 Sep 78 of seedings in a median of Route 29, Gretna; established 31 Mar 77.

| Lime rate | Perennial sweetpea plants/plot* | Perennial sweetpea GI† | Flatpea % cover | Flatpea GI | Crownvetch % cover | Crownvetch GI |
|---|---|---|---|---|---|---|
| 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 $ft^2$
† GI = growth index, average plant height x plants/plot or % cover

Table 7. Hurt median legume experiment; Route 29, south Hurt exit; established 1 Apr 77.

| | % Cover by introduced legumes | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lime @ 0 T/A | | | | | | Lime @ 1.5 T/A | | | | | | Lime @ 3.0 T/A | | | | | |
| | $P_2O_5$, lbs/A | | | | | | $P_2O_5$, lbs/A | | | | | | $P_2O_5$, lbs/A | | | | | |
| | 0 | | 100 | | 200 | | 0 | | 100 | | 200 | | 0 | | 100 | | 200 | |
| | P* | V** | P | V | P | V | P | V | P | V | P | V | P | V | P | V | P | V |
| 9 Jun 78 | | | | | | | | | | | | | | | | | | |
| | 16 | 40 | 24 | 53 | 15 | 26 | 17 | 27 | 13 | 27 | 24 | 20 | 24 | 27 | 19 | 36 | 10 | 35 |
| 5 Jun 79 | | | | | | | | | | | | | | | | | | |
| | 27 | 73 | 25 | 77 | 26 | 71 | 15 | 39 | 8 | 43 | 33 | 62 | 23 | 69 | 20 | 69 | 43 | 60 |

*P = flatpea
**V = crownvetch

lime means 0 lime = 50; 1.5 T/A lime = 33; 3.0 T/A lime = 47

$P_2O_5$ means 0 $P_2O_5$ = 41; 100 lbs/A $P_2O_5$ = 40; 200 lbs/A $P_2O_5$ = 49

species means crownvetch = 63; flatpea = 25

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 Virinigia 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 fertilizer are not exhibited by these data. Crownvetch proved to be superior to flatpea at this site, providing greater cover than flatpea in both 1978 and 1979 and showing a much greater rate of spread from 1978 to 1979 than flatpea. By June 1979 mean cover was 63 per cent for crownvetch, 25 per cent for flatpea. The slow but fair establishment of the two legumes during the severe moisture conditions of the first year of growth indicates that the vegetative cover might have been rapid with more favorable moisture.

This site was mowed several times in both 1977 and 1978. The persistence and spread of both legume species demonstrates their compatability with mowing in the Piedmont region.

## 2.2.5 Seedings of legumes in medians in fall 1977

Location: Salem, Chesapeake, and Pittsylvania and Botetourt Counties. Establishment Date: Fall 1977.

Experimental Methods

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 Botetourt 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 (Table 8), 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 paraquat 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 (Table 8). 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.

Table 8. Chesapeake median legume experiment, Route 58 west; established 27-28 Sep 77.

| | Broadcast | | Disked | | Zip seeded | | Zip + Paraquat | | |
|---|---|---|---|---|---|---|---|---|---|
| | lime | no lime | lime | no lime | lime | no lime | lime | no lime | mean |
| # crownvetch plants/ plot (275 ft$^2$) 28 Oct 78 | | | | | | | | | |
| inoculant coated on seed | 0 | 0 | 14 | 6 | 10 | 2 | 7 | 0.5 | 4.9 |
| inoculant applied loose | 34 | 10 | 10 | 0 | 3.5 | 2.5 | 8 | 1 | 8.7 |
| % crownvetch 16 Jun 79 | | | | | | | | | |
| inoculant coated on seed | 0 | 0 | 6 | 0 | 1 | 0 | 1.5 | 0 | 1.1 |
| inoculant applied loose | 22 | 7.5 | 1.5 | 0 | 2 | 0.5 | 1.5 | 0 | 4.4 |

Table 9. Newport News median legume experiment, I-64; established 28 Feb 78.

| | Flatpea seedlings/plot (189 ft$^2$) 1 Oct 78 | | | | | |
|---|---|---|---|---|---|---|
| | Broadcast | | Disked | | Subsurface seeded | |
| fungicide: | + | - | + | - | + | - |
| | 2.2 | 4.0 | 1.2 | 1.5 | 0.2 | 1.5 |

Table 10. Clifton Forge median legume experiment, I-64; established 12 Apr 78.

| | Seedlings/plot (90 ft$^2$) 14 Jun 78 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Broadcast | | | | Disked | | | | Subsurface seeded | | | |
| | Crown-vetch | | Pea | | Crown-vetch | | Pea | | Crown-vetch | | Pea | |
| Potassium: | + | - | + | - | + | - | + | - | + | - | + | - |
| | 0 | 0.2 | 4.0 | 2.5 | 1.8 | 2.0 | 3.0 | 3.2 | 3.8 | 4.2 | 7.5 | 10 |

## 2.2.6 Seeding of legumes in medians in spring 1978

Location: Newport News, Charlotte County, Clifton Forge.
Establishment Date: Spring 1978.

Three experiments assessing the effects of several variables on introduction of perennial legume into established median scds were initiated in late winter-early spring 1978. In late February at a site alcng I-64 in Newport News variables were species (crownvetch or a mix of flat and sweetpea), fungicide treatment (+ or -), and seeding method (broadcast on unprepared seedbed, broadcast on disked seedbed and subsurface seeding--by zip seeder for crownvetch, by hand, garden corn planter for pea species). Seedling establishment was initially best for subsurface seeded pea species in early spring, but was reversed by late spring at this poorly drained site. Only flatpea persisted by late spring, better on broadcast and no fungicide treatments. In late fall this site was destroyed in regrading operations.

Along Route 360 in Charlotte County in late March 1978 a legume introduction experiment was initiated on a rather hard packed median having the following chemical properties: pH, 6.3 to 7.5; Ca, medium to very high; Mg, very high; P, medium to high +; K, low. K2O @ 100 lbs/A was applied to aid legume establishment. Treatments were as for the Newport News site except that fungicide treatments were omitted. In late spring best legume seeedling emergence was on subsurface seeded plots. These plants were eliminated in the course of the growing season, however, and by fall no legume establishment was observed at this site.

A final spring legume introduction seeding was made along I-64 in Clifton Forge. Here soil properties were: pH, 8.1; Ca, very high; Mg, very high; P, high; K, medium. Treatment variables at this site were similar to those for the Charlotte County experiment except that plots were split with 0 and 100 lbs/A K2O as treatments. As at the other spring seeding sites, emergence of legume seedlings was initially best for subsurface seedings of pea species (Table 10), but legumes subsequently were eliminated by competition.

Failures in these spring seedings were attributed to three principal factors; seeding date too late (Charlotte County and Clifton Forge sites), excessive competition (all three sites), compacted median material (Charlotte County site).

## 2.2.7 Demonstration perennial legume seedings of late winter 1979

Time did not permit establishment of controlled experiments to assess seeding methods for legume introduction in late winter 1979. A determination was made to provide demonstration seedings in all the major regions of the state using an optimal seeding technique. This method involved a late winter seeding date and seedbed preparation by field cultivator, which reduced competition by existing plant covers, loosened the soil of the seedbed and provided many favorable microenvironments for seed germination and seedling establishment. Fertility treatments were uniformly applied without check treatments or control treatments. On March 5, crownvetch @ 20 lbs/A, P205 @ 200 lbs/A, lime @ 1 T/A and woodfiber mulch @ 1500 lbs/A were hydroseeded into two strips tilled by field cultivator through the compacted median soil material on the south half of the 1977 median legume experiment at Routes 29 x 903 south of Gretna in Pittsylvania County.

At the same date a seed mix of flatpea and perennial sweetpea, each @ 15 lbs/A; P205 @ 200 lbs/A; K20 @ 100 lbs/A and woodfiber @ 1500 lbs/A were hydroseeded into field cultivator tilled strips immediately adjacent to the Charlotte County seeding site of 1978.

On March 6, immediately west of the fall 1977 median legume seeding site at Chesapeake, plots of crownvetch @ 20 lbs/A and a pea mix @ 15 lbs/A for each species were applied by hand in three randomized blocks in a strip tilled up by field cultivator. P205 @ 200 lbs/A, K20 @ 200 lbs/A, lime @ 1 T/A, and woodfiber mulch @ 1500 lbs/A were applied by hydroseeder uniformly over the entire site.

A similar seeding was established on March 6 near Greenbay in a median which had been the site of a grass variety trial initiated in spring 1977. Applications differed only in that lime was @ 1.5 T/A and K20 @ 100 lbs/A. On March 19 two 0.1 mi strips x 6 ft tilled by field cultivator were hydroseeded with a 1/4 mix of flat and perennial sweetpea @ 20 lbs/A with 200 lbs/A P205 along the 460 bypass at Farmville.

In Blacksburg perennial legumes were introduced into freshly constructed infield areas of the Prices Fork Road x 460 bypass interchange. Soil properties were: pH, 7.8; Ca, very high; Mg, very high; P, medium + to high; K, medium. Two infield areas northeast of the overpass were tilled with a field cultivator. On April 17, on the northerly, 0.5 A infield area crownvetch @ 20 lbs/A, Ky-31 tall fescue @ 25 lbs/A, annual ryegrass @ 5 lbs/A, N @ 50 lbs/A, P205 @ 200 lbs/A, K20 @ 50 lbs/A and Cellin Fiber Mulch @ 1500 lbs/A were applied by hydroseeder. On April 19, flatpea @ 20 lbs/A

was drilled into about two thirds of the inner area of the 1.5 A infield and perennial sweet pea @ 40 lbs/A drilled on the exterior margin. On April 20 grass seed, fertilizer and mulch were applied by hydroseeder as in the adjacent infield seeded to crownvetch.

Stand counts of some of these 1979 seedings several months after initiation are reported in Table 11. Seedling establishment was comparable at the other two sites and highly successful at all sites. Especially notable are the Chesapeake and Greenbay sites, both of which are typical of the kinds of materials where grass covers are particularly prone to degenerate and difficult to improve through conventional renovation treatments. Plant cover at the sandy Chesapeake site is practically devoid of cool season grass species and must be mowed frequently to keep top growth of a host of weed species reasonably neat. At Greenbay, cool season grasses introduced in a trial in 1977 very rapidly degenerated and were suppressed by warm season grasses and annual legumes due to the rapid decline in nitrogen status of this coarse textured micaceous material. At all sites introduced legumes show promise of rapidly evolving attractive, complete covers to suppress weeds and control erosion. With adequate seedbed preparation and appropriate timing of seedings, renovation of these problem areas by introduction of perennial legumes appears highly feasible.

## 2.3 MOWING MANAGEMENT OF MEDIAN TURFS

### 2.3.1 Grass mowing experiment, Fairfield

Location: Route 11, Fairfield.

Experimental Method

A mowing experiment to investigate the effects of date of first mowing and height and frequency of mowing on removal of seedheads and on tillering was initiated in a grass median along Route 11 in Fairfield in spring 1978. First mowing occurred on either May 20 or June 15. Mower heights were set at 4, 6 or 8 inches. Plots mowed twice were mowed the second time on July 1, if mowed first on May 20, September 1 if mowed first on June 15. On each plot a single wire quadrat 3 in x 36 in was stapled into place and counts made of tall fescue and fine leaved grass tillers. Fine leaved grass species were creeping red fescue and Kentucky bluegrass. Treatments were replicated in three randomized blocks.

Table 11. Demonstration median legume seedings; established late winter 1979.

| | legumes/ft$^2$ | | |
|---|---|---|---|
| | Crownvetch | Sweetpea | Flatpea |
| 16 Jun 79, Chesapeake, Rt. 58 | 4.9 | 0.47 | 1.1 |
| 16 Jun 79, Greenbay, Rt. 360 | 0.90 | 0.79 | 0.81 |
| 26 Jun 79, Large infield, Blacksburg, Rt. 460 | not seeded | 4.9 @ 4.1" | 3.9 @ 3.5" |
| 26 Jun 79, Small infield, Blacksburg, Rt. 460 | 4.8 @ 3.0" | not seeded | not seeded |

Table 12. Fairfield median grass mowing experiment, 1978.

| | | 0.75 ft$^2$ quadrat counts | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Tall fescue tillers | | Orchard grass tillers | | Fine leaves grass tillers | | Tall fescue seedheads |
| Mowing Regime | | 1978 | 1979 | 1978 | 1979 | 1978 | 1979 | 1979 |
| 20 May @ 4" | I | 113 | 146 | 5 | 9 | 3 | 8 | 21 |
| | II | 134 | 170 | 0 | 0 | 68 | 95 | 18 |
| 20 May, 1 Jul @ 4" | I | 96 | 152 | 5 | 3 | 0 | 0 | 47 |
| | II | 148 | 209 | 0 | 0 | 14 | 20 | 19 |
| 15 Jun @ 4" | I | 203 | 304 | 0 | 0 | 3 | 12 | 50 |
| | II | 217 | 204 | 8 | 8 | 9 | 8 | 9 |
| 15 Jun @ 8" | I | 86 | 117 | 4 | 3 | 60 | 32 | 8 |
| | II | 105 | 143 | 0 | 0 | 88 | 162 | 19 |

Mean Density and Height of Tall Fescue Seedheads

| Mowing Regime | 20 May @ 4" | 20 May @ 6" | 20 May @ 8" |
|---|---|---|---|
| 15 Jun 78 | | | |
| density (seedheads/ft$^2$) | .26 | .66 | .96 |
| height | 18 | 22 | 27 |
| 1 Jul 78 | | | |
| density (seedheads/ft$^2$) | .28 | 1.42 | 4.50 |
| height | 18 | 25 | 27 |

Results and Discussion

All three heights of mowing on June 15 removed all tall fescue seedheads for the 1978 growing season at this site. Since flower parts of fescue are inducted only at cool temperatures when days are short, delay until all emerging seedheads are above mower heights permits their complete removal. However, delay of mowing until June 15 may result in mortality due to excess shading for new tillers which, to maintain stand density, are needed as replacements for seedhead tillers which die after seeding. Hence, mowing at an earlier date was investigated to determine both effects on rate of tillering and efficiency of removal of seedheads. Mowing at 8 inches on May 20 gave rather poor elimination of seedheads, which averaged 0.96 and 4.50 per $ft^2$ on June 15 and July 1 respectively. Seedhead density on July 1 for May 20, 8 inch, mowings was about 14 per cent of the value obtained as the mean of seedhead density in quadrat counts of spring 1979; however, this density was sufficient to give the sod a rather unkempt appearance. Mowing at either 4 or 6 inches on May 20 gave good control of fescue seedheads. By September 1, however, all treatments at this site had a rather scraggly appearance. None of the spring mowings eliminated seedheads of greasegrass, a warm season species, as these begin to elongate only in late July and August. Wild carrot, milkweed and dead tops of red clover were scattered through the area. September 1 mowing eliminated this material.

Mowing of a part of this site by highway crews confounded the treatments applied on some quadrats. Tiller counts were made for four treatments on two replicates to determine if changes in turf density could be correlated with differences in mowing regimes. Consistent responses were not observed (Table 12). Tiller density of tall fescue was greater in May 1979 than in May 1978 in all but one of the quadrats counted. The cool spring of 1979 favored tillering (Templeton et al., 1961; Yeh et al., 1976). Apparently variability in the vigor of fescue plants was controlled much more strongly by factors other than mowing treatments. Counts in single quadrats for treatment plots appear to be inadequate to represent tillering response of grass stands to mowing.

### 2.3.2 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 and Ross, 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).

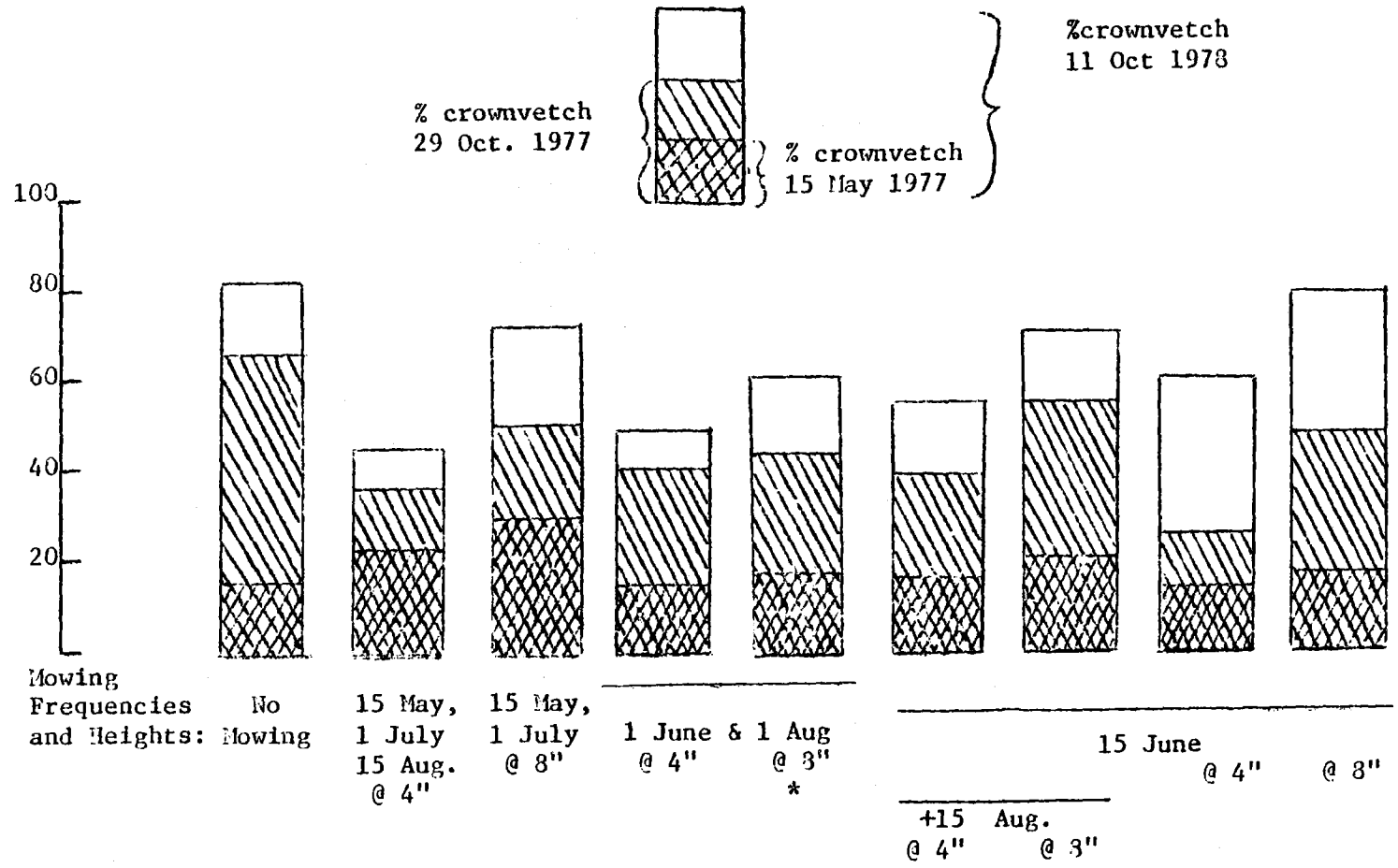
## Experimental Methods

In spring, 1977, an experiment was begun to determine the impact of mowing in 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 wtih 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 October 19, 1977 and October 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. After two years of mowing, the mean cover of crownvetch for this mowing treatment had approximately doubled. Spread of crownvetch for a mowing

Figure 2. Mowing experiment on mixed grass crownvetch stand, I-64, Lexington




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

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 the growth of tall fescue.

## 2.4 COATING OF BACTERIAL INOCULANT ON LEGUME SEED

### 2.4.1 Seed coating experiments at Cloyd's Mountain

Location: Cloyd's Mountain, Rt. 100, Pulaski County.
Establishment Date: 14 April 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 shaley 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 "pelleted" seed using a method described by California workers (Holland and Street, 1968). 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 will aid 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.

Table 13. Legume seed coating and lime experiment, Rt. 100, Pulaski Co.; established 14 Apr 77.

| | Flatpea seedlings/plot 7 Oct 77 | % Grass cover 7 Oct 77 | % Flatpea cover 27 Oct 78 | % Flatpea cover 26 Jun 79 |
|---|---|---|---|---|
| Lime: 2 tons/A | | | | |
| Seed: not coated | 21 | 72 | 10 | 29 |
| Lime: 2 tons/A | | | | |
| Seed: coated | 6 | 77 | 6.7 | 30 |
| Lime: none | | | | |
| Seed: not coated | 14 | 70 | 10 | 29 |
| Lime: none | | | | |
| Seed: coated | 14 | 62 | 8.8 | 23 |

Table 14. Perennial sweetpea renovation experiment, Route 29, Greene Co.; established 11 Aug 77.

| Inoculant coated | Broadcast @ 20 lbs/A Surface + | Broadcast @ 20 lbs/A Surface - | Seeded in rototilled strip Surface + | Seeded in rototilled strip Surface - | Seeded in rototilled strip 1-1/4" deep + | Seeded in rototilled strip 1-1/4" deep - | Seeded in untilled strip Surface + | Seeded in untilled strip Surface - | Seeded in untilled strip 1-1/4" deep + | Seeded in untilled strip 1-1/4" deep - |
|---|---|---|---|---|---|---|---|---|---|---|
| 29 Sep 77 | | | | | | | | | | |
| Seedling emergence/ 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 | | 0.0b | | 4.0a | |
| 6 Jun 79 | | | | | | | | | | |
| Seedling emergence/ plot | 11 | 8.3 | 1.0 | 0.0 | 3.5 | 2.7 | 0 | 1.0 | 2.7 | 1.7 |
| Mean emergence | 9.7 | | 0.5 | | 3.1 | | 0.5 | | 2.2 | |

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 13, 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 erratic; however, lime-treated plots showed bettter 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. Patterns 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 13). Seedling establishment at the calcareous site was negligible.

Observations of the acid site in June 1979 revealed appreciable spread by flatpea. Seedlings of pine have become established in places on this site.

## 2.4.2 Perennial sweetpea renovation experiment, Greene County.

Location: Rt. 29, Greene County. Establishment Date: 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 stie 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 14 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 experment. 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. Seedling emergence was somewhat increased on broadcast plots by June 1979 but showed declines for other treatments.

## 2.4.3 Mulch and seed coating experiment, Saluda

Location: Rt. 17, Saluda. Establishment Date: 7 September 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 not 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 15).

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.

Crownvetch cover had increased to 98 per cent for the site as a whole by June 1979.

## 2.5 MICRONUTRIENT ADDITIONS FOR LEGUMES ESTABLISHMENT IN COASTAL PLAIN

### 2.5.1 Lovegrass and molybdenum experiment, Suffolk.

Location: Rt. 604, Suffolk. Establishment Date: 3 August 1977.

Experimental Methods

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;

Table 15. Mulch and seed coating experiment, Rt. 17, Saluda; established 7 Sep 77.*

| Mulch rates in lbs/A | Straw @ 3000 Woodfiber 750 | Straw @ 3000 Paperfiber 750 | Woodfiber 1500 | Woodfiber 2500 | Paperfiber 1500 | Paperfiber 2500 | No mulch |
|---|---|---|---|---|---|---|---|
| % grass cover 28 Sep 77 | 75a | 69a | 30cd | 23cd | 40c | 19d | 21d |
| Crownvetch: seedlings/ft$^2$ 28 Sep 77 | 2.7a | 3.9a | 7.7a | 7.9a | 6.0a | 6.6a | 6.1a |
| % cover 29 Oct 78 | 90 | 93 | 60 | 63 | 68 | 67 | 93 |

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

Table 16. Lovegrass, molybdenum and seed coating experiment, Rt. 604, Suffolk; established 3 Aug 77.

| | 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 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

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 16 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 of 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.

### 2.5.2 Experiment on Rt. 17, south of Saluda

Location: Rt. 17, south of Saluda. Establishment Date: 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. Molybdenum 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.

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 17). Emergence of sericea lespedeza was the most prominent among the four legume species used, with very few seedlings of the cther three species being evident. Growth of sericea was significantly enhanced in association with bentgrass as compared wtih straw/fescue, the difference being attributable to much more grass competition with the tall fescue as ccmpared 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 wtih no micronutrient response noted. Table 17 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 previcus 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 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.

In June 1979, cover by introduced legumes was little changed from that of May 1978. Where crcwnvetch and perennial pea were growing together blooms from both species displayed a very pleasing mix of color.

Table 17. Micronutrient experiment, Rt. 17, Saluda; established 7 Sep 77.

| | No Micronutrients | | Molybdenum | | Low Micronutrients | | High Micronutrients | |
|---|---|---|---|---|---|---|---|---|
| | K-31 | Bentgrass | K-31 | Bentgrass | K-31 | Bentgrass | K-31 | Bentgrass |
| % grass cover 28 Sep 77 | 57 | 18 | 63 | 10 | 53 | 8 | 42 | 5 |
| Sericea/ft$^2$ 28 Sep 77 | 3.4 | 22 | 2.5 | 22 | 5.8 | 22 | 2.0 | 13 |
| Sericea/ft$^2$ 27 May 78 | 0.30 | 1.0 | 0.60 | 2.5 | 0.60 | 2.9 | 0.07 | 0.75 |
| Sericea growth index (density x ht) 27 May 78 | 0.30 | 1.0 | 0.60 | 3.5 | 0.60 | 5.4 | 0.70 | 0.75 |
| Crownvetch/ft$^2$ 27 May 78 | 0.63 | 1.0 | 0.75 | 2.0 | 0.63 | 3.5 | 0.43 | 0.63 |
| Crownvetch growth index (density x ht) 27 May 78 | 1.0 | 1.7 | 1.5 | 4.5 | 1.3 | 13 | 0.80 | 2.0 |
| Sweetpea/plot 27 May 78 | 21 | 40 | 25 | 28 | 17 | 41 | 17 | 29 |
| Flatpea/plot 27 May 78 | 29 | 57 | 39 | 49 | 37 | 61 | 31 | 49 |

## 2.6 SUMMER ANNUAL ASSOCIATES OF LEGUMES

### 2.6.1 Summer annual companion species experiment, Floyd County

Location: Rt. 644, Floyd County. Establishment Date: 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

Table 18. Summer annual companion species experiment; established 26 May 77.

| Seeding rate (lbs/A | German millet, lbs/A 20 | 30 | Buckwheat, lbs/A 20 | 40 | 60 |
|---|---|---|---|---|---|
| 30 Aug 77 | | | | | |
| Crownvetch/ft$^2$ | 1.8 | 2.3 | 3.3 | 3.2 | 2.8 |
| % cover by annual companion species | 97 | 89 | 70 | 100 | 92 |
| % cover by annual ryegrass and tall fescue | 7.7 | 3.7 | 45 | 65 | 37 |
| Grass growth (average height x % cover) | 26 | 11 | 360 | 430 | 228 |
| Density of annual companion species* (Stems/ft$^2$) | 47 | 65 | 4.3 | 6.0 | 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 |
| 18 Oct 78 | | | | | |
| Seeding rate (lbs/A) | 20 | 30 | 20 | 40 | 60 |
| Grass cover, % | 23 | 17 | 27 | 20 | 25 |
| Crownvetch cover, % | 70 | 66 | 62 | 76 | 67 |
| 22 June 79 | | | | | |
| Crownvetch cover, % | 93 | 91 | 89 | 98 | 96 |
| Crownvetch height (in.) | 21 | 20 | 26 | 22 | 23 |

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 18). 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 in situ 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.

Strong gains in cover by crownvetch were achieved for all treatments in both 1978 and spring 1979.

### 2.6.2 Summer annual companion species experiment, Galax

Location: Rt. 735, Galax. Establishment Date: 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 19. The data clearly show the lesser plant denisty 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 19). As with buckwheat in Floyd County, the fact that growth of crownvetch, which is relatively shade tolerant, was not significantly different for the companion 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 18). 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 cover with 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

Table 19. Buckwheat and Japanese millet experiment, Rt. 735, Galax; established 20 Jun 77.

| | Buckwheat lbs/A | | | Japanese millet lbs/A | |
|---|---|---|---|---|---|
| | 20 | 40 | 60 | 20 | 30 |
| | | | 23 Sep 77 | | |
| 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 |
| | | | 27 Oct 78 | | |
| % 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 |
| | | | 22 Jun 79 | | |
| % crownvetch cover (means of three replications) | 36 | 29 | 24 | 34 | 31 |
| % crownvetch cover (means of two replications) | 20 | 28 | 14 | 30 | 26 |

good water relations. However, in spring 1979 little increase in cover by crownvetch was recorded, except for treatment plots where buckwheat @ 40 lbs/A had been the companion species (Table 19).

## 2.7 PERENNIAL GRASS ASSOCIATES OF LEGUMES

### 2.7.1 Lehman lovegrass and velvet bentgrass experiment, Floyd County

Location: Floyd County. Establishment Date: 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 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 lb/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 (Table 20). 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.

By spring 1979 crownvetch had spread rapidly on plots seeded with bentgrass providing covers comparable to those achieved where Lehmann lovegrass had been the companion species. The best crownvetch cover was in asscciation with the low rate of bentgrass. Bentgrass shows a decline in vigor at this site. As in 1978, crownvetch was enhanced for limed areas.

### 2.7.2 Lehmann lovegrass and velvet bentgrass experiment, Galax

Location: Rt. 735, Galax. Establishment Date: 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.

#### Results and Discussion

Seedling establishment and vigor of crownvetch were postively affected by lime application and asscciation with Lehmann lovegrass (Table 21). 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.

Table 20. 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 |
| 12 Aug 77 | | | | | | | | | | | | | | | | | | |
| % grass cover | 78 | 80 | 88 | 68 | 66 | 63 | 79 | 85 | 92 | 62 | 55 | 64 | 75 | 90 | 82 | 70 | 68 | 69 |
| 18 Oct 77 | | | | | | | | | | | | | | | | | | |
| % grass cover | 80 | 90 | 88 | 83 | 70 | 75 | 95 | 95 | 98 | 83 | 78 | 85 | 78 | 98 | 93 | 85 | 83 | 83 |
| Crownvetch density (Plants/ft$^2$) | 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 |
| 18 Oct 78 | | | | | | | | | | | | | | | | | | |
| % grass cover | 25 | 14 | 3 | 11 | 33 | 34 | 7.5 | 7.5 | 10 | 31 | 36 | 46 | 0 | 13 | 10 | 33 | 13 | 36 |
| % crownvetch cover | 34cd | 30d | 50ab cd | 80a | 43b cd | 43b cd | 81a | 75ab | 84a | 65a bc | 55ab cd | 51ab cd | 79a | 84a | 78ab | 64a bc | 55ab cd | 56ab cd |
| 22 June 79 | | | | | | | | | | | | | | | | | | |
| | 50 | 85 | 46 | 80 | 49 | 46 | 86 | 72 | 82 | 85 | 82 | 80 | 68 | 86 | 84 | 82 | 64 | 68 |

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

Lehmann lovegrass winterkilled at this site but cover by dead canopies persisted. Crownvetch developed much more strongly in association 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).

Where lime had not been applied, crownvetch in spring 1979 showed little change in cover over that attained in 1978. Growth for lime treatments was better, especially where bentgrass was the associate species. For this species, a 5 lbs/A rate most favored crownvetch establishment as at the Floyd County trial.

### 2.7.3 Lehmann lovegrass, velvet bentgrass experiment, Pittsylvania Co.

Location: Rt. 640, Pittsylvania County. Establishment Date: 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 22). 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

Table 21. Lehmann lovegrass, velvet bentgrass experiment, Route 735, Galax; established 20 Jun 77.

| | No lime | | | | | | 1.5 T/A lime | | | | | | 3.0 T/A lime | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Leh. lovegrass | | | Velvet bentgrass | | | Leh. lovegrass | | | Velvet bentgrass | | | Leh. lovegrass | | | Velvet bentgrass | | |
| Seeding rate | 5 | 10 | 15 | 10 | 30 | 60 | 5 | 10 | 15 | 10 | 30 | 60 | 5 | 10 | 15 | 10 | 30 | 60 |
| 23 Sep 77 | | | | | | | | | | | | | | | | | | |
| % grass cover | 87 | 98 | 95 | 75 | 76 | 79 | 99 | 94 | 98 | 72 | 80 | 88 | 95 | 95 | 98 | 88 | 87 | 90 |
| Crownvetch density (plants/ft$^2$) | 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 | 5.2 |
| Crownvetch growth index (Avg. ht. x density) | 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 | 8.0 |
| 27 Oct 77 | | | | | | | | | | | | | | | | | | |
| % grass cover* | 79a | 100a | 87a | 95a | 85a | 83a | 93a | 97a | 93a | 96a | 97a | 97a | 89a | 100a | 97a | 100a | 97a | 100a |
| % crownvetch cover | 57ab | 80a | 67ab | 52ab | 45b | 35b | 80a | 77a | 81a | 56ab | 47b | 50b | 81a | 85a | 80a | 77a | 37b | 41b |
| 22 Jun 79 | | | | | | | | | | | | | | | | | | |
| | 45 | 81 | 45 | 54 | 49 | 36 | 72 | 81 | 75 | 76 | 64 | 60 | 72 | 88 | 74 | 85 | 46 | 55 |

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

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 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 22, 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 discernable 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 winterkill, 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, wtihout 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.

### 2.7.4 Lehmann lovegrass, velvet bentgrass, German millet experiment

Location: Rt. 640, Pittsylvania County. Establishment Date: 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

Table 22. Lehmann lovegrass, velvet bentgrass experiment, Rt. 640, Pittsylvania Co.; established 8 Jul 77.

| | No lime | | | | 1.5 T/A lime | | | | 3.0 T/A lime | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lehmann lovegrass | | Velvet bentgrass | | Lehmann lovegrass | | Velvet bentgrass | | Lehmann lovegrass | | Velvet bentgrass | |
| Seeding rate (lbs/A) | 10 | 20 | 10 | 30 | 10 | 20 | 10 | 30 | 10 | 20 | 10 | 30 |
| % Grass cover - 12 Oct 77 | 45 | 53 | 23 | 28 | 32 | 55 | 25 | 28 | 37 | 53 | 20 | 27 |
| Sweetpea seedlings/plot 12 Oct 77 | 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 Jun 78* | 57 | 53 | 65 | 55 | 38 | 42 | 87 | 72 | 40 | 20 | 50 | 77 |
| Sweetpea seedlings/plot 2 Jun 78 | 5.3 | 11 | 15 | 11 | 11 | 19 | 25 | 17 | 15 | 15 | 16 | 16 |

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

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 23). 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, slcughing 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 winterkilled. 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.

## 2.7.5 Flatpea companion species experiment, Floyd County

Location: Rt. 644, Floyd County. Establishment Date: 10 June 1977.

Experimental Methods

This experiment was established to assess 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,

Table 23. Lehmann lovegrass, velvet bentgrass, German millet experiment, Rt. 640, Pittsylvania Co.; established 19 Jul 77.

| | 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 77 | 77 | 5 | 25 | 90 | 5 | 43 |
| Crownvetch density (plants/ft$^2$) | 5.5 | 12 | 13 | 11 | 11 | 8.0 |
| % cover* 2 Jun 78 | 46 | 27 | 0 | 33 | 3 | 0 |
| Crownvetch density 2 Jun 78 (plants/ft$^2$) | .11 | .24 | .16 | .14 | .10 | .09 |
| Vetch growth index, 2 Jun 78 (vetch density x avg. height) | .45 | 1.3 | .88 | .39 | .29 | .26 |

* Value for % cover of areas seeded with German millet-tall fescue mix are for millet in Oct 77 and for tall fescue in Jun 78.

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 24). 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. Sparse stands of flatpea began to appear but seedlings were almost entirely confined to the bottom five feet of the slope.

Cover by flatpea in spring 1979 was little changed from that of 1978. All grass associates showed sharp declines in cover, especially for Manhattan perennial ryegrass. This variety was affected by disease as well as decline in nitrogen status which adversely affected the other grass associates. While lovegrass was markedly receded, a considerable protective cover of dead thatch still remained. However, this too had begun to be eroded away in places. The rapid decline of grasses at this site underscores the desirability of establishing perennial legumes to serve as successor species as nitrogen becomes limiting. Rough or stairstep grading would have greatly facilitated establishment of flatpea at this site.

## 2.8 WINTER DORMANT SEEDING

### 2.8.1 Winter dormant seeding experiment, Blacksburg

Location: Route 460 bypass-Prices Fork Road interchange.
Establishment Date: 5 January 1979.

Experimental Methods

Crownvetch seed which has not been processed to remove hulls is largely hard, unable to germinate. Seeds of many legume species are released from hardness by natural

Table 24. Flat pea-companion species experiment, Route 644, Floyd County; established 10 June 77.

| | Koket Chewings fescue | | | Manhattan perennial ryegrass | | | Weeping lovegrass | | | Ky 31 tall fescue |
|---|---|---|---|---|---|---|---|---|---|---|
| (lbs/A) | 15 | 50 | 90 | 25 | 60 | 90 | 5 | 10 | 15 | 60 |
| 26 Aug 77 | | | | | | | | | | |
| % grass cover | 12e | 18de | 33cde | 29cde | 33cde | 34cd | 49bc | 71ab | 90a | 15de |
| 2 Oct 78 | | | | | | | | | | |
| % grass cover | 87 | 97 | 85 | 83 | 73 | 77 | 85 | 90 | 87 | 85 |
| % flat pea cover | 3.7 | 7.0 | 4.3 | 2.0 | 15 | 8.7 | 9.3 | 2.0 | 8.3 | 8.7 |
| 22 Jun 79 | | | | | | | | | | |
| % grass cover | 42 | 44 | 32 | 10 | 8 | 16 | 31 (55) | 32 (77) | 39 (88) | 42 |
| % flat pea cover | 6.2 | 4.7 | 4.7 | 2.2 | 13 | 7.0 | 7.7 | 4.5 | 13 | 4.0 |

statification in the course of winter. Use of unhulled (unprocessed) seed of crownvetch might be advantageous because destruction of seedlings by premature germination, possible where hulled seed are used, would be prevented by hardness. A mean 41.6 per cent of the weight of unhulled seed was determined to be composed of hulls in three replicate determinations. Rate of application of unhulled seed was correspondingly increased to provide an equivalent rate of actual seed to that of processed seed. Treatments of crownvetch seed form were combined factorially with companion species treatments which were no cereal rye and cereal rye @ 200 lbs/A (var., Abruzzi). Treatments were applied on January 5, 1979 in four randomized blocks on a gently sloping infield area at the interchange of the Route 460 bypass-Prices Fork Road interchange in Blacksburg. This area had been mulched with straw and seeded by contract seeders in late fall 1978.

Results and Discussion

By early April rye had begun to emerge where seeded. Stand counts of crownvetch seedling density at the end of April did not demonstrate any superiority for unhulled seed of crownvetch (Table 25). By the end of June, two replications of the experiment had been destroyed by highway construction. Rye had grown up to three feet high and, though rather sparsely distributed, provided adequate erosion control. Counts of plants per square foot reflect about 18 per cent establishment for seed applied. Crownvetch establishment at this time reflected no significant advantage of either form of seed nor did association with rye significantly affect stands. These data suggest that for areas not prone to erosion dormant seeding of crownvetch may be accomplished by use of heavy seeding rates of cereal rye for rapid development of a companion species in late winter.

## 2.9 RENOVATING CUT SLOPES THROUGH LEGUME INTRODUCTION

### 2.9.1 Renovation experiment, Charlottesville

Location: I-64, Charlottesville. Establishment Date: 14 October 1976.

Table 25. Winter dormant seeding experiment, Rt. 460 Bypass, Blacksburg; established 5 Jan 79.

| Crownvetch seed: | Rye @ 200 lbs/A hulled | Rye @ 200 lbs/A unhulled | No rye hulled | No rye unhulled |
|---|---|---|---|---|
| 25 Apr 79 Crownvetch density (plants/ft$^2$) | 1.02 | 1.44 | 1.60 | 1.12 |
| 29 Jun 79 Crownvetch density (% cover) | 3.00 | 7.38 | 4.88 | 1.56 |
| Rye density (plants/ft$^2$) | 15.4 | 13.5 | | |

Table 26. Renovation experiment on a tall fescue grassed cut, I-64, Charlottesville; established 14 Oct 76.

| | % legume cover | | |
|---|---|---|---|
| | crownvetch | sweetpea | flatpea |
| no lime | 35 | 11 | 1 |
| lime | 30 | 4 | 1 |

Table 27. Renovation of a weedy cut slope, Rt. 29, Madison Co.; established 10 Aug 77.

| | Experiment #2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $P_2O_5$ (lbs/A) | 0 | | | 100 | | | 200 | | |
| $K_2O$ (lbs/A) | 0 | 50 | 100 | 0 | 50 | 100 | 0 | 50 | 100 |
| % crownvetch 15 Jun 79 | 25 | 17 | 16 | 20 | 38 | 29 | 26 | 42 | 55 |

| | Experiment #3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Paraquat | | | | No paraquat | | | |
| Ky-31 (lbs/A) | 0 | | | 25 | 0 | | | 25 |
| lime (T/A) | 0 | 1.0 | 0 | 1.0 | 0 | 1.0 | 0 | 1.0 |
| % crownvetch 15 Jun 79 | 35 | 10 | 35 | 3.2 | 12 | 0 | 0.7 | 6.3 |

Experimental Methods

This experiment was established in early fall 1976 on a north facing cut slope dominated by tall fescue. At time of establishment, this site was free of weeds and woody species, but the fescue stand had begun to thin. In such circumstance erosion and invasion by volunteer species may proceed rapidly. Added expenses are entailed in keeping the ditch line and 30 foot margin of the interstate free of woody volunteers and noxious weeds. Thus, timely establishment of strong perennial legume cover is advantageous as these greatly retard invasion of undesirable species (Sharp and Ross, 1978).

Material exposed in this cut was still partially consolidated and, thus, this gravelly material was prone to drought. Legume treatments were perennial sweetpea, flatpea and crownvetch, each @ 20 lbs/A. Legume treatments were split into 0 and 1 T/A lime subplots. P205 @ 200 lbs/A was applied over the entire site and the experiment replicated twice.

Results and Discussion

Establishment of legumes was poor at this site in June 1979 (Table 26). The winter following application of treatments was severe and the first full growing season thereafter was extremely dry. Response to lime was not marked but growth by crownvetch was superior to that of the Lathyrus species. Woody species had begun to invade this site, sumac being the most prominent.

## 2.9.2 Renovation experiments, Madison County

Location: Route 29, Madison County. Establishment Date: 10 August 1977.

Experimental Methods

Three experiments assessing variables in renovation seedings were established in August 1977 on a west facing cut slope along Route 29 in Madison County. These sites were dominated by weeds, among which wild lettuce was most abundant. Initial cover by grass was almost completely eliminated. Soil properties were: pH, 6.0; Ca, medium +; Mg, very high -; phosphorus, high +; K, medium -. On all three experiments crownvetch @ 20 lbs/A was applied by

hydroseeder with 750 lbs/A woodfiber; experiments 1 and 2 received 1 T/A lime in addition. Treatments of fertilizer and tall fescue were applied by hand.

Experiment 1 received 7 fertility treatments applied in three randomized block replications. Three treatments were P2O5 @ 100 lbs and K2O 50 lbs combined with 0, 25 or 75 lbs/A. In three additional treatments P2O5 and K2O rates were doubled and again combined with 0, 25 or 75 lbs/A N. A check, no fertilizer, treatment was also included.

In experiment 2, P2O5 @ 0, 100 and 200, K2O @ 0, 50 and 100 were applied in factorial treatments to give nine in all. The experiment was replicated three times in randomized blocks.

For experiment 3, Paraquat @ 2 quarts/A (applied by backpack sprayer) and no Paraquat treatments formed main plots of a split plot design of three replications. Lime and no lime and tall fesce @ 25 lbs/A and no tall fescue were combined factorially and applied randomly for each main plot.

Results and Discussion

For experiments 1 and 2, no seedlings of crownvetch were observed in fall 1977. Use of woodfiber in these experiments may have been detrimental as it may have hindered seed from reaching the soil surface on this weed dominated slope. A very small population of erratically distributed seedlings was observed on experiment 3. Paraquat did not greatly reduce weed cover in this site but may have been obnoxious to seed eating animals and thus permitted more seed to survive.

By June 1979, crownvetch establishment was minimal on experiment 1 (Table 27). At the north end of this experiment a thick stand of thistles had become established. Elimination of these weeds by herbicides should be combined with introduction of crownvetch since, in Virginia, good covers by crownvetch are very rarely contaminated by this weed, while degenerated fescue stands immediately adjacent may have profuse growths of thistle. Use of nitrogen here enhanced the vigor of the existing weedy cover.

Crownvetch in experiment 2 and 3 had established strong cover in many places by June 1979. These vigorous stands of crownvetch had significantly suppressed weedy growth over a considerable portion of the site and likely will achieve complete domination in several years. Where phosphorus was not applied in experiment 2, addition of potassium appears to have favored competition by weedy species. Crownvetch stands were most vigorous. Where phosphorus and potassium were both

applied at the highest rates (200 and 100 lbs/A respectively).

Crownvetch establishment for experiment 3 was better where Paraquat had been applied. Crownvetch growth was also better where no lime was applied. Since crownvetch can grow vigorously under mildly acid conditions, application of lime under such circumstances is not warranted. Material of highway cuts and fills is predominately not soil in the sense used by soil scientists, which refers, rather, to the surficial stratum where weathering processes and biological activity is intense. Highway cut materials are largely devoid of organic matter upon initial exposure and coarser textured than the top-most layer of true soil; both of these properties dispose such deep lying materials to detrimental effects of overliming by rendering micronutrients poorly available.

### 2.9.3 Renovation experiment, New Kent County

Location: I-64, New Kent County. Establishment Date: 24 March 1979.

#### Experimental Methods

A renovation experiment was established in late March 1978 on a west facing weedy and partially eroding cut slope originally seeded to lovegrass in New Kent County. Soil material was a coarse textured, Coastal Plains sedimentary stratum of pH, 4.9 to 5.9; Ca, medium to high -; Mg, high to very high; and phosphorus, very high. Objectives of this experiment were to determine the relative adaptation of several legume species and the effect of rate of lime on establishment. Crownvetch @ 20 lbs/A and a 50-50 mix of flatpea and perennial sweetpea @ 20 lbs/A were applied by hydroseeder as main plots in three randomized block replications. Woodfiber @ 1500 lbs/A and 15-30-15 fertilizer @ 667 lbs/A were also applied by hydroseeder with lime treatments of 0, 1 and 2 T/A, which were randomized within main plots.

#### Results and Discussion

By fall 1978 establishment of legumes was minimal. This renovation seeding in the Coastal Plain was probably carried out at too late a date, especially because spring 1978 was somewhat drier than normal in this area. An additional

Table 28. Renovation of a weedy and eroding cut slope, I-64, New Kent Co.; established 24 Mar 78.

| | Number of legume plants/plot | | | | | |
|---|---|---|---|---|---|---|
| | crownvetch | | | flatpea | | |
| lime (T/A) | 0 | 1.0 | 2.0 | 0 | 1.0 | 2.0 |
| 29 Oct 78 | 0 | 1.0 | 0.67 | 0 | 0 | 0.67 |
| 6 Jun 79 | 0.67 | 3.0 | 12 | 0 | 0.33 | 0 |

Table 29. Soil fertility under perennial legume stands.

| Perennial sweetpea | pH | CaO | MgO | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|
| I-81 N of Rt. 311, Salem exit | 8.1 | VH | VH | M | L+ |
| I-81 S of Fairfield exit | 6.3 | M+ | VH | H- | H |
| Rt. 29, 24 mi S of Culpeper | 6.9 | M | M+ | L | H- |
| I-195 Rosewood For. exit | 7.5 | VH | VH | H | H- |
| I-64, 0.1 mi E of mile post 175, Henrico Co. | 5.4 | M+ | VH | M- | L+ |
| I-64 W of Rockville exit, Goochland Co. | 5.3 | M- | M+ | M | M- |
| I-64, 0.5 mi E of mile post 143, Louisa Co. | 5.4 | M- | VH | L | L |
| I-64 W of mile post 140, Louisa Co. | 6.3 | H- | VH | H | M |
| Rt. 460, Elam, Prince Edward Co. | 7.1 | H+ | VH | H | H- |
| Rt. 460 x 627, 1.4 mi W of Elam, Prince Edward Co. | 6.3 | M | VH | M | M |
| Rt. 40, 0.1 mi W of Charlotte C.H., Charlotte Co. | 5.5 | M- | M- | H- | M- |
| Rt. 40, Phoenix, Charlotte Co. | 6.8 | H | VH | M- | H |
| Rt. 40, W end Keysville, Charlotte Co. | 5.8 | M- | H | L | H- |
| Rt. 40 W of Keysville, Charlotte Co. | 4.8 | M- | H | H- | M |
| Rt. 46, 2.8 mi S of Nottoway River, Brunswick Co. | 6.2 | H+ | M- | VH | M |
| Rt. 58 E end Brodnax, Brunswick Co. | 6.1 | M- | L+ | H- | M |
| Rt. 460 W end Lynchburg by Rt. 826 | 6.1 | H- | M+ | L | M- |
| Rt. 460 approx. 5.0 mi E of Lynchburg by Rt. 688, Campbell Co. | 6.8 | H | VH | M- | M |
| **Crownvetch** | | | | | |
| Rt. 460 x 58, Suffolk | 6.0 | M | M+ | VH | M |
| I-64 W of mile post 145, Louisa Co. | 6.5 | H+ | VH | VH | M |
| Rt. 460 x 501, Lynchburg | 7.4 | VH | VH | VH | L+ |
| Rt. 460, Appomattox-Prince Edward Co. line | 5.2 | M+ | VH | VH | M |
| Rt. 460, 2.0 mi E of Pr. Edward Co. line | 5.8 | M+ | VH | VH | M |
| Rt. 360 x 662, Greenbay, Pr. Edward Co. | 5.1 | H- | VH | H+ | M- |
| Rt. 360 x 630, Meherrin, Pr. Edward Co. | 5.9 | H | H | VH | H- |
| Rt. 360 E of x Rt. 92, Charlotte Co. | 6.0 | M+ | VH | VH | M |
| Rt. 40, just S of Roanoke River, Halifax Co. | 5.8 | M- | H | H | M- |

adverse factor for this seeding was the inclusion of 100 lbs/A N which markedly stimulated weed competition.

By June 1979 weed growth was profuse on much of this experiment. However, crownvetch growth, though limited, had begun to be a significant component at this site with a marked lime response observable. Perennial sweetpea had failed to establish and only one plant of flatpea was growing. Observations of this site in the future ought to provide useful information on the extent of crownvetch's ability to spread and subdue weedy growth in this environment.

### 2.9.4 Renovation experiment, Williamsburg

Location: I-64, Williamsburg. Establishment Date: 22 February 1979.

#### Experimental Methods

A renovation experiment was set out in late February 1979 on a west facing (hot) cut slope along I-64 in Williamsburg through sandy material similar to that of the renovation site in New Kent County of the previous year. The lovegrass cover established within the last year had numerous bare spots. Three treatments were randomized in each of three, blocked replications. One treatment was a check, no renovation, in order to provide a standard for rate of grass degeneration and of woody and weedy species invasion against which renovation treatments may be compared in the future. Both renovation treatments received cereal rye (var., Abruzzi) @ 30 lbs/A, crownvetch, flatpea and perennial sweetpea each @ 20 lbs/A, P205 @ 100 lbs/A, K20 @ 50 lbs/A and lime @ 1 T/A. The two renovation treatments differed in rate of N: 0 and 20 lbs/A. These treatments were applied by hydroseeder with woodfiber mulch @ 750 lbs/A.

#### Results and Discussion

Time did not permit taking of detailed quantitative data at this site. However, qualitative observations were made in June 15, 1979. Effects of treatments were quite consistent for the three replications. Cereal rye applied with no nitrogen fertilizer provided sparse cover for bare areas with little tillering and leaf production by plants. Where N @ 20 lbs/A had been applied, rye growth was leafier, with more tillers and dense enough to provide good stabilization of

bare areas and will give a good *in situ* mulch when it dies back. However, growth of legume species in the understory was not appreciably affected by the denser rye canopy. For both renovation treatments crownvetch establishment was strong with many plants at 8 inches both in the midst of dense lovegrass and in areas which had been bare before seeding. A rough estimate of crownvetch density was 1 plant/3 square feet. Establishment of *Lathyrus* species was slight; most seedlings were found at the lower margin of bare areas. These large seeded legumes readily roll off of smooth areas, are much slower to germinate than crownvetch, and, at equivalent weight applications, are distributed in much lower numbers per unit area, thus decreasing the probability that a given seed will fall in a microenvironment favorable for germination and establishment. However, observations of previous seedings of these legume species tend to indicate that, once established, flatpea may be the best adapted to conditions in the Coastal Plains. Thus, continued observation of this site is warranted to determine competitive relations between these legumes over a longer term.

Use of rye @ 30 lbs/A and modest rates of nitrogen with the renovation procedures used here appears to be excellent for rapid stabilization of bare areas and introduction of legumes. A late winter seeding date is crucial for optimizing favorable moisture conditions for establishment of surface seeded legumes, especially in the Coastal Plain region where temperatures increase earlier than in the rest of the state and whose sandy soils are prone to drought. A seed mix including both crownvetch and flatpea is very desirable as the former species is likely to provide a cover more rapidly, while the latter is more likely to be well adapted to the region in the long term and thus will eventually succeed the crownvetch. During the period of succession a pleasing mix of legume species will control erosion and exclude volunteer species. This experiment provides a site to test these hypotheses.

### 2.9.5 Renovation experiment, Fancy Hill

Location: I-81, Fancy Hill. Establishment Date: 22 March 1979.

#### Experimental Methods

In the limestone valley area west of the Blue Ridge and, also, to a much lesser degree, in the Piedmont, species of the genus *Centaurea* (knapweed = star thistle) have invaded

stands of tall fescue which have declined because of limited available nitrogen. Invasion by knapweed is especially pronounced on the drcughthier slopes. This genus is non-leguminous, and, although apparently tolerant of lower fertility than tall fescue, is subject itself to decline as nitrogen becomes still more limiting. This prccess appears to be already started as the annual legume, hop clover, was observed to encroach in spring 1979 in previously solid stands of knapweed along I-81. Cover by summer annual species increases the probablility of erosion on long cut slopes, since no living protective cover persists through winter.

A renovation seeding of perennial legumes was begun in late summer 1978 at a site typical of many. On an east facing cut slope immediately south of mile post 179 in the vicinity of Fancy Hill, Rockbridge County a perennial species of the knapweed genus, identified as Centaurea maculosa, formed in 1979 an almost exclusive vegetative cover. Soil materials at the site were derived from limestone and had the following characteristics: pH, 6.4; Ca, high; Mg, high -; P, medium; K, high.

Renovation treatments at this site were factorial combinations of seeding date (late August 1978 and late March 1979), herbicide (none, Paraquat @ 2 qt/A and Round Up @ 1 qt/A) and species introduced (crownvetch @ 20 lbs/A and a mix of flatpea and perennial sweetpea each @ 10 lbs/A) plus a check, no renovation, treatment. All renovation plots received 100 lbs/A P205. With woodfiber @ 850 lbs/A as a mulch, treatments were applied by hydroseeder, herbicide treatments being cosprayed with seed along with X-77 spreader.

## Results and Discussion

Paraquat applied in late summer seedings killed new seedlings of knapweed and top growth of established plants. However, one month after spraying, new growth was abundant from established crowns. Late summer application of Round Up did not affect knapweed. In early September careful investigation of all summer seeded plots failed to locate any legume seedlings nor a trace of seed applied. At this time knapweed had set seed in prodigous amounts. Stands of knapweed may be associated with significant populations of seed eating animals for whom legume seed applied serves merely as a side order.

Late winter seedings were applied in late March at which time no seedlings were observed on fall seeded plots. Neither Paraquat nor Round Up gave good kills. Phosphate

fertilizer applied along with seed and herbicide was a 0-44-0 grade, less pure than the 0-46-0 grade used in late summer seedings. Clay filler in the fertilizer may have inactivated the herbicides before they reacted with plant material. Both herbicides used are bound strongly by soil particles.

In mid-May 1979 a single seedling of crownvetch in the cotyledon stage and partially eaten by insects was observed on spring seeded plots. Ungerminated seed of crownvetch and pea species were observed on spring seeded plots but at a much reduced density to that initially applied. Removal of introduced legume seed appears to be a significant factor at this site. In renovating sites such as this a device which would place seed beneath the surface of the soil would be highly advantageous.

## 2.10 SPREAD OF LEGUMES

### 2.10.1 Crownvetch spread experiment, Christiansburg

Location: Route 460, Christiansburg, bypass.

Experimental Methods

Over a period of years crownvetch has been observed at many sites to achieve complete covers by spread out from initially sparsely distributed "islands" in the midst of grass stands. At some sites growth from such islands appears to proceed very slowly if at all. What controls rate of spread is not known. Lack of the proper strain of bacterial symbiont in uninvaded areas may be a controlling factor. This possiblity was investigated at a site on a northeast facing cut slope along the Route 460, Christiansburg bypass. On this slope crownvetch covers the lower portion up to a fairly even line above which a thin stand of tall fescue is growing. Soil going across the slope in a 40 foot high strip was determined to be near neutrality and above, ranging from pH 6.3 to 8.1; Ca, medium + to very high; Mg, low to very high; P, high + to very high; K, low - to medium -. These characteristics were not thought to imply limiting values for crownvetch spread. Since boron is less available at higher pH's and is required in relatively large amounts by legumes (Murphy and Walsh, 1972), this element was included as a treatment. Effect of inoculant was investigated by mixing ample quantities of crownvetch inoculant in moist sand which was distributed in plots extending from the edge of existing crownvetch cover upward for 40 feet. Boron was applied @ 2 lbs/A as Boron-65. Factorial combination of boron and no boron, inoculant and no inoculant formed four treatments

which were applied randomly in three replicated blocks on October 13, 1978. An additional application of inoculant was applied to inoculant plots on March 29, 1979.

Results and Discussion

As of June 1979 crownvetch spread had not been pronounced enough on any of the plots to permit reliable discrimination between treatments. This site will need to be observed for a period of time, perhaps with further application of inoculant on appropriate plots. Application of potassium in split plots of the present experiment might be worthwhile to determine if this element may be a factor for spread at this site.

## 2.10.2 Soil fertility data associated with perennial legume stands

In many parts of Virginia perennial sweetpea has been observed as a volunteer species in highway corridors. Soil samples were collected from beneath a number of such stands as well as from several long established experimental seeding sites in order to determine fertility characteristics associated with these persistent stands. Data presented in Table 29 demonstrates that perennial sweetpea is adapted to a wide range of soil reactions. Severely acid soils, however, are not found. Ca and Mg tended to be in ample supply. Thus, these data support the use of adequate lime for establishment and spread of this species. Phosphorus and potassium were found to vary very widely. While ample applications of both of these elements is a good practice for seedings of perennial sweetpea, these data suggest that, where acidity is not limiting, this species can be expected to colonize areas of low fertility.

Soil samples from crownvetch sites in the Piedmont and from one in the Coastal Plain had a range of pH's similar to that found for perennial sweetpea. Likewise, Ca and Mg values fell in the upper range. As for sweetpea, adequate liming is important for vigor and spread of crownvetch. These data suggest that crownvetch may be more demanding than perennial sweetpea in phosphorus and potassium nutrition. However, since crownvetch has not been observed to volunteer, except in so far as it spreads vegetatively from sites where it has been seeded, these data may be biased due to the fact that fertilizer applications are more likely to be associated with sites under crownvetch than sweetpea.

## 2.11 HYDROMULCHING MATERIALS

### 2.11.1 Mulch experiment, Blacksburg

Location: Bypass 460, Blacksburg. Establishment Date: 10 August 1978.

#### Experimental Methods

This experiment was set out on August 10, 1978 on a 1.5:1, east facing cut slope through shale saprolite along bypass 460 in Blacksburg. The objective of this experiment was to assess the effectiveness of Cellin Fiber Mulch, processed to three different grades of fineness. This mulch appears to be composed principally of waste magazine paper and was processed by a hammermill equipped with 1/4, 3/8 or 1/2 inch screens. A standard summer season seed mix including German millet @ 15 lbs/A and crownvetch @ 20 lbs/A was applied by hydroseeder over the entire site prior to application of the test mulches. These mulches were applied by themselves @ 1500 and @ 2500 lbs/A and @ 750 lbs/A as a tack for straw. Woodfiber mulch @ 1500 lbs/A and no mulch served as comparison treatments. The experiment was replicated in two randomized blocks.

#### Results and Discussion

Table 30 reports values for erosion control and plant emergence for the varying mulch treatments. All mulch treatments reduced erosion and enhanced establishment of vegetation as compared with the no mulch treatment. However, on both August 18 and 26 Cellin Mulches tended to perform less well than woodfiber mulch with the trend being a decrease in both erosion control and seedling emergence with increase in grind size. Straw mulch was adequately tacked by Cellin Mulches and tended to enhance emergence rate of crownvetch. The Cellin Mulches formed a papier mache like crust which may have mechanically constrained the emergence of seedlings. The finest grind of Cellin Fiber Mulch, which passed through 1/4 inch screens of a hammermill, performed the best of the three Cellin Mulch types; its performance may be considered adequate but inferior to that of woodfiber mulch under the test conditions.

Table 30. Blacksburg mulch experiment, Rt. 460 Bypass; established 10 Aug 78.*

| | Straw + 750 lbs/A | | | | 1500 lbs/A | | | | 2500 lbs/A | | | Check |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $G_1$ | $G_2$ | $G_3$ | W. F. | $G_1$ | $G_2$ | $G_3$ | W.F. | $G_1$ | $G_2$ | $G_3$ | |
| 23 October | | | | | | | | | | | | |
| Erosion Index | 6 | 6 | 5.5 | 6.5 | 8 | 8 | 6.5 | 7.5 | 9.5 | 8.5 | 5.5 | 3 |
| | d | d | d | cd | b | b | cd | bc | a | ab | d | e |
| 18 August | | | | | | | | | | | | |
| Millet/ft$^2$ | 19 | 20 | 21 | 37 | 35 | 28 | 7 | 41 | 30 | 36 | 2 | 9 |
| | d | d | d | b | b | c | e | a | c | b | f | e |
| Grass/ft$^2$ | 5 | 10 | 9 | 32 | 16 | 9 | 3 | 17 | 8 | 9 | 3 | 3 |
| | def | cd | cde | a | c | cde | f | b | cdef | cde | f | f |
| GI Millet | 17 | 18 | 14 | 46 | 19 | 16 | 3.6 | 38 | 15 | 24 | .9 | 4.4 |
| | d | d | d | a | d | d | e | b | d | c | e | e |
| GI Grass | 5.7 | 13 | 10.1 | 56 | 12 | 8.1 | 2.6 | 21 | 7.2 | 10.5 | 2.4 | 3.3 |
| | efg | c | cde | a | cd | cdef | g | b | defg | cde | g | fg |
| 26 August | | | | | | | | | | | | |
| Millet/ft$^2$ | 18 | 19 | 10 | 26 | 21 | 19 | 5 | 33 | 22 | 16 | 2.2 | 8.8 |
| | abc | abc | abc | ab | abc | abc | bc | a | abc | abc | c | bc |
| Grass/ft$^2$ | 7.2 | 7.8 | 8.2 | 13 | 3.8 | 3.5 | 3.2 | 7.8 | 3.5 | 2.5 | 1 | 2 |
| | b | b | b | a | c | c | cd | b | c | cd | d | d |
| Crownvetch/ft$^2$ | 0 | .75 | .25 | 1.5 | 0 | 0 | 0 | .5 | 0 | 0 | 0 | 0 |
| GI Millet | 50 | 54 | 37 | 75 | 33 | 40 | 5 | 92 | 49 | 25 | 4.8 | 13 |
| | c | bc | cd | ab | cd | cd | e | a | cd | de | e | e |
| GI Grass | 17 | 20 | 18 | 35 | 6.5 | 8.2 | 4 | 21 | 7 | 3.3 | 1.9 | 2.6 |
| | b | b | b | a | c | c | c | b | c | c | c | c |

* Erosion Index: 10=completely stable, 1=complete washout
Growth Index (GI): plant density x average height

Means in a row having the same letter are not significantly different at the 5% level of probability

W.F. = Woodfiber Mulch
$G_1$ = Cellin Fiber Mulch, grind #1, 1/4"
$G_2$ = Cellin Fiber Mulch, grind #2, 3/8"
$G_3$ = Cellin Fiber Mulch, grind #3, 1/2"

## 2.11.2 Mulch experiment, Halifax Co.

Location: Rt. 797, Halifax County. Establishment Date: 4 October 1978.

### Experimental Methods

This experiment was established on two cut slopes, approximately 1:1 in grade on Route 797 in Halifax County. One replication was placed on a west facing cut of greenstone saprolite; two were placed on an east facing cut of coarse textured saprolite derived from a low base metamorphic material. Seed and fertilizer were applied by hydroseeder uniformly over the experimental site at the following rates: lime, 1.5 T/A; 15-30-15 fertilizer, 1000 lbs/A; creeping red fescue, 30 lbs/A; Ky-31 tall fescue, 60 lbs/A; Abruzzi cereal rye, 40 lbs/A; unhulled sericea lespedeza, 15 lbs/A; crownvetch, 20 lbs/A. Test materials included the three grades of Cellin Fiber Mulch and Astro-Mulch of International United Chemical Company. As for the Bypass 460 experiment at Blacksburg, hydromulch materials were tested at two rates, 1500 and 2500 lbs/A, and @ 750 lbs/A as tack for straw; woodfiber mulch and no mulch treatments were included as standards of comparison. A randomized block design was used.

### Results and Discusssion

One replication of the experiment was largely washed away by concentrated flow of water soon after establishment of the experiment. Mulching materials on the two remaining replicates were found to reduce erosion largely as a function of their ability to enhance establishment of vegetative cover, in particular that provided by cereal rye. In mid October erosion ratings of mulch treatments were not greatly different from that of the unmulched, check treatment (Table 31). Straw treatments, however, had much more vigorous stands of cereal rye than other treatments; these stands likely account for the much greateer stability found for straw treatments later in January. Erosion control and seedling establishment tended to be better for wood fiber and Astro-Mulch treatments than for Cellin Fiber Mulch. Among the latter the two smaller grinds tended to perform better than the largest grind. As for the earlier mulch experiment, a 2500 lbs/A rate appears to give no significant improvement over a 1500 lb/A rate.

Table 31. Halifax County mulch experiment, Pt. 735; established 4 Oct 78; data collected 17 Oct 78.*

| | 750 lbs/A Mulch + Straw | | | | | | 1500 lbs/A Mulch | | | | | 2500 lbs/A Mulch | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Check | $G_1$ | $G_2$ | $G_3$ | W.F. | A.M. | $G_1$ | $G_2$ | $G_3$ | W.F. | A.M. | $G_1$ | $G_2$ | $G_3$ | A.M. |
| Erosion Index | 7 abc | 8 abc | 8.5 ab | 7 abc | 9.5 a | 8.5 ab | 4 cd | 4 cd | 3 d | 5 bcd | 5.5 bcd | 6 bcd | 5 bcd | 5 bcd | 6.5 abcd |
| Rye/ft$^2$ | 3.5 d | 30 ab | 32.5 a | 27.5 b | 32.5 a | 29 ab | 9 cd | 8 d | 8 d | 14 c | 8 d | 9 cd | 14 c | 10 cd | 8.5 d |
| Grass/ft$^2$ | 4 d | 7 bcd | 5 d | 6 cd | 5.5 cd | 8 bc | 11 b | 6 cd | 3 bc | 7 bcd | 11 b | 7.5 bcd | 18 a | 8.5 bc | 9 bc |
| Rye Growth Index | 10 g | 110 abc | 120 ab | 100 c | 126 a | 106 bc | 25 efg | 19 fg | 17 fg | 44 d | 34 def | 22 fg | 41 de | 8 g | 22 fg |
| Grass Growth Index | 0.75 | 7 | 5 | 7 | 5.5 | 10 | 4.5 | 3.0 | 4.5 | 5.5 | 8.0 | 3.8 | 10 | 2.5 | 4.0 |
| 9 Jan 1979 | | | | | | | | | | | | | | | |
| Erosion Index | 2.8 | 8.5 | 9 | 8.3 | 8.8 | 8.7 | 5.0 | 4.4 | 3.6 | 4.6 | 5.9 | 4.9 | 4.6 | 2.8 | 6.0 |
| % rye cover | 2.3 | 66 | 79 | 61 | 32 | 70 | 15 | 16 | 15 | 26 | 25 | 15 | 37 | 6 | 13 |
| % fescue cover | 10 | 42 | 39 | 36 | 39 | 46 | 19 | 14 | 12 | 18 | 32 | 25 | 28 | 10 | 30 |

*Erosion Index: 10 = stable, 1 = complete washout
Growth Index: plant density x average height

Means in a row having the same letter are not significantly different at the 5% level of probability.

W. F. = Wood Fiber Mulch
A. M. = Astro-Mulch of United Inter. Chemical Company
$G_1$ = Cellin Fiber Mulch, grind #1, 1/4"
$G_2$ = Cellin Fiber Mulch, grind #2, 3/8"
$G_3$ = Cellin Fiber Mulch, grind #3, 1/2"

## 2.12 LIMING OF SLOPES OF EXTREME ACIDITY DUE TO EXPOSURE OF SULFIDES

### 2.12.1 Lime experiment of an acid sulfate cut slope, Clifton Forge

Location: I-64, Clifton Forge. Establishment Date: 16 March 1978.

Experimental Methods

At several locales in Virginia extremely acid conditions due to exposure to atmospheric conditions of sulfide bearing strata have completely thwarted attempts to establish protective vegetative covers. Sulfide materials are concentrated under waterlogged, near shore conditions, and appear in such locales presently as well as in exposures of uplifted strata of sedimentary material accumulated under comparable conditions of previous geological epochs. Pyrite is the principal sulfide mineral of these depcsits. Its oxidation involves many reactions some of which are catalyzed by bacteria. A schematic representation of the process giving the quasi-stable end products, including amounts of acid generated, is presented below.

$$FeS2 + H2O + 3\ 1/2\ O2 \text{ -- } FeSO4 + H2SO4$$

$$4FeSO4 + 10\ H2O + O2 \text{ -- } 4Fe(OH)3 + 4H2SO4$$

Ponnamperuma (1972) presents a thorough discussion of acid sulfate formation for sulfide bearing soils which is applicable also to geological relicts of such materials.

Along I-64 in the vicinity of Clifton Forge many cut slopes were exposed of Devonian shales bearing large amounts of sulfides. Extreme acid conditions due to sulfide oxidation have dissolved the shaley material, producing a structureless, heavy textured surficial layer in which plants cannot grow and which is subject to sloughing thereby exposing fresh, unoxidized sulfides. These slope conditions may mend with extreme slowness and difficulty unless adequate methods of liming raise pH values high enough to permit introduction of stabilizing vegetation.

Since the effect of lime surface applied moves downward very slowly, methods are required which will permit neutralization processes to proceed at depths sufficient to provide adequate rooting depth for plants. On an acid sulfate site along I-64 near Clifton Forge a trial was initiated in November 1977 to test several liming methods.

For two treatments, horizontal trenches about 10 inches deep were cut in November 1977 into the acid slope with picks and shovels at the top of the experimental area and 15 feet down slope. These trenches were filled with limestone gravel of the following properties:

| Sieve | Total % Passing |
|---|---|
| 2 inch | 100 |
| 1 inch | 95 |
| 3/8 inch | 72 |
| #10 | 32 |
| #40 | 16 |
| #20 | 8 |

In March 1978 ground agricultural limestone @ 3 T/A and @ 6 T/A were applied as treatments with and without these trenches. These treatments plus a check, no lime, treatment were randomized in two blocked replicates. Over all plots sericea lespedeza @ 30 lbs/A, deertongue @ 20 lbs/A, annual ryegrass @ 7 lbs/A, 15-30-15 fertilizer @ 667 lbs/A and woodfiber mulch @ 1500 lbs/A were applied by hydroseeder.

Results and Discussion

Establishment of all species seeded was poor in spring 1978, probably in part due to dryness. In late spring a seeding contractor applied a further application of lime @ 2 T/A as well as additional fertilizer, millet, tall fescue, crownvetch and straw. This seeding also failed to establish appreciable vegetation. Marked differences in plant distribution were observable, however. What had been check, no lime, treatments were completely devoid of vegetation while limed plots had some cover, stronger on plots where trenches had been emplaced.

In May 1979 soil samples were collected from two areas in each plot: that lying between the two trenches (top) and that lying six feet below the lower trench (bottom). Samples were collected to a depth of four inches below the broadcast lime level with the lime itself, one half inch lying below the lime and any sloughed, overlying material rejected from the sample. Values for pH in May 1979 and in November before lime application are presented in Table 32. Amelioration of extreme acid condition is shown to be much more effectively accomplished on plots having limestone gravel filled trenches. Gravel in these trenches served to intercept acid water percolating downslope, neutralizing a significant portion of it. The large particle size of the gravel prevented the reaction from completely consuming the carbonate in a rapid reaction. A section of trench excavated

Table 32. Experiment on sulfide-bearing cut slope, I-64, Clifton Forge; established 1 Dec 77.

| | | Dec 1977 | May 1979 | |
|---|---|---|---|---|
| | | pH in $H_2O$ | pH in $H_2O$ | pH in 0.01 M $CaCl_2$ |
| Check no lime | top I | 2.8 | 3.2 | 3.0 |
| | top II | 2.3 | 2.7 | 2.7 |
| | bottom I | 4.7 | 3.0 | 2.8 |
| | bottom II | 2.3 | 2.7 | 2.6 |
| 3 T/A lime | top I | 2.5 | 3.2 | 3.0 |
| | top II | 2.4 | 3.6 | 3.7 |
| | bottom I | 2.4 | 3.3 | 3.1 |
| | bottom II | 2.3 | 2.9 | 2.8 |
| 6 T/A lime | top I | 2.5 | 4.3 | 3.9 |
| | top II | 2.4 | 2.7 | 2.6 |
| | bottom I | 2.5 | 3.4 | 3.1 |
| | bottom II | 2.3 | 3.9 | 3.7 |
| Limestone gravel trench + 3 T/A lime | top I | 5.4 | 6.5 | 6.3 |
| | top II | 2.3 | 5.8 | 5.7 |
| | bottom I | 2.6 | 5.8 | 5.7 |
| | bottom II | 2.6 | 5.5 | 5.5 |
| Limestone gravel trench + 6 T/A lime | top I | 2.4 | 4.1 | 3.8 |
| | top II | 2.4 | 5.7 | 5.8 |
| | bottom I | 2.3 | 3.7 | 3.5 |
| | bottom II | 2.5 | 3.4 | 3.3 |

Samples collected to 4" depth with top 0.5 inch below lime application discarded.

Table 33. Soil characteristics at two acid sulfate sites.

| | pH | CaO | MgO | $P_2O_5$ | $K_2O$ | S |
|---|---|---|---|---|---|---|
| Suffolk, Rt. 58 x 13 | 2.6 | L (388) | M+(222) | M-(40) | L(24) | |
| Richmond, I-95 x 295 | 2.7 | M-(1108) | M (192) | H(165) | L(37) | 0.37% |
| | 3.0 | H-(2115) | H-(259) | H+(243) | L(37) | 0.30% |

in May revealed that much of the finer sized fractions had been consumed but a large amount of unreacted gravel of larger size remained. The whole mass was cemented together by iron oxides which had precipitated from acid waters as the pH was raised through the neutralizing action of the gravel. Though still severely acid, soil material on limestone trenched plots is predominately within the range that will permit establishment of the most acid tolerant species. A further seeding of lovegrass will be made in summer 1979 which likely will demonstrate by extent of vegetative cover the feasibility of this liming method.

Emplacement of limestone gravel filled trenches after sulfide bearing cuts have already been brought down would be a very expensive operation. However, this experiment shows that where stairstep grading of such material has been employed, filling of steps with limestone gravel will succeed in effectively moderating the effects of oxidation processes. Identification of geological formations having high probabilities of sulfide occurrence and measurement of core samples for sulfur content in suspect areas will permit adequate planning to avoid costly remedial actions and bare, eroding slopes. pH measurement of core samples will not be of use in predicting sulfides as these produce acid conditions only after a period of exposure to air, water and biological activity.

### 2.12.2 Acid sulfate sites in Suffolk and Richmond

Occurrence of sulfide bearing materials may be relatively common in highway construction in the Coastal Plain. In the Suffolk, Chesapeake, Norfolk area fill slopes are often constructed of materials exhumed from poorly drained sites near or below sea level which are prone to accumulate sulfides. The extremely acid conditions of the incomplete section of Route 13 near Business 58 in Suffolk have likely been produced by exposure of such materials. Characteristics of a sample collected at this site are reported in Table 33.

Partially consolidated materials of Tertiary age accumulated in similar circumstances may occur in other parts of the Coastal Plain and be exposed in the course of highway construction. Such is the case in the vicinity of I-95 x 295 interchange near Richmond presently under construction. Soil characteristics, including per cent total sulfur, for several samples from this area are given in Table 33. Sulfur values are somewhat higher than the upper range found in surface soils. Assuming that the sulfur determined had been associated until recently with iron as the sulfide, pyrites, 0.30 per cent S implies the presence of 3750 lbs of pyrite per acre x 6 inches, assuming 2 million pounds per acre x 6

inches. This quantity of pyrite, upon oxidation, would require 6256 lbs of CaCO3 to be neutralized. Oxidation processes without doubt proceed at depths greater than 6 inches. However, liming would not require neutralization of all acidity generated since much of this is removed by leaching.

## 2.13 AMERICAN BEACHGRASS

### 2.13.1 American beachgrass experiment, Bland County

Location: I-77, Bland County. Establishment Date: 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 soil adversely affected this species. Beachgrass establishment remained stable through June 1979 and from four hills runners had spread as much as three feet, probably where local soil conditions were not as severely acid as elsewhere. Though beachgrass shows some promise for stabilizing loose, mobile, shaley slopes, it would be best adapted to calcareous shales.

## 2.14 EXPERIMENTS OF PREVIOUS CONTRACTS

Establishment of these experiments and several years results have been reported on by Wright et al. (1976).

### 2.14.1 Variety trial of perennial sweetpea and flatpea, Blacksburg

Location: VPI & SU Turf Center, Blacksburg. Establishment Date: 14 April 1975.

A variety trial of perennial sweetpea seed from seven sources and of the flatpea variety, "Lathco," was initiated in Blacksburg, April 14, 1975. Observations of cold tolerance by flatpea and perennial sweetpea types were made in late December 1978 for canopies regrown following an August mowing. Values presented in Table 34 reveal that the canopy of perennial sweetpea possess remarkable cold tolerance. A mean 53 per cent of the canopy which had regrown following mowing persisted for sweetpea types, best persistence (72 per cent) being from seed from Corvalis, Oregon. Barely 5 per cent canopy remained green for flatpea. Persistence of live canopies of perennial sweetpea at this site was greater than for unmowed stands nearby on Route 460 bypass. Thus, mowing may improve cold tolerance of perennial sweetpea canopies though data from a controlled experiment are not available.

Crownvetch had spread along the alleyways between seeded pea plots over a major portion of the experiment. A likely source for this contaminant was the hydroseeder used to apply woodfiber tack to straw serving as mulch to establish the legumes. The vigorous spread of crownvetch from such a low rate of seed in the midst of well developed stands of perennial pea is noteworthy. By late December frosts had killed back crownvetch top growth which had regrown after August mowing. A dense mass of foliage concentrated immediately around vetch crowns had regrown and apparently was escaping further frost damage through the temperature moderating effects from overlying frost-killed canopy. The basal cold tolerant organs cause all three legumes to be persistent perennials.

### 2.14.2 Legume companion species experiment, Lynchburg

Location: Routes 460 x 291, Lynchburg. Establishment Date: 2 April 1975.

Table 34. Variety trial of perennial sweetpea and flatpea, VPI Turf Center, Blacksburg; established 14 Apr 75; data collected 21 Dec 78.

| | | Perennial Sweetpea | | | | | | |
|---|---|---|---|---|---|---|---|---|
| plant type: | Flatpea Lathco | Bristol | Draper | Composite | Northrup King | Oregon | Penn Draper | Brodnax |
| % cover: | 95 | 93 | 67 | 90 | 89 | 93 | 72 | 83 |
| Winter* growth index: | 5 | 59 | 44 | 63 | 59 | 72 | 25 | 52 |

* Winter growth index = % green canopy, 1 Dec % cover x 100.

Table 35. Legume companion species experiment, Rts. 460 x 291, Lynchburg; established 2 Apr 75; data collected 3 May 79.*

| Companion species: | | None | | | Ky 31 @ 30 An RyGr @ 20 | | | Ky 31 @ 20 CRF @ 20 | | | Ky 31 @ 40 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Legume seeded: | | FP | SP | CV | FP | SP | CV | FP | SP | CV | FP | SP | CV |
| % cover by species | FP | 52 | 0 | 10 | 100 | 0 | 5 | 72 | 2.5 | 2.5 | 88 | 0 | 0 |
| | SP | 2.5 | 65 | 0 | 0 | 55 | 0 | 0 | 90 | 2.5 | 0 | 28 | 0 |
| | CV | 46 | 25 | 95 | 15 | 50 | 92 | 22 | 10 | 95 | 15 | 65 | 82 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | | Mean on plots not originally seeded into (spread) |
|---|---|---|---|---|---|
| | | May 79 | Jun 76 | May 79 | May 79 |
| % cover by species | FP | 28 | 25 | 78 | 3.3 |
| | SP | 20 | 10 | 52 | 0.8 |
| | CV | 52 | 23 | 91 | 42 |

* FP = flatpea @ 30; SP = sweetpea @ 30; CV = crownvetch @ 30; An RyGr = annual ryegrass, CRF = creeping red fescue. Because of redundancy in ground cover where legume canopies are intermixed, legume covers may sum to greater than 100%.

Legume cover on this northeast facing 1:1 cut slope was 96 per cent on May 3, 1979. Crownvetch shows little differential response to companion species applied four years earlier; its vigor, greater than that of the other two legume species, is reflected by values reported for establishment and spread (Table 35). The two perennial pea species have established the best covers where seeded with tall fescue at the lesser rate (20 lbs/A) plus annual ryegrass (for flatpea) or creeping red fescue (for sweetpea). The shift in per cent cover from June 1976 to May 1979 demonstrates that all three legumes are well adapted on this acid, cool aspect, Piedmont site. Though erosion and invasion by herbaceous weedy species is completely controlled at this site, black locust has begun to invade, probably from runners, at the crest of the slope. This site will be a useful one to observe the rate of spread of locust into a strong leguminous cover.

Cover by perennial sweetpea is provided by a relatively sparsely distributed number of plants which yearly regrow from crowns, creating a canopy of roughly 10 $ft^2$. Apparently the prolonged growth of perennial sweetpea in late fall is sufficient to prevent winter annual species from establishing. In early May 1979 regrowth from crowns was about half complete and, consequently, cover by this species was estimated by summation of fresh green canopy cover with areas covered by dead foliage of the previous years growth. By contrast, flatpea stands had already regrown sufficiently to give live ground cover over the whole of their previous year's growth area. This faster re-establishment of territorial control may be due to a denser distribution of basal shoots derived from rhizomatous growth.

### 2.14.3 Legume companion species experiment, Patrick County

Location: Route 635, Patrick County. Establishment Date: 24 May 1974.

Companion species for this experiment are given in Table 36. By July 6, 1978 effects of the three companion species on legume growth were obscurred. Cover by flatpea was 100 per cent on all plots seeded; crownvetch had attained a mean 74 per cent cover. Both legumes gave excellent stabilization of this 1:1 slope and excluded weeds and woody species, thereby reducing the need for brush cutting. Sericea establishment was poor and was invaded by the other two legumes, principally flatpea.

Table 36. Legume companion species experiment, Rt. 635, Patrick Co., established 24 May 74; data collected 6 Jul 78.* (All seeding rates in lbs/A)

| Species seeded: | Ky-31 tall fescue @ 40 over all plots | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crownvetch @ 15 | | | | | | Flatpea @ 15 | | | | Sericea @ 30 |
| | Lovegrass | | | German millet | | Ky-31 only | Lovegrass | | German millet | | German millet |
| | 5 | 10 | 15 | 10 | 20 | | 5 | 10 | 10 | 20 | 20 |
| % legume cover with straw | | | | | | | | | | | |
| crownvetch | 50 | 82 | 90 | 65 | 45 | 78 | 0 | 0 | 0 | 0 | 20 |
| flatpea | 40 | 0 | 0 | 35 | 25 | 10 | 100 | 100 | 100 | 100 | 50 |
| sericea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| % legume cover without straw | | | | | | | | | | | |
| crownvetch | 90 | 82 | 65 | 85 | 68 | 82 | 0 | 0 | 0 | 0 | 10 |
| flatpea | 5 | 5 | 20 | 10 | 25 | 12 | 100 | 100 | 100 | 100 | 50 |
| sericea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | Mean on plots not originally seeded into (spread) |
|---|---|---|---|---|
| % cover by species | crownvetch | 38 | 74 | 2.5 |
| | flatpea | 54 | 100 | 20 |
| | sericea | 1.9 | 22 | 0 |

* Rates of species seeded are in lbs/A.

### 2.14.4 Legume companion species experiment, Patrick County

Location: Route 635, Patrick County. Establishment Date: 5 July 1974.

Both crownvetch and flatpea attained virtually complete covers by July 6, 1979; thus initial treatment effects were no longer observable. However, sericea showed better growth where seeded with German millet and tall fescue than with lovegrass. This difference is probably due to the persistence of lovegrass as a perennial in contrast to millet. Thus, as long as lovegrass, a warm season species, persists it competes strongly during the warm summer months when sericea growth is favored. Tall fesuce is less aggressive than lovegrass because of poor summer growth.

Greater spread of crownvetch than flatpea at this site, contrasts with the better performance of flatpea at the site adjacent seeded on May 24, 1974; this may be attributed to the confounding of the legume treatment applications by seed present in the crownvetch straw used as mulch.

### 2.14.5 Lime and nitrogen rate experiment, Patrick County

Location: Route 856, Patrick County. Establishment Date: 26 June 1974.

The superior performance of sericea lespedeza on unlimed plots compared with flatpea and crownvetch confirms the remarkable acid tolerance of sericea (Table 38). The apparent decline of flatpea on unlimed plots by 1978 is due to exclusion from 1979 data of values from plots bordering lime blocks and contaminated by that treatment; values for these plots had been included in 1976 data. Thus, on unlimed plots flatpea and crownvetch were near failures at this highly acid site. However, a few weak plants of flatpea have persisted. Bacterial nodules from these plants might prove to be useful in development of a strain of inoculant more acid tolerant than that currently available. Table 38 shows that crownvetch increased its cover from 1976 to 1978 where lime had been applied. The effect of rate of nitrogen was no longer expressed in 1978, except where sericea had been seeded. On unlimed plots sericea cover remained stable from 1976 to 1978, low N plots permitting stands roughly twice as good as for high N plots. On limed plots, sericea cover had remained stable for low N treatment but started to decline where the high rate of N had been applied. These characteristics are attributed to more vigorous competition at the high N rate by weeping lovegrass, like sericea a warm season species and in competition with it during the season of optimal growth.

Table 37. Lime and legume companion species experiment, Rt. 635, Patrick Co.; established 5 Jul 74; data collected 6 Jul 78.*

% legume cover by species

| species seeded: | lovegrass @ 10 Ky-31 @ 50 crownvetch @ 15 | lovegrass @ 10 Ky-31 @ 50 flatpea @ 15 | lovegrass @ 10 Ky-31 @ 50 sericea @ 30 | millet @ 20 Ky-31 @ 50 sericea @ 30 |
|---|---|---|---|---|
| 1 T/A lime | | | | |
| crownvetch | 97.5 | 0 | 97 | 2.5 |
| flatpea | 2.5 | 100 | 0.5 | 12.5 |
| sericea | 0 | 0 | 0 | 43.5 |
| 2 T/A lime | | | | |
| crownvetch | 100 | 0 | 97.5 | 67.5 |
| flatpea | 0 | 100 | 1.5 | 0 |
| sericea | 0 | 0 | 11.5 | 17.5 |
| 3 T/A lime | | | | |
| crownvetch | 100 | 0 | 95 | 35 |
| flatpea | 0 | 100 | 0 | 10 |
| sericea | 0 | 0 | 2.5 | 38 |
| 4 T/A lime | | | | |
| crownvetch | 100 | 2.5 | 72.5 | 82.5 |
| flatpea | 0 | 97.5 | 2 | 10 |
| sericea | 0 | 0 | 0.5 | 3 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | Mean in sericea plots (spread) |
|---|---|---|---|---|
| % cover by species | crownvetch | 59.3 | 99.4 | 68.7 |
| | flatpea | 27.3 | 99.4 | 4.6 |
| | sericea | 7.3 | 14.5 | 14.6 |

* Rates of species are in lbs/A.

From observations at this site and at the July 5, 1974 experiment on Route 635 discussed above, it may be inferred that German millet plus tall fescue is superior to weeping lovegrass as companion species for establishment of sericea during the summer. The high rate of N did not adversely affect legume covers eventually attained by crownvetch and flatpea and is recommended to help insure rapid establishment of grass covers to hold lime and fertilizer applications in place, thus preserving fertility conditions which facilitate encroachment of crownvetch and flatpea once grass covers weaken due to the inevitable decline in available nitrogen.

Numerous woody shoots had begun to appear on the poorly vegetated, no lime plots. Near complete exclusion of woody species where crownvetch and flatpea had vigorous covers indicates that persistent legumes would reduce maintenance costs by keeping the strip above the ditch line free of brush.

### 2.14.6 Legume companion species experiment, Franklin County

Location: Route 785, Franklin County. Establishment Date: 27 September 1974.

This is the only experimental site observed which has shown a decline in cover by perennial pea species and crownvetch over the last several years (Table 39). This decline is unexplained. Although previous descriptions of this experiment indicated that flatpea had been the only Lathyrus species seeded, in 1978 the majority of vegetative cover was provided by perennial sweetpea, with flatpea persisting weakly in the understory.

### 2.14.7 Legume companion species experiment, Rocky Gap

Location: Route 61, Rocky Gap. Establishment Date: 18 September 1974.

At this site crownvetch and flatpea were seeded together @ 15 lbs/A each, except for one treatment without companion species where crownvetch rate was doubled. Companion species tested were cereal rye @ 30 lbs/A, annual and perennial ryegrass @ 40 lbs/A and Ky-31 tall fescue @ 40 lbs/A. Lime was applied @ 3000 lbs/A. By June 1979 legume cover was 100 per cent over the entire experiment. Flatpea composed 98 per cent of the legume cover for the easterly five sixths of the experiment and crownvetch the balance. For the remaining portion of the experiment, the slope curved toward the west; here flatpea cover was 70 per cent, crownvetch 30 per cent.

Table 38. Lime and nitrogen rate experiment, Rt. 856, Patrick Co.; established 26 Jun 74; data collected 6 Jul 78.

| N lbs/A | | no lime | | | lime @ 2 T/A | | |
|---|---|---|---|---|---|---|---|
| | | Sericea | Flatpea | Crown-vetch | Sericea | Flatpea | Crown-vetch |
| | 23 Jun 76 | | | | | | |
| 50 | % legume | 70 | 5 | 0 | 100 | 100 | 64 |
| 100 | % legume | 42 | 22 | 0 | 100 | 97 | 81 |
| | 6 Jul 78 | | | | | | |
| 50 | % legume | 73 | 2.5 | 0 | 98 | 100 | 90 |
| | % lovegrass | 11 | 25 | 21 | 0 | 0 | 8.2 |
| 100 | % legume | 38 | 1.5 | 0 | 74 | 100 | 89 |
| | % lovegrass | 31 | 24 | 30 | 1.2 | 0 | 8.2 |

Table 39. Legume companion species experiment, Rt. 785, Franklin Co.; established 27 Sep 74; data collected 24 May 78.*

| | % legume cover | |
|---|---|---|
| | 23 Jun 76 | 24 Apr 78 |
| CV @ 35 + Pea @ 15 | 90 | 40 |
| CV @ 35 + Pea @ 50 | 56 | 21 |
| CV @ 50 + Pea @ 15 | 100 | 44 |
| CV @ 50 + Pea @ 50 | 81 | 44 |
| CV @ 35 + Pea @ 15 + C. rye @ 20 | 87 | 34 |
| CV @ 35 + Pea @ 15 + C. rye @ 40 | 100 | 36 |
| CV @ 35 + Pea @ 15 + A. ryegr @ 30 | 80 | 25 |
| CV @ 35 + Pea @ 15 + A. ryegr @ 60 | 100 | 23 |
| CV @ 35 + Pea @ 15 + A. ryegr @ 30 + Ky 31 @ 30 | 100 | 20 |
| CV @ 35 + Pea @ 15 + A. ryegr @ 30 + Ky 31 @ 60 | 93 | 24 |

* Rates of species are in lbs/A. CV = crownvetch; Pea = indeterminate mix of sweet and flatpea; C. rye = cereal rye; A. ryegr = annual ryegrass; Ky 31 = Ky 31 tall fescue.

A soil sample was taken from beneath vigorous flatpea canopies on several plots at the eastern end of the experment. The material was a very heavy clay of pH 3.55 and 3.65 for replicated subsamples, measured in 0.01 M CaCl2. The pH measured for the sample diverges greatly from the value of 5.1 measured for a sample collected in 1974 prior to establishment of the experiment. Extreme acidity may or may not explain the predominance of flatpea over crownvetch at this site. The experiment is situated in a 15 foot high strip along the base of a tall cut slope. Downward movement of water may cause the very stiff clay on this cool aspect slope to be saturated for extended periods. Crownvetch does poorly on poorly drained sites while flatpea appears to be more tolerant. A seeding of flatpea near mile post 186 of I-81 in Rockbridge County into a poorly drained median area has been flourishing for a number of years. The better performance of crownvetch where an aspect change creates a warmer environment suggests that drainage may be a factor. Further soil samplings need to be made to determine soil reactions across the site.

### 2.14.8 Legume overseeding experiment, Virginia Beach

Location: Route 44, Virginia Beach. Establishment Date: 16 May 1974.

Legumes were introduced into a thin fescue sod of a north facing fill slope of coastal sedimentary material in May 1974, with seedbeds tilled or sprayed with Paraquat to reduce fescue competition; soil fertility was amended with and without lime and phosphorus. By June 1979 flatpea alone exhibited significant cover, with inconsistent responses to soil amendments (Table 40). Covers by crownvetch, sericea and sumac were poor or nonexistent.

### 2.14.9 Legume overseeding experiment, Virginia Beach

Location: Indian River Road x I-64, Virginia Beach.

Four legume overseeding experiments were established in fescue sods on north facing fill slopes of the interchange of I-64 and Indian River Road in September 1973, February 1974, October 1974 and October 1975. Seedbed and fertility treatments applied were those used for the Route 44, Virginia Beach experiment. September 1973 and February 1974 experiments were identical, except for seeding date. The earlier seeding date gave superior establishment of crownvetch and perennial sweetpea, the latter legume performing best. However, sweetpea covers had not increased

Table 40. Legume overseeding experiment, Rt. 44, Virginia Beach; established 16 May 74; data collected 7 Jun 79.*

| | % legume cover | | | |
|---|---|---|---|---|
| | Paraquat + Surface Seed | | Tilled | |
| | $P_2O_5$ + lime | Check | $P_2O_5$ + lime | Check |
| crownvetch | 0 | 1.5 | 5 | 5 |
| sericea | 0 | 0 | 0 | 0 |
| flatpea | 53 | 18 | 25 | 28 |
| sumac + scotchbrome | 0 | 0 | 0 | 0 |

Table 41. Legume overseeding experiment, Rt. 126, Lynchburg; established 2 Apr 75; data collected 5 Jun 79.

| | Paraquat | | $P_2O_5$ @ 100 lbs/A | | $P_2O_5$ + paraquat | | Check | |
|---|---|---|---|---|---|---|---|---|
| | CV | FP | CV | FP | CV | FP | CV | FP |
| % legume cover | 99 | 92.5 | 90 | 100 | 88 | 91.5 | 93 | 99.5 |
| % tall fescue cover | 0 | 0.5 | 10 | 0 | 7.7 | 0 | 5.5 | 0 |
| % crownvetch cover | 99 | 37.5 | 87.5 | 26 | 78.8 | 40.5 | 93 | 57.5 |
| % flatpea cover | 4.5 | 74 | 5.8 | 87.5 | 10.3 | 55 | 1.5 | 52.5 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | Mean on plots not originally seeded into (spread) |
|---|---|---|---|---|
| % cover by species | CV | 65.2 | 89.6 | 40.9 |
| | FP | 36.4 | 67.3 | 5.5 |

* Paraquat @ 2 qts/A; $P_2O_5$ @ 100 lbs/A; crownvetch @ 30 lbs/A; flatpea @ 30 lbs/A. CV = crownvetch; FP = flatpea. Because of redundancy in ground cover where legume canopies are intermixed, legume covers may sum to more than 100%.

over values reported for 1976 by spring 1979. The best legume covers were provided by October 1974 seedings of flatpea and crownvetch on a site to the east of I-64 on the north facing fill slope of the Indian River Road overpass. Here, crownvetch and flatpea had complete covers on seeded plots and were vigorously invading plots where sericea and sumac had failed. The two species were growing very vigorously in association in many places. No covers had developed by spring 1979 for plots seeded in October 1975, where the entire experiment was tilled. It is unclear what variables are controlling legume establishment at these sites. However, flatpea appears to be the best adapted of the species seeded.

### 2.14.10 Legume overseeding experiment, Lynchburg

Location: Route 126, Lynchburg. Establishment Date: 2 April 1975.

Flatpea @ 30 lbs/A and crownvetch @ 30 lbs/A were overseeded in early spring 1975 into a stand of cereal rye and tall fescue on a south facing cut slope in the Lynchburg area. Additionally, plots were treated with and without Paraquat and amended with and without lime and phosphorus. By June 1979 there was no consistent response tc variables, except for species of legume (Table 41). Both establishment and spread were greater for crownvetch than for flatpea. Crownvetch successfully excluded herbaceous weeds but some shoots of the winter annual wild lettuce were observable in the midst of flatpea canopies. Apparently flatpea dies back early enough in the fall to permit some seedlings of wild lettuce to become well enough established to persist through winter. Black locust had begun to invade at the crest of the slope and sycamore at the base.

### 2.14.11 Legume overseeding experiment, Afton Mountain

Location: I-64, Afton Mountain. Establishment Date: 30 August 1973.

On this steep, north aspect cut slope, perennial sweetpea, crownvetch, sericea and a mix of sumac and scotch broom were overseeded into a fescue stand in blocks treated or untreated with lime and phosphorus in August 1973. These treatments were repeated within three seedbed preparation treatments: none, paraquat and tillage. Wright et al. (1976) reported strong establishment of crownvetch one year later, marginal establishment of perennial sweetpea and sericea, and failure for sumac-scotch broom seedings. By June 1979 crownvetch

Table 42. Legume overseeding experiment, I-64, Afton Mountain; established 30 Aug 73; data collected 14 Jun 79.

| | | Treatments Applied* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No seedbed preparation | | | | Paraquat | | | | Tilled | | | |
| | | CV | SP | SER | SUM | CV | SP | SER | SUM | CV | SP | SER | SUM |
| % cover by species | CV | 98.5 | 77 | 96 | 95 | 99.5 | 52 | 95 | 99.2 | 98.5 | 58.8 | 97.5 | 83.5 |
| | SP | 0.25 | 16.5 | 0 | 1.5 | 0 | 48 | 3.8 | 0 | 1.0 | 41.3 | 0.75 | 15 |
| | SER | 0 | 0 | 0 | 0 | 0 | 0 | .12 | 0 | 0 | 0 | 0 | 0 |
| stems/plot | SUM | .12 | 0 | .12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.12 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | Mean on plots not originally seeded into (spread) |
|---|---|---|---|---|
| % cover by species | CV | 87.5 | 98.8 | 83.7 |
| | SP | 10.6 | 35.2 | 3.7 |

* CV = crownvetch @ 20 lbs/A; SP = sweetpea @ 40 lbs/A; SER = sericea @ 40 lbs/A; SUM = sumac @ 15 lbs/A, 1 hr. $H_2SO_4$ treated.

showed complete covers for seeded plots regardless of accompanying treatments. It invaded strongly into other legume plots (Table 42). Fertility response was insignificant in 1979 for sweetpea but Paraquat treatment aided establishment. A modest increase of 21 to 35 for mean per cent cover by sweetpea on plots into which it had been seeded occurred between August 1975 and June 1979. Sericea and sumac plots were dominated almost exclusively by crownvetch.

### 2.14.12 Legume overseeding experiment, Afton Mountain

Location: I-64, Afton Mountain. Establishment Date: 1 March 1974.

This experiment was identical to the last, except for the late winter seeding date. As for fall seeding, fertility response was negligible and sericea and sumac establishment was almost nil in June 1979 (Table 43). However, establishment of perennial sweetpea from later winter 1974 seeding was twice the rate of August 1973 seeding. Response to seedbed treatments was inconsistent. Though rate of spread by perennial sweetpea is slow at this site, this species may in the future prove as well or better adapted than crownvetch. The strong crownvetch stands are desirable as they are aesthetically pleasing in themselves and control erosion and invasion by weeds and woody species. The slow, but persistent, spread of sweetpea in the midst of strong crownvetch cover suggests that addition of a small amount of perennial sweetpea seed into crownvetch seed mixes for highway seedings would permit the development of mixed legume stands pleasing because of foliage and color variations.

### 2.14.13 Legume overseeding experiment, Afton Mountain

Location: I-64, Afton Mountain. Establishment Date: 17 May 1974.

This experiment was similar to the two other Afton Mountain overseeding experiments, except for placement on a hot aspect slope, substitution of flatpea for sweetpea and late spring seeding date. Delay in seeding and the hot aspect of this rocky slope largely account for the relatively poor growth of crownvetch at this site (Table 44). Crownvetch showed better establishment where plots had been tilled than where sprayed with Paraquat. No treatment responses, except legume species were significant. Flatpea establishment was excellent, probably due to its superior drought tolerance. Despite inferior establishment by

Table 43. Legume overseeding experiment, I-64, Afton Mountain; established 1 Mar 74; data collected 14 Jun 79.

| | | Treatments Applied* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No seedbed preparation | | | | Paraquat | | | | Tilled | | | |
| | | CV | SP | SER | SUM | CV | SP | SER | SUM | CV | SP | SER | SUM |
| % cover by species | CV | 98.8 | 27.5 | 99 | 84.8 | 98.3 | 36 | 93.8 | 85.8 | 99.8 | 25.5 | 61.3 | 87 |
| | SP | 1.2 | 72.5 | 1.0 | 15.2 | 1.5 | 64 | 6.2 | 13.8 | 0.2 | 74.5 | 38.7 | 9.4 |
| | SER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| stems/plot | SUM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | Mean on plots not originally seeded into (spread) |
|---|---|---|---|---|
| % cover by species | CV | 74.8 | 98.9 | 66.7 |
| | SP | 25.2 | 70.3 | 10.1 |

* CV = crownvetch @ 20 lbs/A; SP = sweetpea @ 40 lbs/A; SER = sericea @ 40 lbs/A; SUM = sumac @ 15 lbs/A, 1 hr. $H_2SO_4$ treated

crownvetch, this species proved as effective in spreading as flatpea. As at the Route 126, Lynchburg experiment, flatpea permitted establishment of some wild lettuce shoots, principally at the periphery of stands where flatpea growth was less dense.

Table 44. Legume overseeding experiment, I-64, Afton Mountain; established 17 May 74; data collected 14 Jun 79.

| | | CV | FP | SER | SUM | CV | FP | SER | SUM |
|---|---|---|---|---|---|---|---|---|---|
| % cover by species | CV | 60 | 14.5 | 47.5 | 45.8 | 32.5 | 2.5 | 14.5 | 25 |
| | FP | 8.8 | 77.5 | 1.2 | 23 | 20 | 88.3 | 2.5 | 18.8 |
| | SER | 3.0 | .25 | 6.5 | 2.5 | 8.2 | 1.8 | 25 | 6.5 |
| stems/plot | SUM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | Over whole experiment | Mean on original treatment plots (establishment) | Mean on plots not originally seeded into (spread) |
|---|---|---|---|---|
| % cover by species | CV | 26.3 | 46.3 | 19.7 |
| | FP | 34.6 | 82.9 | 16.6 |
| | SER | 8.7 | 23.3 | 3.8 |

CV = crownvetch @ 20 lbs/A; FP = flatpea @ 40 lbs/A; SER = sericea @ 40 lbs/A; SUM = sumac @ 15 lbs/A

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# LITERATURE CITED

Anderson, A. J., 1956, Molybdenum as a fertilizer, Adv. Agron., 8, 164-202.

Blaser, R. E. and W. H. McKee, 1967, Regeneration of woody vegetation along roadsides, Nat. Acad. Sci. Highway Research Board, Pub. 1439; 104-115.

Campbell, M. H. and F. G. Swain, 1973, Effect of strength, tilth and heterogeneity of the soil surface on radicle-entry of surface-sown seeds, J. Brit. Grassl. Soc. 28, 41-50.

Clarkson, D. T., 1966, Aluminum tolerance in species within the genus Agrostis, J. Ecol., 54, 167-178.

Dodson, J. W., C. D. Fisher and E. R. Beatty, 1976, Yield and persistence of several legumes growing in tall fescue, Agron. J., 68, 123-125.

Heath, M. E., D.S. Metcalfe and R. F. Barnes (eds.), 1973, Forages, 3rd Edition, Iowas State U. Press, Ames, Iowa.

Holland, A. A. and J. E. Sweet, 1968, Pellet inoculation of legume seed, AXT-280, Univ. Calif., Agricultural Ext. Serv.

Jones, M. B., J. C. Burton and C. E. Vaughn, 1978, Role of inoculation in established subclover on California annual grasslands, Agron. J., 70, 1081-1088.

Kipps, M. S., 1970, Production of Field Crops, 6th Edition, McGraw Hill, New York.

Mays, D. A. and E. M Evans, 1972, Effects of variety, seeding ratio, companion species, and cutting schedule on crownvetch yield, Agron. J., 64, 283-285.

Parker, J. R. and R. V. Connin, 1964, Grasshoppers: their habits and damage, Agric. Res. Serv., USDA, Washington.

Ponnamperuma, F. N., 1972, The chemistry of submerged soils. Adv. Agron. 24:29-96.

Sharp, W. C., 1978, Ability of Crownvetch to suppress woody plant invasion, Agronomy Abstracts, 1978, Annual Meetings, Amer. Agron. Soc.

Stevenson, F. J. and M. S. Ardakani, 1972, Organic matter reactions involving micronutrients in soils, In J. J. Mortvedt et al. (eds.), Micronutrients in Agriculture, Soil Sci. Soc. of Am., Madison, Wisc.

Templeton, W. C., Jr., G. O. Mott and R. J. Bula, 1961, Some effects of temperature andlight on growth and flowering of tall fescue, Festuca arundinaceae Schreb. I. Vegetative Development, Crop Sci. 1:216-219.

Woodruff, J. M., 1971, Morphological development and physiology of crownvetch, Ph.D. Thesis, VPI & SU, Blacksburg, Va.

Woodruff, J. M. and R. E. Blaser, 1969, Annual Report: Turf establishment and maintenance on steep slopes along Virginia highways, VPI & SU Research Div., Blacksburg, Va.

Yeh, R. Y., A. G. Matches and R. L. Larson, 1976, Endogenous growth regulators and summer tillering of tall fescue, Crop Sci. 16:409-413.

Appendix A

SPECIES CITED

| Common Names | Scientific Names |
|---|---|
| American beachgrass | Ammophila breviligulata Fernald. |
| Birdsfoot trefoil | Lotus corniculatus L. |
| Buckwheat | Fagopyrum esculentum L. |
| Cicer milkvetch | Astragalus cicer L. |
| Crownvetch | Coronilla varia L. |
| Deer tongue | Panicum clandestinum |
| Fescue | Festuca L. |
| Chewnings | rubra var. commutata Gaud. |
| varieties used | Banner |
| | Jamestown |
| | Koket |
| Hard | ovinia 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 |

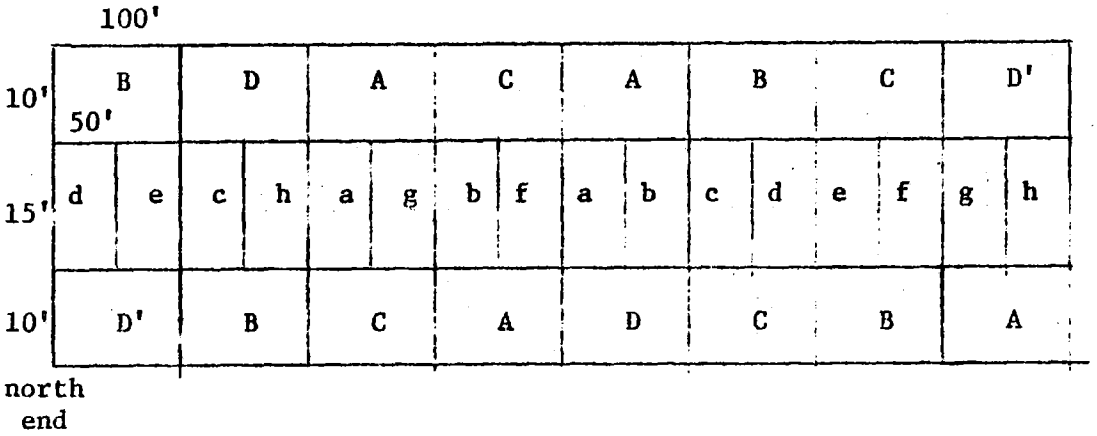
| Common Names | Scientific Names |
|---|---|
| Star Thistle | *Centaurea maculosa* Lam. |
| Sericea lespedeza | *Lespedeza cuneata* (*sericea*) (Dumont) G. Dons |
| Velvet Bentgrass | *Agrostis canina* L. |

# Appendix B

## DIAGRAMS OF EXPERIMENTS

Insert Experiment Diagrams here.

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

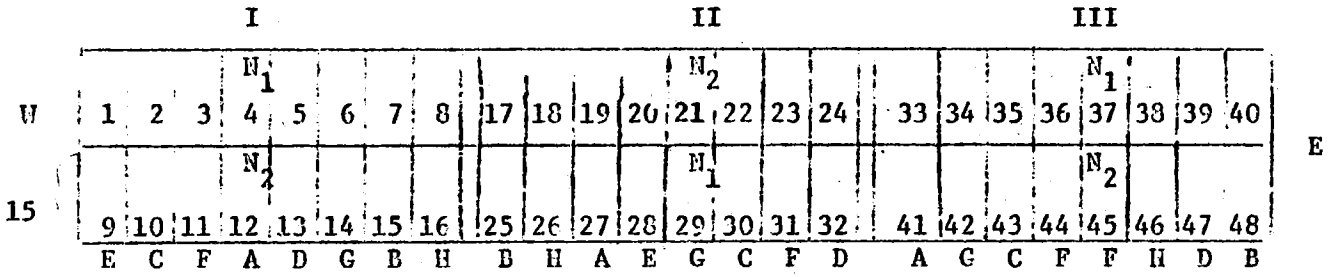
a. Flat pea @ 20
b. Sweet pea @ 20
c. Milk vetch @ 20
d. Trefoil @ 20
e. Flat pea @ 10
f. Sweet pea @ 10
g. Milk vetch @ 10
h. Trefoil @ 10

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

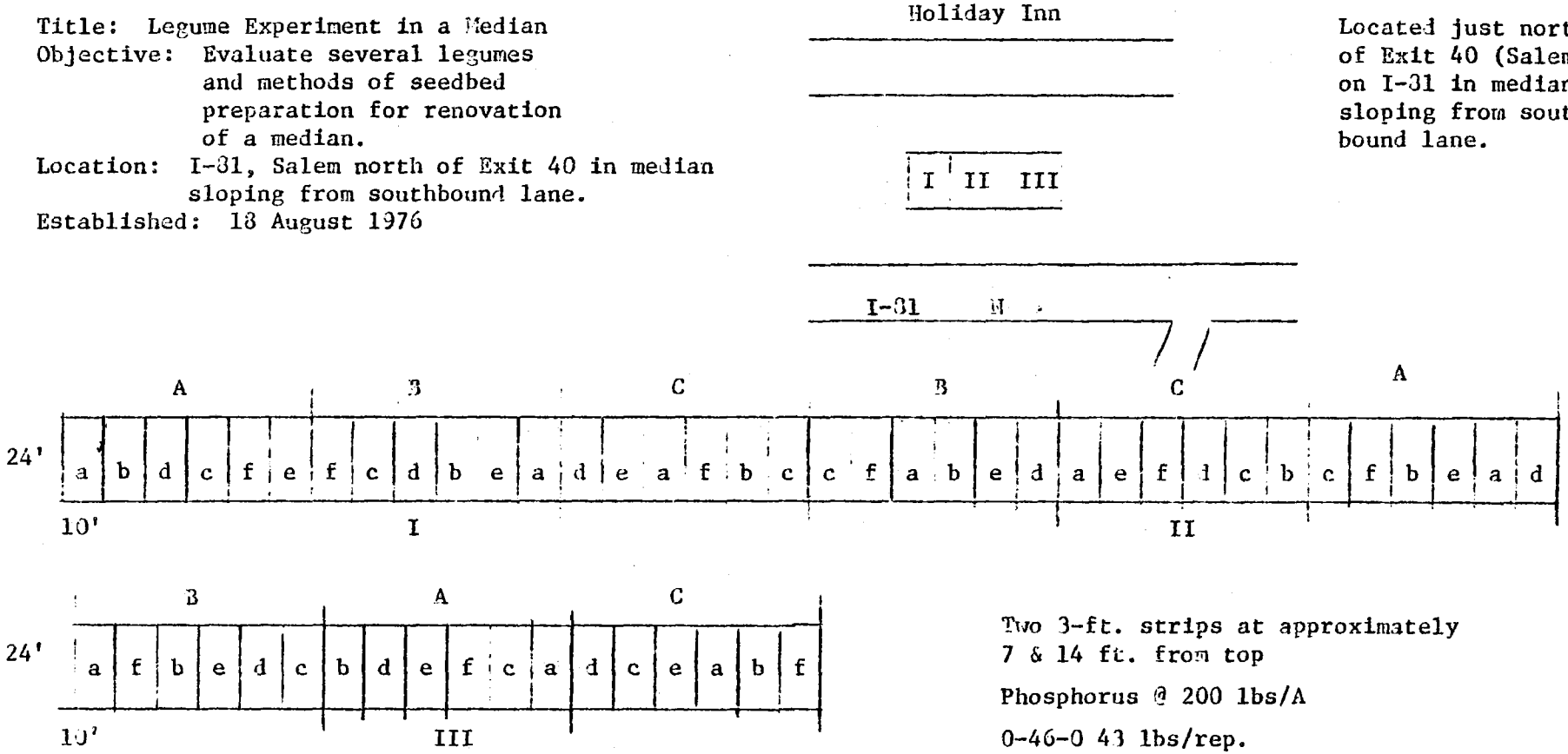



Plot size: 15' x 12.5'
Treatments: All plots: 2 Tons/A dolomitic lime
500 lbs/A 10-20-10

$N_1$ = 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




Located just north of Exit 40 (Salem) on I-31 in median sloping from southbound lane.

Two 3-ft. strips at approximately 7 & 14 ft. from top

Phosphorus @ 200 lbs/A

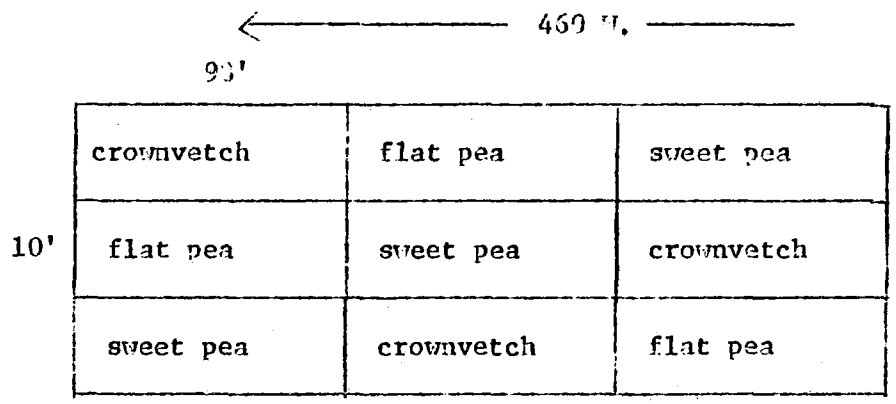
0-46-0 43 lbs/rep.
14.3 lbs/main plot

A - till
B - paraquat
C - check

a - Birdsfoot trefoil @ 20 lbs/A
b - Milkvetch @ 15 lbs/A
c - Crownvetch @ 15 lbs/A
d - Sweet pea @ 25 lbs/A
e - Flat pea @ 25 lbs/A
f - Sericea @ 35 lbs/A

pH 7.7
Ca-VH
Mg-VH
P - H
K - L+

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

3784

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

driveway

| | 0 T/A | | | | 1.5 T/A | | | | 3.0 T/A | | | | 3.0 T/A | | | | 0 T/A | | | | 1.5 T/A | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | D 1 | A 2 | C 3 | B 4 | A 5 | D 6 | B 7 | C 8 | C 9 | A 10 | B 11 | D 12 | A 13 | B 14 | D 15 | C 16 | D 17 | A 18 | C 19 | B 20 | D 21 | B 22 | A 23 | C 24 | III |
| S | | | | | | | | | | | | | | | | | | | | | | | | | N |
| II | B 25 | C 26 | A 27 | D 28 | C 29 | D 30 | A 31 | B 32 | A 33 | C 34 | B 35 | D 36 | B 37 | D 38 | A 39 | C 40 | A 41 | C 42 | B 43 | D 44 | C 45 | B 46 | D 47 | A 48 | IV |
| | 3.0 T/A | | | | 0 T/A | | | | 1.5 T/A | | | | 1.5 T/A | | | | 3.0 T/A | | | | 0 T/A | | | | |

crossway

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

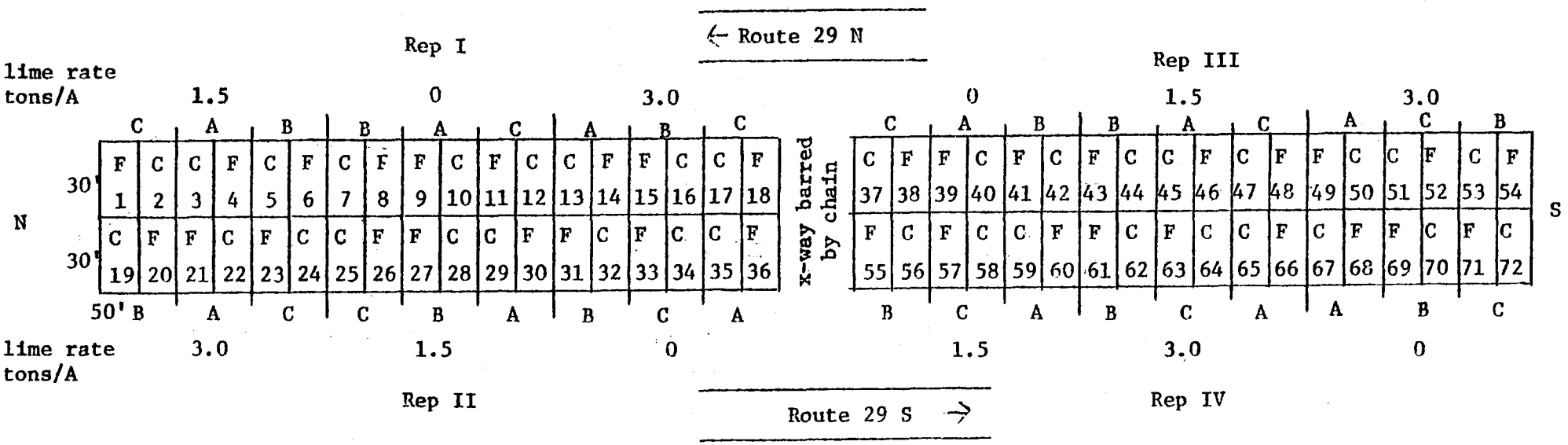
Lime as on map.
All plots: 300 lbs/A 10-20-10
30 lbs/A Jamestown creeping red fescue

Subplots: 15' x 60'

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

3785

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.

3786

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 | $Z\bar{\bar{p}}g$ |
| | 2 | 1 | | 1 | 1 | |
| | 3 | 2 | | 2 | 3 | |
| Bg | 2 | 1 | Dg | $Zp\bar{g}$ | 1 | 2 | $D\bar{g}$ |
| | 1 | 3 | | | 3 | 1 | |
| | 2 | 1 | | | 1 | 3 |
| Zpg | 1 | 2 | $D\bar{g}$ | $Z\bar{p}g$ | 3 | 1 | Dg |
| | 3 | 3 | | | 2 | 2 |
| | 1 | 2 | | | 3 | 2 |
| $D\bar{g}$ | 2 | 3 | $Z\bar{\bar{p}}g$ | $Z\bar{\bar{p}}g$ | 2 | 1 | $B\bar{g}$ |
| | 3 | 1 | | | 1 | 3 |
| | 3 | 2 | | | 2 | 1 |
| $Z\bar{\bar{p}}g$ | 1 | 1 | $Z\bar{p}g$ | Zpg | 1 | 3 | $Zp\bar{g}$ |
| | 2 | 3 | | | 3 | 2 |
| | 3 | 1 | | | 1 | 2 |
| Dg | 2 | 3 | Bg | $D\bar{g}$ | 3 | 1 | Bg |
| | 1 | 2 | | | 2 | 3 |
| | 2 | 1 | | | 3 | 1 |
| $B\bar{g}$ | 3 | 2 | $Zp\bar{g}$ | Dg | 1 | 2 | $Z\bar{p}g$ |
| | 1 | 3 | | | 2 | 3 |

S

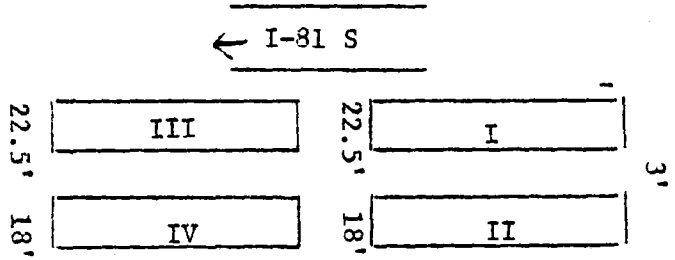
## Treatments

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, 100 $P_2O_5$, 50 $K_2O$
3 = 50 N, 200 $P_2O_5$, 50 $K_2O$

Crownvetch @ 10 lbs/A on all plots.



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 |

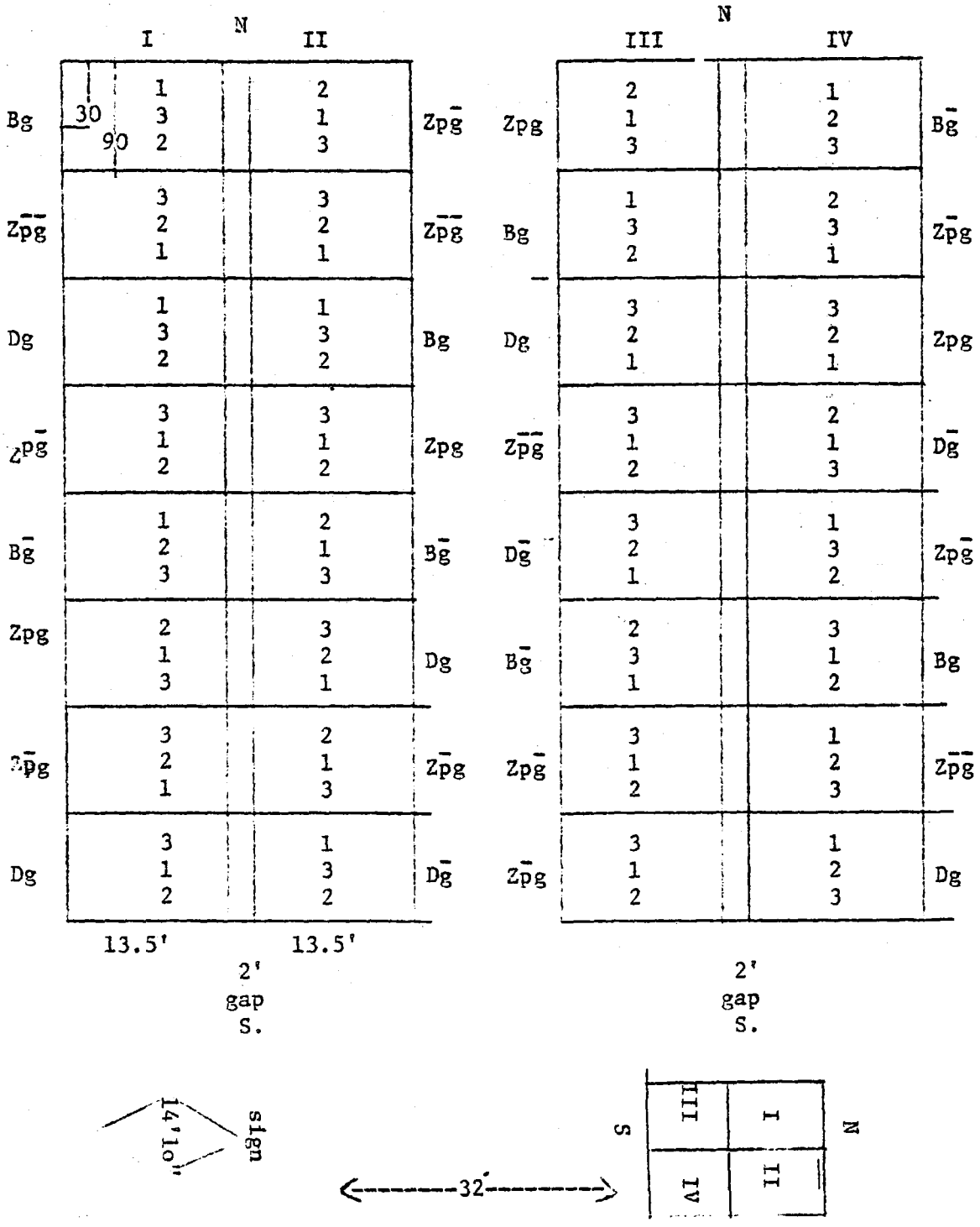
Title: Legume Experiment in a Median

Objectives: Determine effective methods for establishing crownvetch in existing grass sods of highway medians; compare methods of 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

N

| | I | II | | III | IV | |
|---|---|---|---|---|---|---|
| | 2 | 2 | | 3 | 1 | |
| (8) Zpg | 1 | 3 | $Z\bar{p}\bar{g}$ | 1 | 3 | $B\bar{g}$ + $Z\bar{p}g$ |
| | 3 | 1 | | 2 | 2 | |
| | 1 | 1 | | 1 | 3 | |
| (7) Bg | 3 | 3 | $B\bar{g}$ | 2 | 2 | $Z\bar{p}g$ |
| | 2 | 2 | | 3 | 1 | |
| | 2 | 3 | | 2 | 2 | |
| (6) $Z\bar{p}g$ | 1 | 2 | $Z\bar{p}g$ | 3 | 1 | $D\bar{g}$ |
| | 3 | 1 | | 1 | 3 | |
| | 3 | 2 | | 3 | 3 | |
| (5) Dg | 2 | 1 | $Z\bar{p}\bar{g}$ | 2 | 2 | $Z\bar{p}\bar{g}$ |
| | 1 | 3 | | 1 | 1 | |
| | 1 | 1 | | 2 | 3 | |
| (4) $B\bar{g}$ | 3 | 3 | $D\bar{g}$ | 1 | 1 | Dg |
| | 2 | 2 | | 3 | 2 | |
| | 33 | 3 | | 1 | 1 | |
| (3) $Z\bar{p}g$ | 1 | 2 | Zpg | 3 | 3 | Zpg |
| | 2 | 1 | | 2 | 2 | |
| | 1 | 2 | | 3 | 2 | |
| (2) Dg | 2 | 1 | Dg | 2 | 1 | Bg |
| | 3 | 3 | | 1 | 3 | |
| | 2 | 3 | | 2 | 1 | |
| (1) $Z\bar{p}\bar{g}$ | 3 | 1 | Bg | 1 | 2 | $Z\bar{p}\bar{g}$ |
| | 1 | 2 | $+Z\bar{p}g$ | 3 | 3 | |

3' gap S 3' gap

**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, inoculant, and lime

$\bar{g}$ = no coating on crownvetch seed

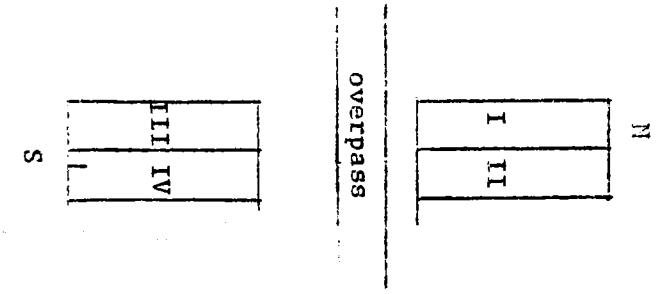
Fertilizer rates (lbs/A)

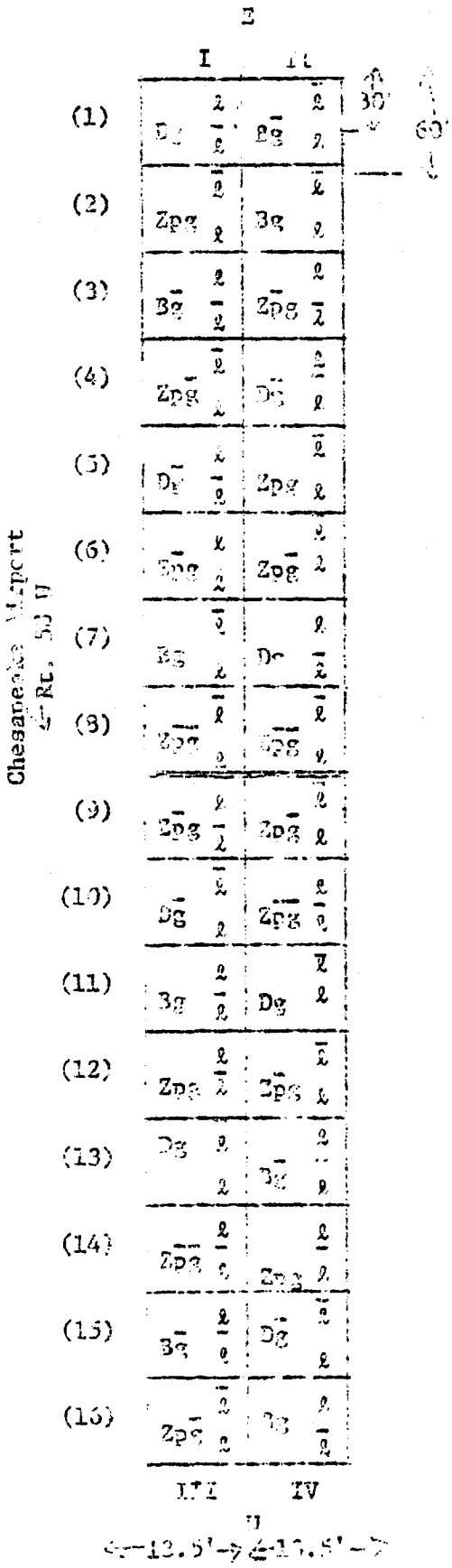
1 = 0 N, 100 $P_2O_5$, 50 $K_2O$

2 = 50 N, 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. 50 west bound just to west from Chesapeake Airport, Chesapeake.

Established: 27-28 September 1977.

Treatments:

- g = 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
- c = crownvetch seeds coated with gum, inoculand, and lime
- c̄ = no coating on crownvetch seed

- ℓ = lime at 1 ton/A
- ℓ̄ = no lime

All plots

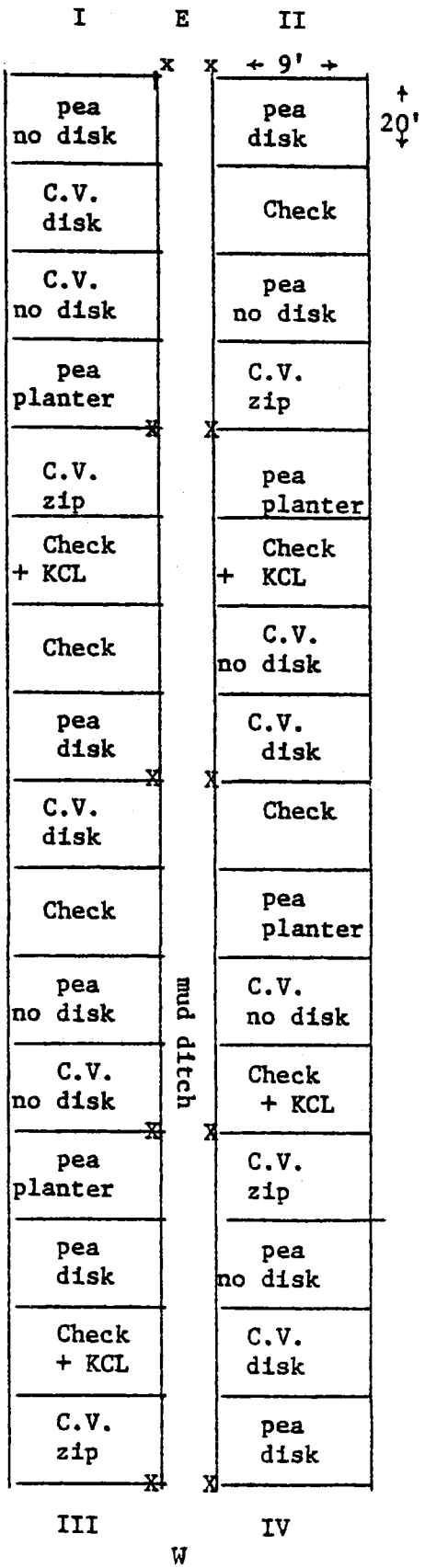
$P_2O_5$ at 100 lbs/A

$K_2O$ at 50 lbs/A

Crownvetch at lbs/a

Title: Legume experiment in a median.

Objectives: Assess value of different mehtods of seeding leguminous species into a grassy median in Peidmont region. Evaluate crownvetch vs. sweet pea/flat pea mix for use in improving vigor and appearance of highway median vegetation.




Site: East of Route 92 intersection near Route 685 intersection on Route 360, Charlotte County. Test plot signs are placed 20' east and west of either end of the experiment.

Chemical Properties: pH - 7.4; Ca - H; Mg - VH: P - M: K - L.

Date Established: 30 March 1978

Treatments: Crownvetch was seeded @ 10 lbs/A, broadcast on disk and no disk plots and zip seeded with 1 qt/A paraquat application on zip seed plots. Pere-nial pea plots were broadcast seeded @ 5 lbs/A sweet, 5 lbs/A flat pea on disk and no disk plots. Hand planted pea plots were planted with garden corn planter at 2' intervals at approximate 1" depth, approx. 3 seed per planting in rows spaced 2' apart. Rows ran E-W starting 1.5' from E-W edge of plot, plantings began 2' from end of row giving 5 flat, 4 sweet pea plantings per row. Check and check + KCL received no legume seedings. All but check plots received 100 lbs/A $K_2O$ as KCL.

x = wooden stake pounded down to surface

Title: Legume experiment in a median.
Objective: Assess different methods for establishment of perennial legumes in a highway median.
Location: Median I-64 just west of east Clifton Forge exit.
Soil Material: pH - 8.1; Ca - Very high; Mg - Very high; P - High; K - Medium.
Established: 12 April 1978.

Treatments: Ko - no KCl  $K_1$ - K as KCl @ 100 lbs/A

W

| | | 4.5' | | 4.5' | |
|---|---|---|---|---|---|
| | C.V. broadcast | 1 $K_1$ | Ko 25 | pea broadcast | |
| | C.V. disk | 2 Ko | $K_1$ 26 | C.V. zip | |
| | pea planter | 3 Ko | $K_1$ 27 | pea disk | |
| I | pea disk | 4 $K_1$ | Ko 28 | C.V. broadcast | III |
| | C.V. zip | 5 $K_1$ | $K_1$ 29 | pea planter | |
| | pea broadcast | 6 Ko | Ko 30 | C.V. disk | |
| | pea planter | 7 $K_1$ | Ko 31 | pea planter | |
| | C.V. zip | 8 Ko | $K_1$ 32 | pea broadcast | |
| | pea disk | 9 Ko | Ko 33 | C.V. zip | |
| | C.V. disk | 10 $K_1$ | $K_1$ 34 | pea broadcast | |
| | pea planter | 11 Ko | Ko 35 | C.V. disk | |
| | C.V. zip | 12 $K_1$ | $K_1$ 36 | pea planter | |
| | pea disk | 13 $K_1$ | $K_1$ 37 | pea broadcast | |
| | C.V. disk | 14 Ko | Ko 38 | C.V. zip | |
| | pea broadcast | 15 $K_1$ | $K_1$ 39 | pea planter | |
| II | C.V. zip | 16 Ko | Ko 40 | C.V. disk | IV |
| | pea planter | 17 Ko | Ko 41 | pea broadcast | |
| | C.V. zip | 18 $K_1$ | $K_1$ 42 | C.V. disk | |
| | pea disk | 19 $K_1$ | $K_1$ 43 | pea broadcast | |
| | C.V. disk | 20 Ko | Ko 44 | C.V. zip | |
| | pea broadcast | 21 Ko | $K_1$ 45 | pea planter | |
| | C.V. zip | 22 $K_1$ | Ko 46 | C.V. disk | |
| | pea planter | 23 Ko | $K_1$ 47 | pea broadcast | |
| | C.V. zip | 24 $K_1$ | Ko 48 | C.V. disk | |

20'

E

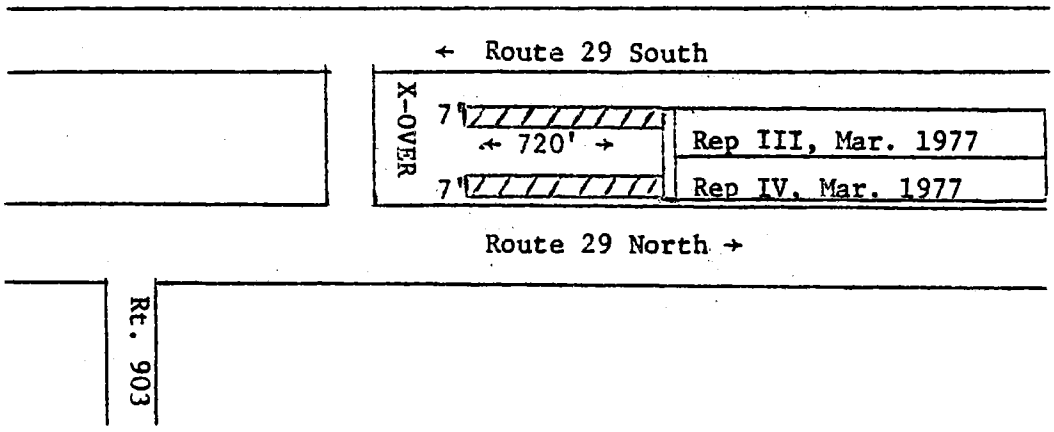
Crownvetch was seeded @ 10 lbs/A, broadcast on disk and no disk plots and zip seeded with 1 qt/A paraquat application on zip seed plots along seeded row. Perennial pea plots were broadcast seeded @ 5 lbs/A sweet, 5 lbs/A flat pea on disk and no disk plots. Hand planted pea plots were planted with garden corn planter at 2' intervals at approximate 1" depth, approximately 3 seeds per planting in rows spaced 2' apart. Rows E-W starting 1.25' from E-W edge of plot, plantings began 2' from end of row giving 5 flat, 4 sweet pea plantings per row.

Title: Demonstration seeding of crownvetch into a compacted median dominated by weeds and warm season grases in Pittsylvania Co.

Objective: Assess whether tillage by a field cultivator and late winter seeding of crownvetch result in rapid legume establishment.

Site: Six foot wide swaths were tilled through Reps. I and II of a median legume experimental site initially seeded March 31, 1977 north on Route 29 from the intersection with Route 903 south of Gretna. In April 1978 this site was seeded with a flatpea-sweetpea mix by no till seeder. Neither of the two previous seedings of legumes resulted in legume establishment in the portion of the median passing through a cut area (Reps. I and II).

Established: March 5, 1979



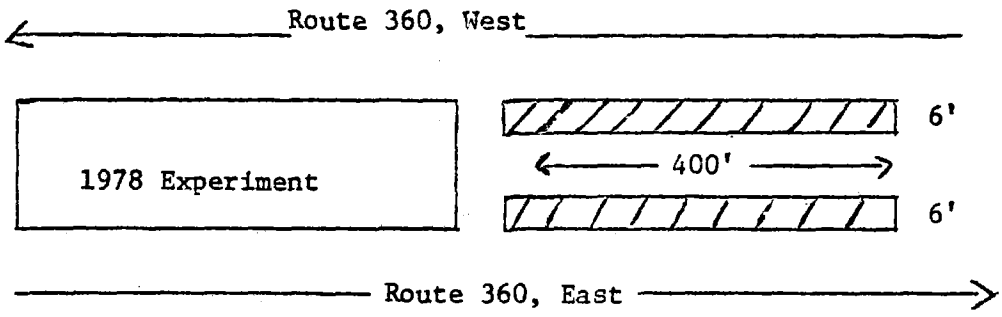

Treatments: ▨ = strip tilled to 6-8" with field cultivator mounted with 5 chisel points set 16" apart and seeded by hydroseeder with Pennfine crownvetch @ 20 lbs/A, 200 lbs/A $P_2O_5$, 1T/A lime, 1500 lbs/A wood fiber mulch. Strip on east side tilled twice.

Title: Demonstration seeding of flatpea - perennial sweetpea mix into a compacted median in Charlotte Co.

Objective: Assess whether tillage by field cultivator and late winter seeding of flatpea and perennial sweetpea will aid legume establishment.

Site: Route 360 Charlotte Co. East of Route 92 intersection and near Route 685 intersection; immediately east of experimental site seeded to legumes March 30, 1978 without tillage. Median has compacted alluvial material.

Established: March 5, 1979



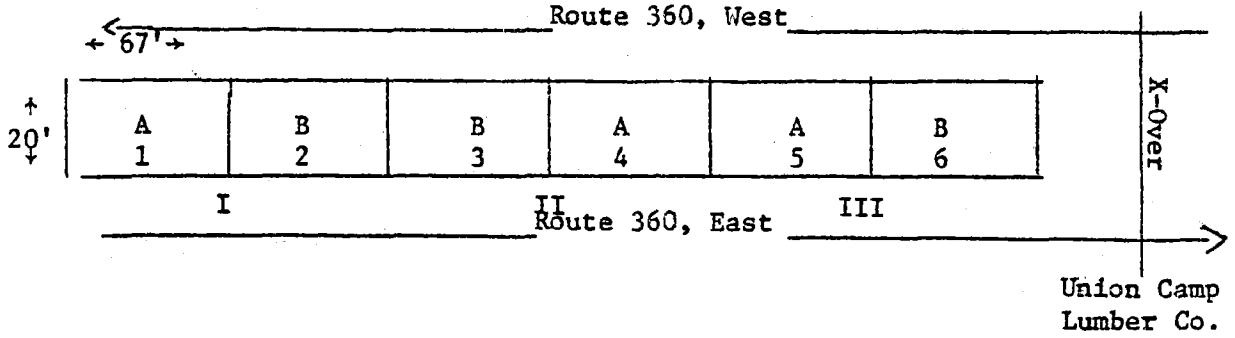

Treatments: ▨ = Strip tilled to 6 - 8" with field cultivator mounted with 5 chisel points set 16" apart and seeded with "Lathco" flatpea and 1978 perennial sweetpea from VCIA Mt. Holly farm, each @ 15 lbs/A, 200 lbs/A $P_2O_5$, 100 lbs/A $K_2O$, 1500 lbs/A woodfiber mulch.

Title: Demonstration seeding of flatpea-perennial sweetpea mix and crownvetch into a weedy median in Prince Edward Co.

Objective: Assess use of perennial legumes for improvement of median vegetation At this site cool season grasses seeded March 29, 1977 in a species and variety trial were unable to persist in competition with warm season grasses and weeds. The soil material is coarse textured and very micaceous.

Site: Median of Route 360, 3 miles east of Greenbay, West of industrial intersection for Union Camp Lumber County.

Established: March 6, 1979




Treatments: A = Pennfine crownvetch @ 20 lbs/A
B = 1978 "Lathco" flatpea and 1978 VCIA perennial sweetpea each @ 15 lbs/A

All Plots: Cereal rye @ 30 lbs/A
$P_2O_5$ @ 200 lbs/A
$K_2O$ @ 100 lbs/A
Woodfiber @ 1500 lbs/A
Lime @ 3000 lbs/A

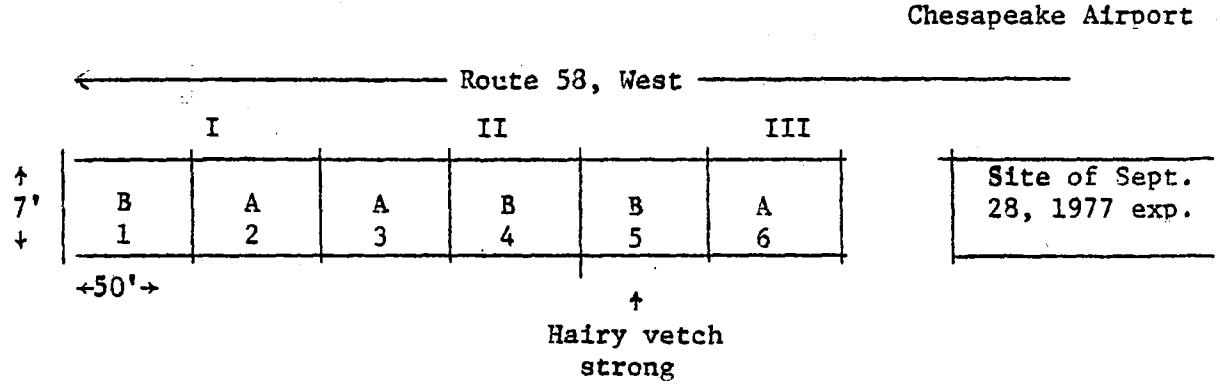
The entire site was tilled twice with a field cultivator mounted with chisel points.

Title: Demonstration seeding of flatpea and crownvetch in a compacted median in the Coastal Plain

Objective: Assess use of late winter seeding with seedbed preparation by field cultivation to introduce perennial legumes in a median turf.

Site: Along Route 58, West, Chesapeake, opposite Chesapeake Airport, and immediately west of experimental site seeded to legumes September 28, 1977.

Established: March 6, 1979




Treatments: A=Pennfine crownvetch @ 20 lbs/A
B=1978 "Lathco" flatpea @ 15 lbs/A +
1978 VCIA sweetpea @ 15 lbs/A

All plots: $P_2O_5$ @ 200 lbs/A
$K_2O$ @ 200 lbs/A
Lime @ 2000 lbs/A
woodfiber @ 1500 lbs/A

The entire site was tilled twice with a field cultivator mounted with chisel points.

3798

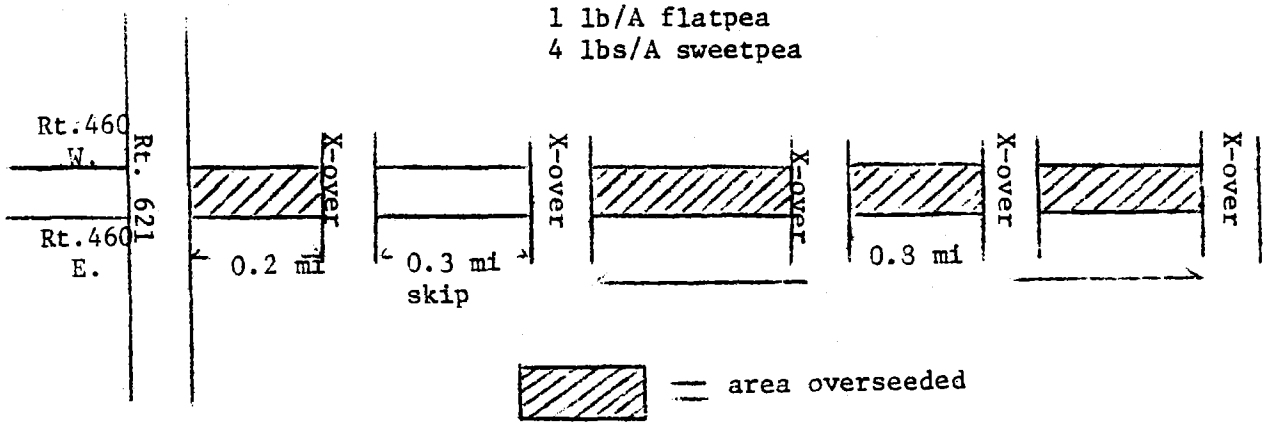
Title: Median legume overseeding demonstration

Objective: Assess feasibility of legume introduction by late winter overseeding into median turf.

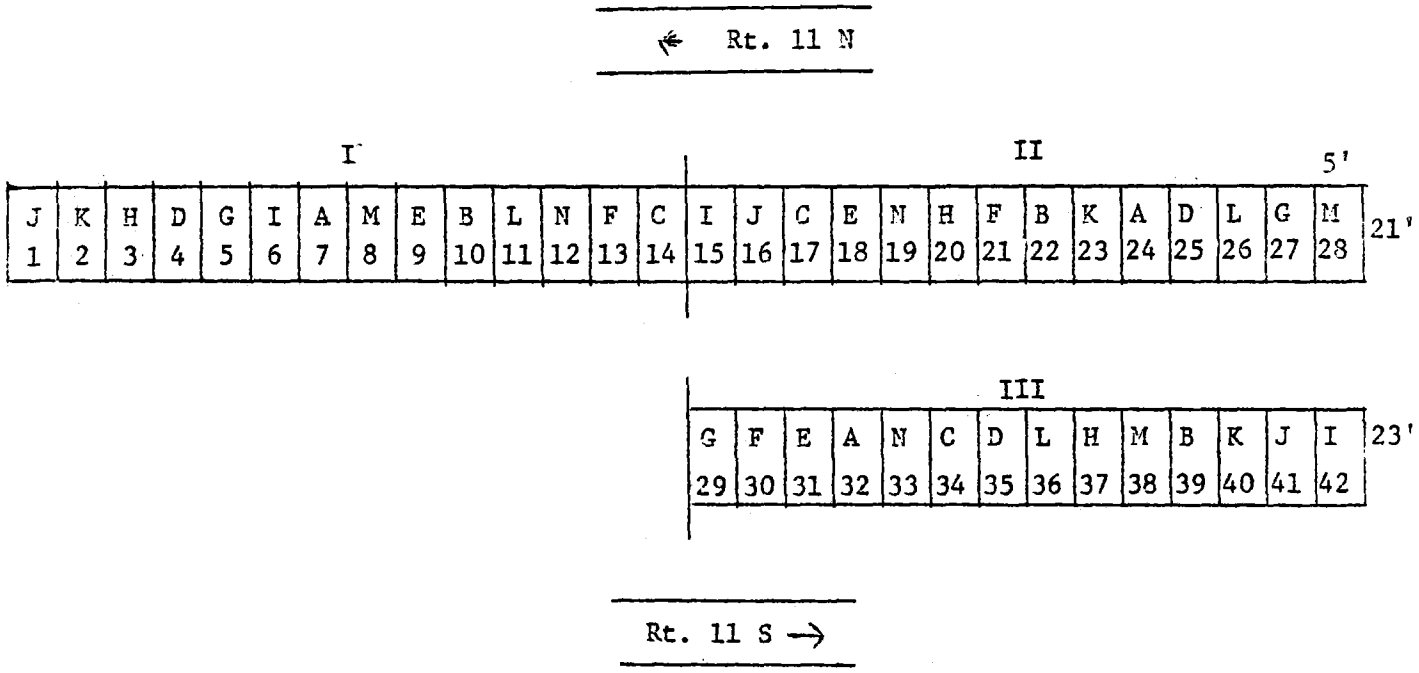
Location: Median turf of Rt. 460 starting at Ford, Dinwiddie Co. going eastward approximately one mile

Established: 13 March 1979

Applied by hydroseeder: 1 T/A lime
200 lbs/A $P_2O_5$
100 lbs/A $K_2O$
20 lbs/A crownvetch
1 lb/A flatpea
4 lbs/A sweetpea



Title: Mowing management of grass median.
Objective: Assess the effects of different mowing heights and dates and frequency of mowing on removal of grass seed heads and density of grass tillering.
Location: Median of Route 11, Fairfield, just north of Route 716 and the C & O Gulf station.

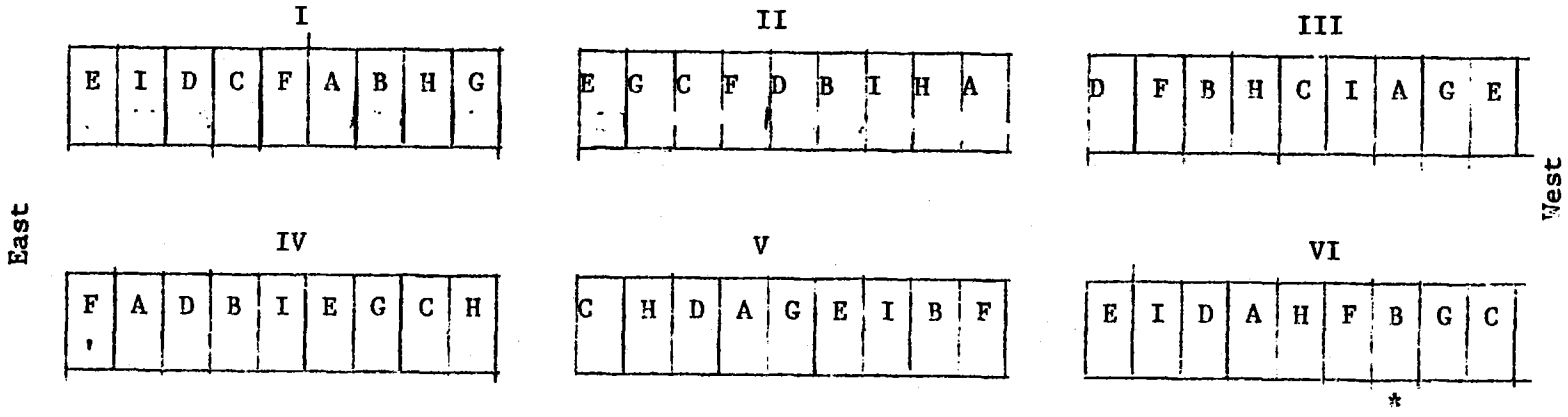



Mowing Regimes:

A - 20 May @ 6"
B - 20 May @ 4"
C - 20 May @ 4"; 1 Jul @ 4"
D - 20 May @ 4"; 1 Jul @ 8"
E - 20 May @ 8"
F - 20 May @ 8"; 1 Jul @ 4"
G - 20 May @ 8"; 1 Jul @ 8"
H - 15 Jun @ 6"
I - 15 Jun @ 4"
J - 15 Jun @ 4"; 1 Sep @ 4"
K - 15 Jun @ 4"; 1 Sep @ 8"
L - 15 Jun @ 8"
M - 15 Jun @ 8"; 1 Sep @ 4"
N - 15 Jun @ 8"; 1 Sep @ 8"

A 3/4 $ft^2$ wire counter was placed in each treatment plot. Initial tiller counts were made in May 1978 before first mowing.

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"

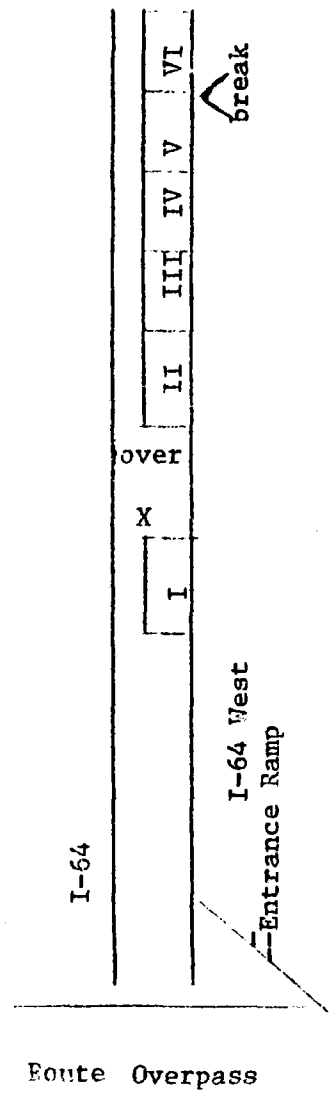
G = a) mow 15 Jun @ 8"
b) mow 15 Aug @ 8"

H = mow 15 Jun @ 8"

I = mow 15 Jun @ 4"

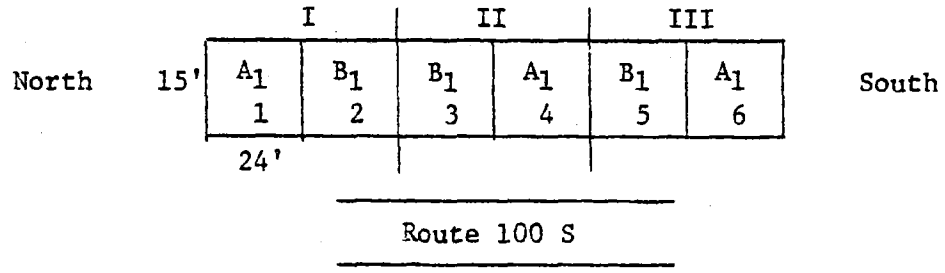
*This treatment in block VI left unmowed after May 15 mowing

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

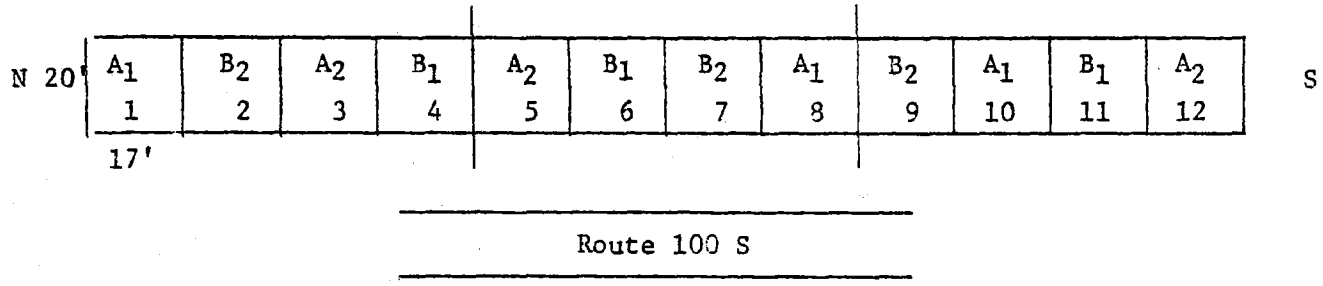



3800

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.



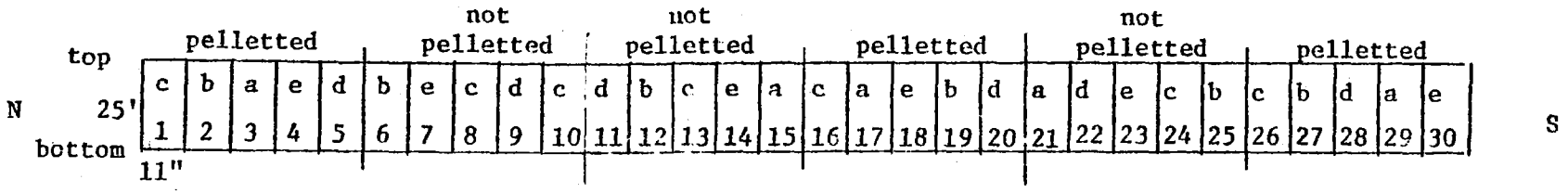

Treatments: All plots: 30 lbs N/A as $NH_4NO_3$
200 lbs $P_2O_5$/A as con super
100 lbs $K_2O$/A as KCl
6 lbs/A annual ryegrass
10 lbs/A Ky 31

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

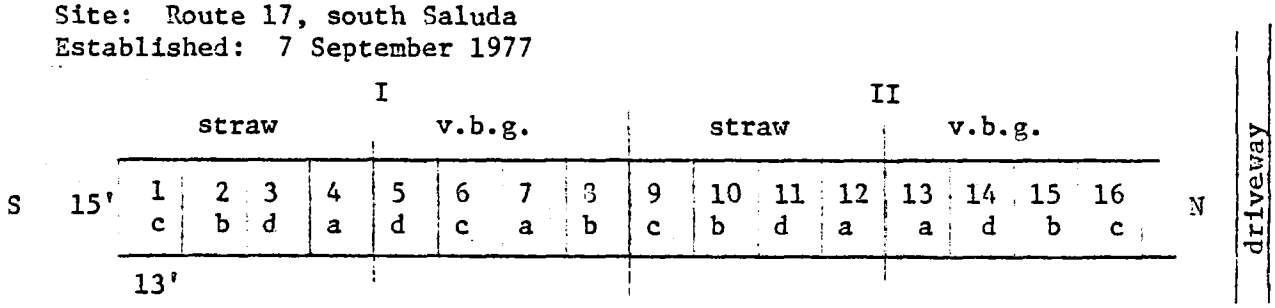
a) broadcast on surface @ 20 lbs/A
b) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed on surface
c) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed at 1-1/4" depth
d) in strip 5' from top, at 12" intervals, 5 seeds per interval, seed on surface in rototilled strip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

3802

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




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.

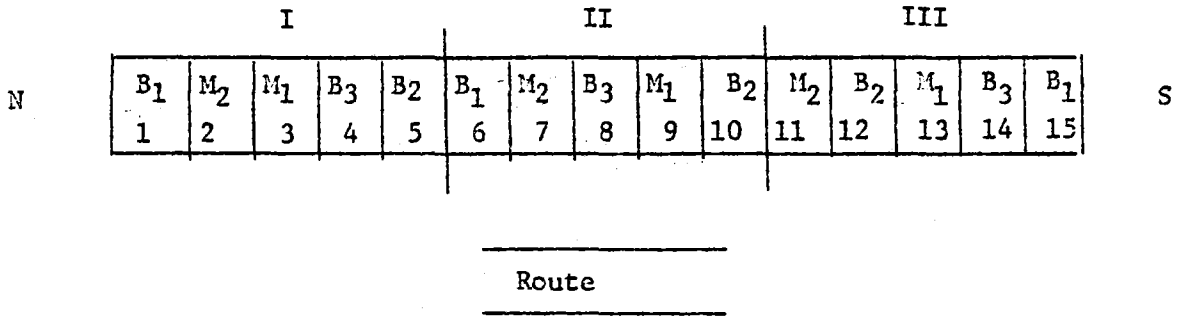
Subplots: a = no micronutrients
b = Mo @ 2 oz/A
c = Mo @ 2 oz/A
Cu @ 2 lbs/A
Zn @ 3 lbs/A
Fe @ 5 lbs/A
Mn @ 5 lbs/A
B @.5 lbs/A
d = Mo @ 15 oz/A
Cu @ 6 lbs/A
Zn @ 9 lbs/A
Fe @ 15 lbs/A
Mn @ 15 lbs/A
B @ 1.5 lbs/A

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

3804

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

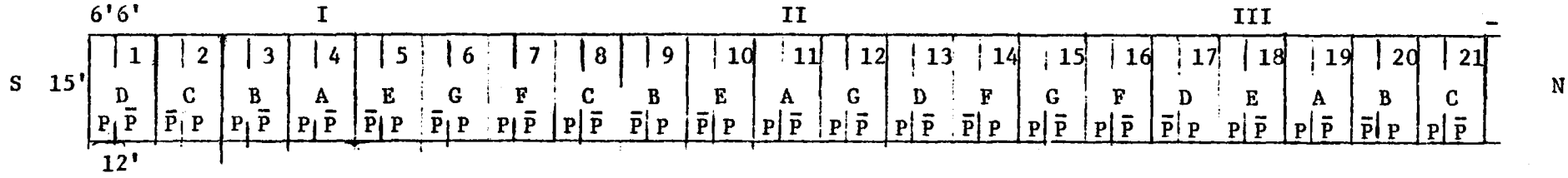



Treatments: $M_1$ = 20 lbs/A German millet
$M_2$ = 30 lbs/A German millet
$B_1$ = 20 lbs/A Buckwheat
$B_2$ = 40 lbs/A Buckwheat
$B_3$ = 60 lbs/A Buckwheat

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: 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

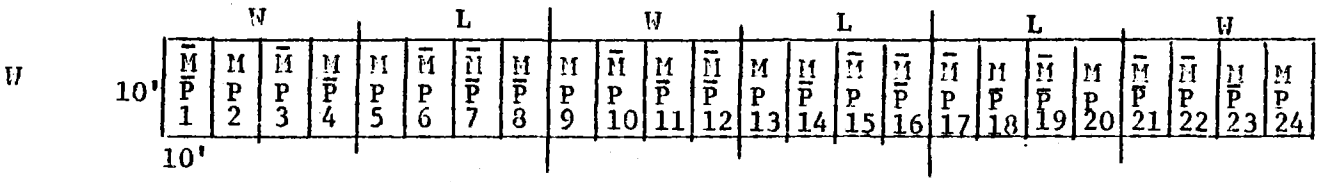



Route 17

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

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

Title: Lovegrass and Molybdenum 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

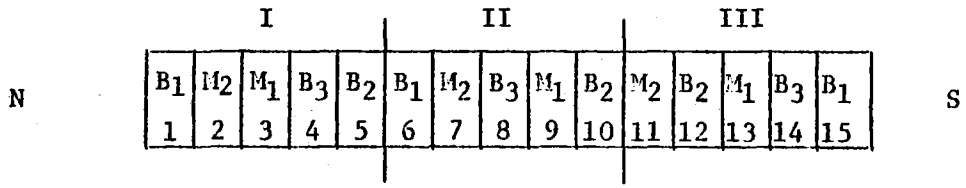



| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\bar{M}\bar{P}$ 1 | M P 2 | $\bar{M}$ P 3 | M $\bar{P}$ 4 | M P 5 | $\bar{M}$ P 6 | $\bar{M}\bar{P}$ 7 | M $\bar{P}$ 8 | M P 9 | $\bar{M}$ P 10 | M $\bar{P}$ 11 | $\bar{M}\bar{P}$ 12 | M P 13 | M $\bar{P}$ 14 | $\bar{M}$ P 15 | $\bar{M}\bar{P}$ 16 | $\bar{M}$ P 17 | M $\bar{P}$ 18 | $\bar{M}\bar{P}$ 19 | M P 20 | $\bar{M}\bar{P}$ 21 | $\bar{M}$ P 22 | M $\bar{P}$ 23 | M P 24 |

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
$\bar{P}$ = sericea seed not pelletted
M = Mo @ 2 oz./A
$\bar{M}$ = no Mo
W = weeping lovegrass @ 10 lbs/A
L = Lehmann lovegrass @ 10 lbs/A

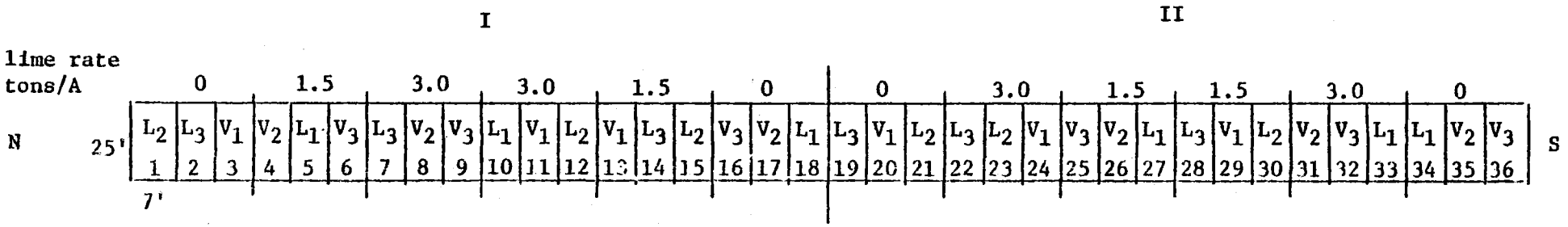
Title: Summer Annual Companion Species Experiment
Objective: Evaluate use and rates of buckwheat and Japanese millet as summer annual companion species for establishment of crownvetch.
Location: Route 735, Galax
Established: 20 June 1977




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



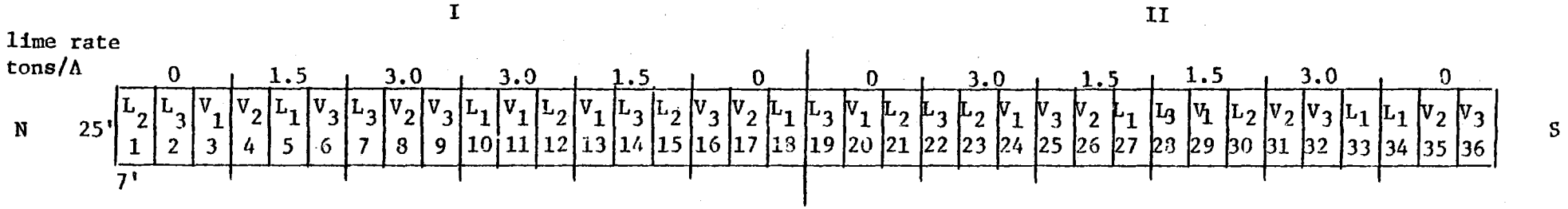

Treatments: lime @ 0, 1.5 and 3.0 tons/A

$L_1$ = 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

3809

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

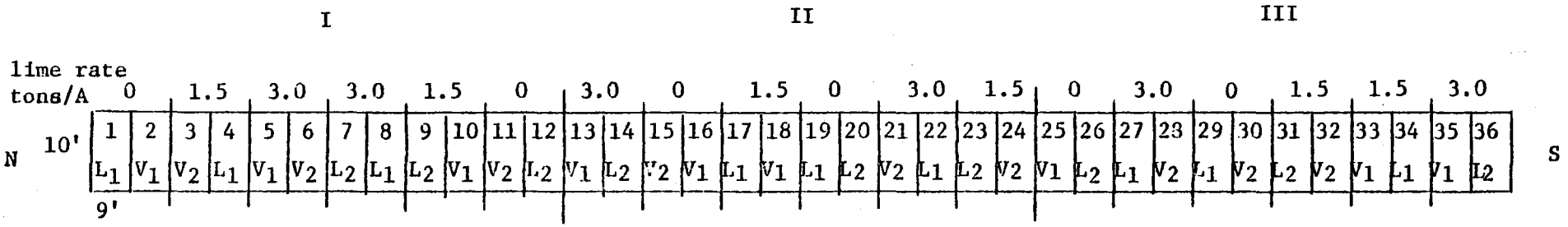



Treatments: lime @ 0, 1.5 and 3.0 tons/A

$L_1$ = 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.

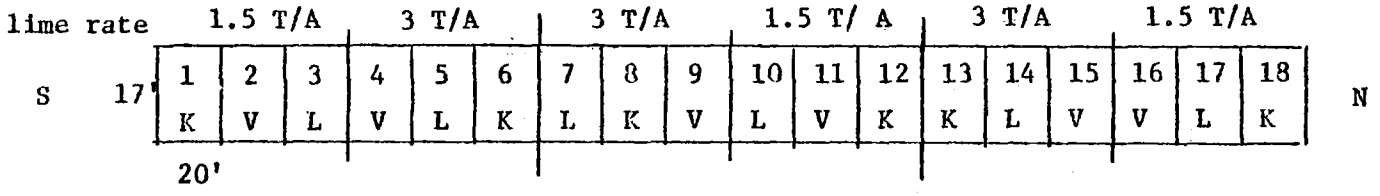



Treatments: dolomitic lime @ 0, 1.5, and 3.0 tons/A
$V_1$ = velvet bentgrass @ 10 lbs/A
$V_2$ = velvet bentgrass @ 30 lbs/A
$L_1$ = Lehmann lovegrass @ 10 lbs/A
$L_2$ = Lehmann lovegrass @ 20 lbs/A

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

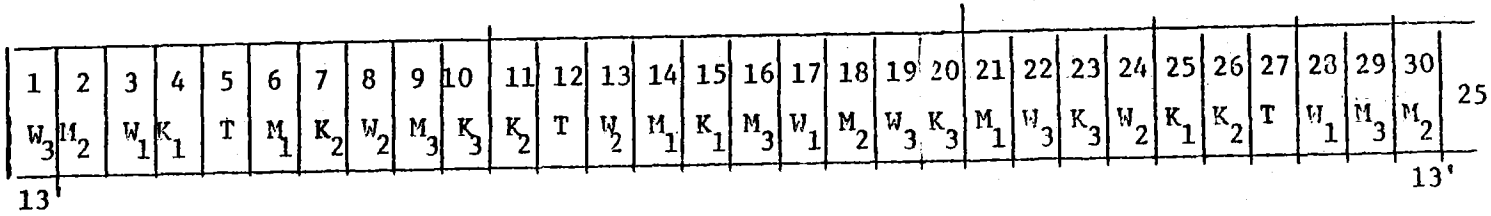
This is quite sandy material.




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




Route 644

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

3812

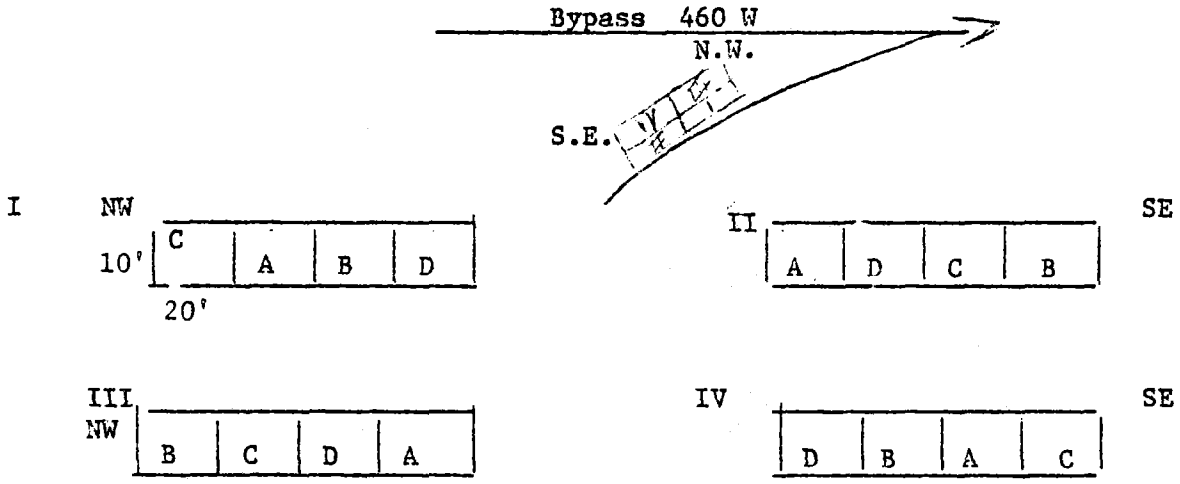
Title: Winter dormant seeding of crownvetch

Objective: To determine whether for winter seedings unhulled seed of crownvetch provides better seedling establishment the spring following seeding than hulled seed and to investigate interactions with heavy seedings of cereal rye.

Site: An infield area furtherest to the northeast at the interchange of bypass 460 and Prices Fork Road in Blacksburg. The site is almost flat in an area leveled in summer, 1978, and seeded by contractors in fall.

Soil characteristics: pH 7.7; Ca - VH (3358), Mg - VH (398), P - H - (101), K - M (177)

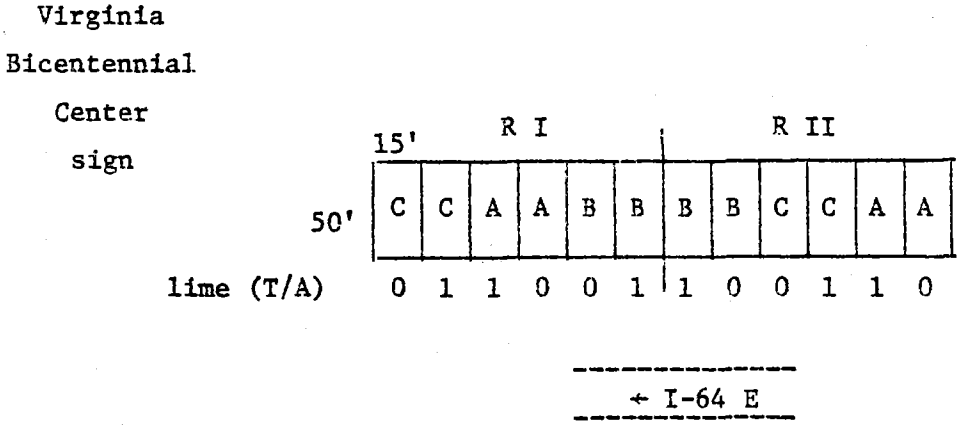
Established: January 5, 1979




Treatments: A = no rye + hulled crownvetch @ 20 lbs/A
B = no rye + unhulled crownvetch @ 20 lbs/A
C = rye @ 200 lbs/A + hulled crownvetch @ 20 lbs/A
D = rye @ 200 lbs/A + unhulled crownvetch @ 20 lbs/A

Weight of unhulled crownvetch is on the basis of seed with hulls removed.

Title: Renovation experiment in tall fescue sod.
Objective: To determine response to lime and legume species for renovating cut slopes.
Location: I-64 E, 1/2 mile west of Charlottesville-Scottsville exit on north facing slope.
Established: 14 Oct 76.




$P_2O_5$ @ 200 over entire experiment.

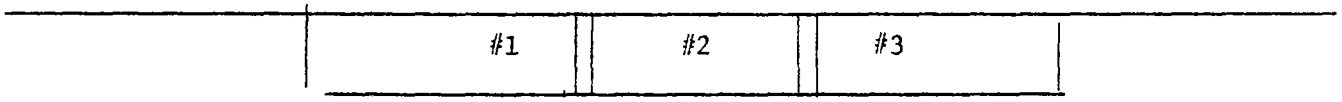
A - sweetpea @ 20 lbs/A
B - flat pea @ 20 lbs/A
C - crownvetch @ 20 lbs/A

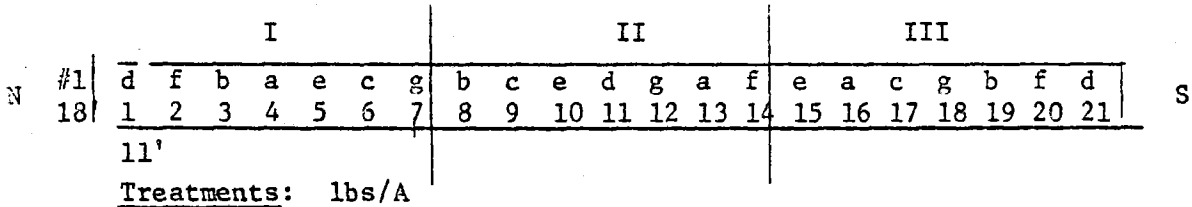
Title: Renovation experiments on woody cut slopes

Objectives: Evaluate methods for establishment of crownvetch in cut slopes dominated by annual weeds; variables: lime, fertilizer, paraquat, tall fescue.

Site: Weedy cut slope on median side of Route 29 south, near Route 629, Madison County.

Established: 10 August 1977.

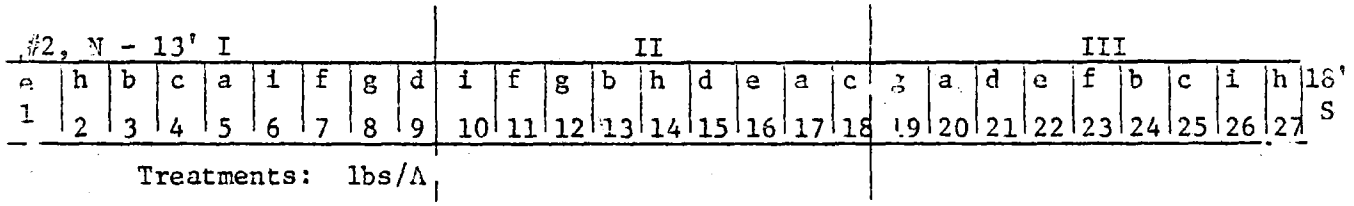



Treatments: lbs/A

| | N | $P_2O_5$ | $K_2$ | | N | $P_2O_5$ | $K_2$ |
|---|---|---|---|---|---|---|---|
| a | 0 | 0 | 0 | e | 0 | 200 | 50 |
| b | 0 | 100 | 25 | f | 25 | 200 | 50 |
| c | 25 | 100 | 25 | g | 75 | 200 | 50 |
| d | 75 | 100 | 25 | | | | |

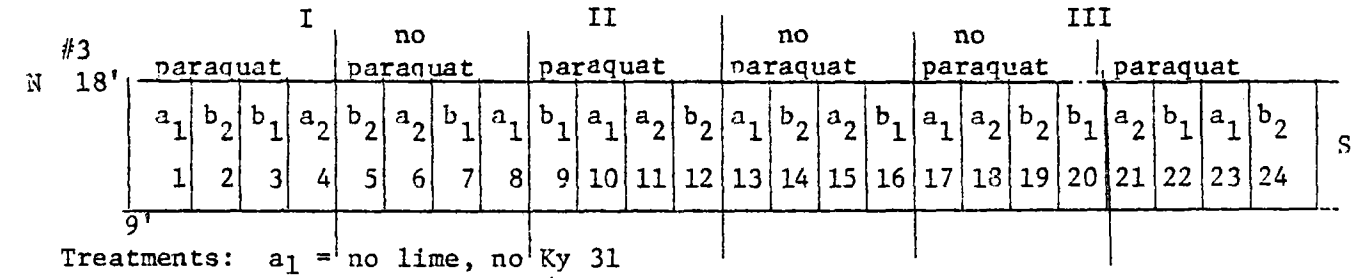
All plots: crownvetch @ 20 lbs/A, woodfiber @ 750 lbs/A, lime @ 1 ton/A




Treatments: lbs/A

| | N | $P_2O_5$ | $K_2$ | | N | $P_2O_5$ | $K_2$ |
|---|---|---|---|---|---|---|---|
| a | 0 | 0 | 0 | f | 0 | 100 | 50 |
| b | 0 | 100 | 0 | g | 0 | 100 | 100 |
| c | 0 | 200 | 0 | h | 0 | 200 | 50 |
| d | 0 | 0 | 50 | i | 0 | 200 | 100 |
| e | 0 | 0 | 100 | | | | |

All plots: crownvetch @ 20 lbs/A, woodfiber @ 750 lbs/A, lime @ 1 ton/A.



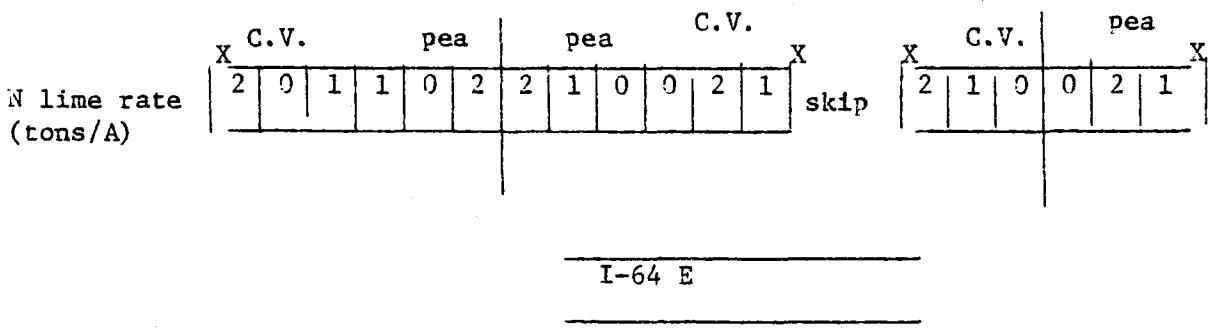

Treatments: $a_1$ = no lime, no Ky 31
$a_2$ = lime @ 1 ton/A, no Ky 31
$b_1$ = no lime, Ky 31 @ 25 lbs/A
$b_2$ = lime @ 1 ton/A, Ky 31 @ 25 lbs/A

Paraquat plots = 2 qts./A

All plots: N @ 25 lbs/A, $P_2O_5$ @ 100 lbs/A, $K_2O$ @ 50 lbs/A, crownvetch @ 20 lbs/A.

3810

Title: Renovation experiment on an eroding cut slope
Objective: Assess value of crownvetch and a perennial sweetpea/flatpea mix at varying rates of lime for renovation of a balding vegetative stand in coastal plain.
Site: Approximately 100 yards west of mile post 222 on I-64 east, New Kent Co. on south facing cut slope, very sandy material.
Established: 24 March 1978




I-64 E

Treatments: C.V. = crownvetch @ 20 lbs/A
pea = perennial sweetpea @ 10 lbs/A
flatpea @ 10 lbs/A

X = snow fence post

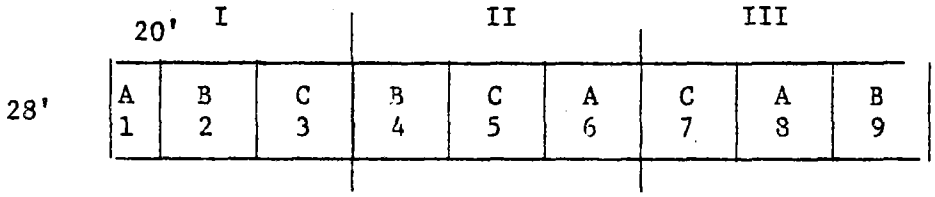
Over whole experiment: 667 lbs/A 15-30-15
15 lbs/A woodfiber

Title: Legume renovation experiment

Objective: (1)To evaluate use of cereal rye with and without nitrogen fertilization as companion species for late winter introduction of legumes on a partially bare cut slope (2) to provide a site where vigor of vegetative cover and rate of weed and woody species encroachment might be evaluated where legumes have and have not been introduced.

Location: Right hand cut slope, I-64, Williamsburg; 0.1 mile east of m.p. 236.

Established: 22 February 1979

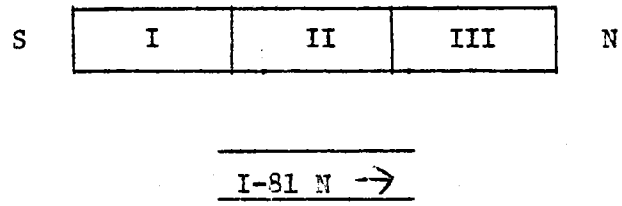



A = check; no revovation treatment

B = Cereal rye @ 30 lbs/A; crownvetch, flat & sweetpea, each @ 20 lbs/A; $P_2O_5$ @ 100 lbs/A, $K_2O$ @ 50 lbs/A, lime @1 T/A.

C = Cereal rye @ 30 lbs/A, crownvetch, flat & sweetpea, each @ 20 lbs/A; $P_2O_5$ @ 100 lbs/A; $K_2O$ @ 50 lbs/A, N @ 20 lbs/A, and lime @ 1 T/A.

Title: Renovation of a knapweed dominated cut slope.
Objective: Investigate effect of date of seeding, herbicide treatment and species on renovation of a cut slope dominated by weeds (star thistle).
Location: East facing cut slope along I-81 N south of mile post 179 and Fancy Hill exit. Slope dominated by star thistle (Centaurea maculosa) which, at date of fall seeding, had mature tops and regrowth at ground level.
Soil Material: pH - 6.4; Ca - High; Mg - High -; P - Medium; K - High +.




11'

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I 10' | Lrs 1 | Lpf 2 | Ls 3 | C 4 | Lf 5 | Lpf 6 | Lrf 7 | Lps 8 | Vf 9 | Vrs 10 | Vs 11 | Vrf 12 | Vps 13 |
| II | Lf 14 | Vrf 15 | Vps 16 | Lpf 17 | Lrf 18 | Vrs 19 | Vs 20 | Vpf 21 | Ls 22 | Lps 23 | Vf 24 | C 25 | Lrs 26 |
| III | Ls 27 | Lrs 28 | Lrf 29 | Vf 30 | Lps 31 | Vrs 32 | C 33 | Vs 34 | Vrf 35 | Vpf 36 | Lf 37 | Vps 38 | Lpf 39 |

Treatments:
L - Flat and sweet pea mix @ 10 lbs/A each
V - Crownvetch @ 20 lbs/A
p - paraquat @ 2 qts/A
r - roundup @ 1 qt/A
f - late summer application (22-23 Aug 78)
s - spring application (16 Mar 79)

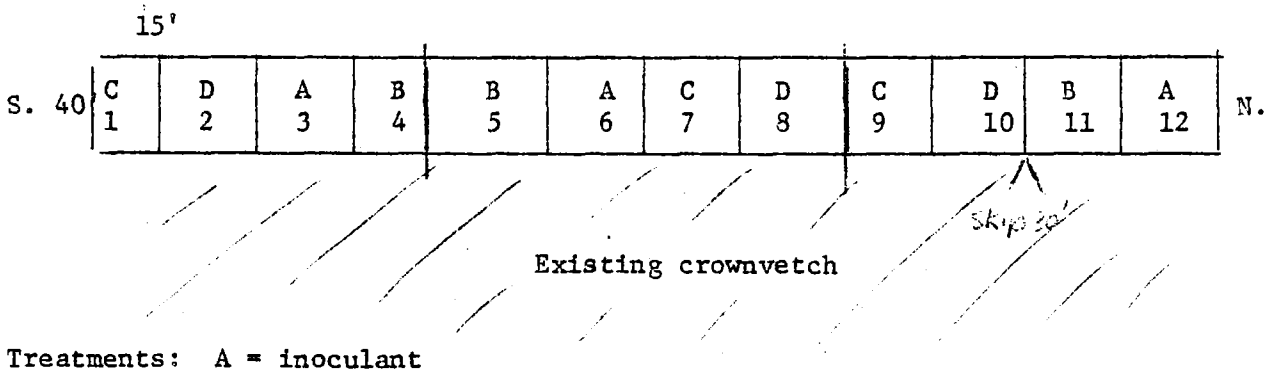
All plots received 850 lbs/A woodfiber; 100 lbs/A $P_2O_5$ as consuper. Plots were laid out in 10' strip running along the length of the cut near its crest. Herbicide treatments were sprayed with seed, fertilizer, and mulch by hydroseeder with X-77 used as surfactant.

Title: Crownvetch spread experiment

Objectives: To determine if boron or bacterial inoculant additions can aid in spread of crownvetch on a highly alkaline site.

Site: Northeast facing cut slope nearest to Rt. 11 on bypass 460, Christiansburg. This slope has crownvetch growing on its lower half. pH ranged from 6.3 to 8.1; phosphorus from high to very high; potassium from low to low-medium.

Established: Boron and inoculant were applied mixed with moistened clean sand on October 13, 1978. A second application of inoculant was made on March 29, 1979.




Treatments: A = inoculant
B = Boron @ 2 lbs/A as Boron-65
C = Boron @ 2 lbs/A + inoculant
D = Check

3829

Title: Mulch experiment, Blacksburg.
Objective: Assess value of Cellin Corp. paper fiber mulches as aids to establishment of vegetation in Virginia highway corridors during summer seeding season.
Location: Exit facing cut slope, Route 460 Blacksburg bypass just S of Prices Fork Road.
Established: 10 Aug 1978


Straw @ 3000 lbs/A

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep I | $G_1$ @ 750 | $G_2$ @ 750 | C.W. @ 750 | $G_3$ @ 750 | $G_3$ @ 2500 | $G_3$ @ 1500 | $G_1$ @ 1500 | no mulch | C.W. @ 1500 | $G_2$ @ 2000 | $G_2$ @ 1500 | $G_1$ @ 2500 | 22' |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |

10'

Straw @ 3000 lbs/A

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep II | $G_3$ @ 1500 | $G_2$ @ 2500 | $G_1$ @ 1500 | $G_3$ @ 750 | C.W. @ 750 | $G_1$ @ 750 | $G_2$ @ 750 | C.W. @ 1500 | no mulch | $G_3$ @ 2500 | $G_2$ @ 1500 | $G_1$ @ 2500 | |
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |

$G_1$ = Cellin grind #1, 1/4"
$G_2$ = Cellin grind #2, 3/8"
$G_3$ = Cellin grind #3, 1/2"
C.W. = Conwed woodfiber mulch

All plots received:
lime @ 2T/A
15-30-15 @ 667 lbs/A
German millet @ 15 lbs/A
Annual ryegrass @ 6 lbs/A
Ky 31 fescue @ 50 lbs/A
Crownvetch @ 20 lbs/A

3821

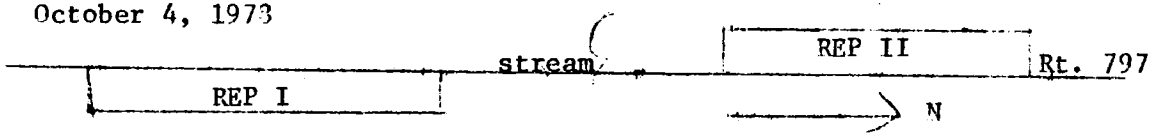
Title: Mulch experiment, Halifax Co.

Objectives: Assess value of new mulching materials for effectiveness in erosion control and as aids to establishment of vegetation in Virginia highway corridors.

Site: Cut slopes, Rt. 797, Halifax Co.

Soil Properties: pH; ($H_2O$) 6.4, (0.01 M Ca ) 5.4; calcium, medium; magnesium, very high; phosphorus, high; potassium, low.

Established: October 4, 1973




Rep I. N.

Straw @ 3000 lbs/A

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12' | $G_3$ @ 2500 | $G_1$ @ 2500 | W.F. @ 1500 | $G_2$ @ 2500 | A-M @ 750 | $G_1$ @ 750 | $G_3$ @ 750 | W.F. @ 750 | $G_2$ @ 750 | NO Mul. | A-M @ 1500 | $G_1$ @ 1500 | $G_2$ @ 1500 | $G_3$ @ 1500 | A-M @ 2500 |

S.

9'

Rep II S.

Straw @ 3000 lbs/A

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12' | $G_1$ @ 1500 | $G_3$ @ 2500 | $G_2$ @ 1500 | $G_3$ @ 1500 | $G_1$ @ 2500 | A-M @ 1500 | $G_2$ @ 2500 | W.F. @ 750 | A-M @ 750 | $G_2$ @ 750 | $G_3$ @ 750 | $G_1$ @ 750 | A-M @ 2500 | W.F. @ 1500 | NO Mul. |

N.

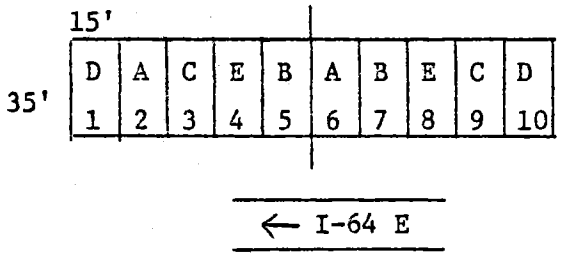
9'

All plots received: lime @ 1.5 T/A
15.30.15 fertilizer @ 1000 lbs/A
Creeping red fescue @ 30 lbs/A
Ky 31 tall fescue @ 60 lbs/A
Abruzzi rye @ 40 lbs/A
Unhulled sericea lespedeza @ 15 lbs/A
crownvetch @ 20 lbs/A

6, $6_2$, $6_3$ = Cellin Fiber Mulch of Cellin Manufacturing, Inc., passing 1/4", 3/8" and 1/2" screens of hammermill; W. F. = woodfiber mulch of ConWed; A-M = Astro-Mulch of International United Chemical Co.

3822

Title: Lime experiment on an acid sulfate cut slope.
Objective: Evaluate different liming methods for mederation of intensely acid conditions on cuts through coal like material containing acid producing sulfides.
Location: North-west facing cut along I-64 near Clifton Forge just before bridge over Simsons Creek.
Soil Material: pH - 2.5; Ca - Low; Mg - Low; P - Low; K - Low.
Established: Trenches for limestone dug and filled with limestone gravel 29-30 November 1977. Ground limestone and other treatments applied 16 March 1978.



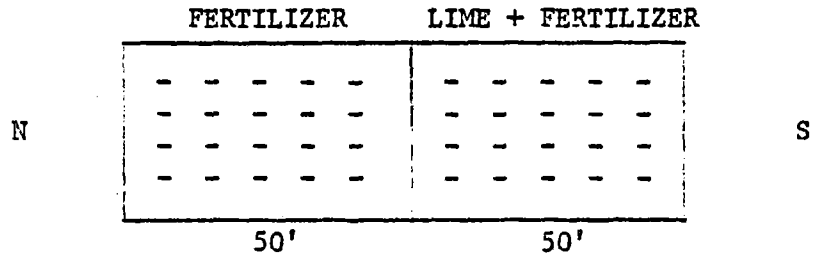

Treatments:
A - No lime
B - 3 T/A lime
C - 6 T/A lime

D & E plots had trenches approximately 1 ft. deep dug across slope with a pitch of 1' per 15' and placed at the top of the treatment plot and 15' down. These trenches were filled with limestone gravel. One dump truck load of gravel was placed in the 8 trenches of the experiment. D plots received an addition of 3 T/A ground limestone broadcast; E plots 6 T/A.

All plots: sericea lespedeza @ 30 lbs/A
deertongue @ 20 lbs/A
annual ryegrass @ 7 lbs/A
15-30-15 @ 667 lbs/A
woodfiber @ 1500 lbs/A

A 10' strip at the bottom of the experiment was overseeded with velvet bentgrass A 5 lbs/A.

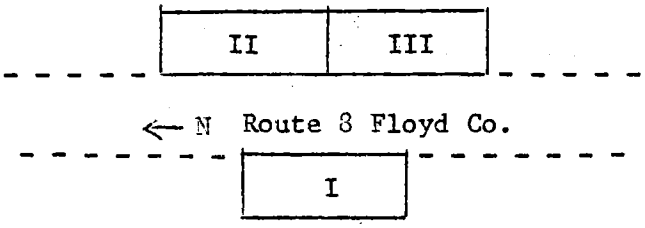
Title: American Beach Grass Experiment
Location: East cut slope immediately north of Bastian exit on Route 77, Bland County.
Objective: Assess use of American beach grass on very mobile, coarse textured slopes.
Established: April 5, 1977




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

Title: Summer companion species experiment.
Objective: Investigate relative merits of various summer companion species in establishment of crownvetch; assess interactions between summer companion species where more than one seeded together.
Location: Wills Ridge, Route 8, Floyd Co. Reps II and III on west facing cut; Rep I on east facing cut.
Soil Materials: pH - 5.2; Ca - Low-; Mg - Low; P - Low; K - Low.
Established: 23 June 1978




| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rep I. S | E 1 | N 2 | D 3 | C 4 | L 5 | H 6 | A 7 | K 8 | J 9 | B 10 | I 11 | F 12 | M 13 | G 14 | N |
| 10' | | | | | | | | | | | | | | | |
| Rep II. N | J 15 | C 16 | N 17 | D 18 | H 19 | G 20 | K 21 | L 22 | F 23 | I 24 | B 25 | E 26 | A 27 | M 28 | S |
| Rep III. N | G 29 | H 30 | J 31 | N 32 | M 33 | L 34 | A 35 | C 36 | B 37 | K 38 | D 39 | F 40 | I 41 | E 42 | S |

Treatments

A - German millet @ 15 lbs/A + Lehmann lovegrass @ 3 lbs/A + W. lovegrass @ 4
B - German millet @ 15 lbs/A + Weeping lovegrass @ 7 lbs/A
C - Buckwheat @ 45 lbs/A + Lehmann lovegrass @ 3 lbs/A + W. lovegrass @ 4 lbs/A
D - Buckwheat @ 45 lbs/A + Weeping lovegrass @ 7 lbs/A
E - Japanese millet @ 10 lbs/A + Lehmann lovegrass @ 3 lbs/A + W. lovegrass @ 4
F - Japanese millet @ 10 lbs/A + Weeping lovegrass @ 7 lbs/A
G - Lehmann lovegrass @ 3 lbs/A + Weeping lovegrass @ 4 lbs/A
H - Weeping lovegrass @ 7 lbs/A
I - Ky 31 fescue @ 50 lbs/A
J - German millet @ 15 lbs/A + Lehmann lovegrass @ 7 lbs/A
K - German millet @ 15 lbs/A + Lehmann lovegrass @ 3 lbs/A + Ky 31 @ 50 lbs/A
L - German millet @ 15 lbs/A + Ky 31 @ 50 lbs/A
M - Cereal rye @ 40 lbs/A + Lehmann lovegrass @ 3 lbs/A + W. lovegrass @ 4 lbs/A
N - Sprangletop @ 12 lbs/A

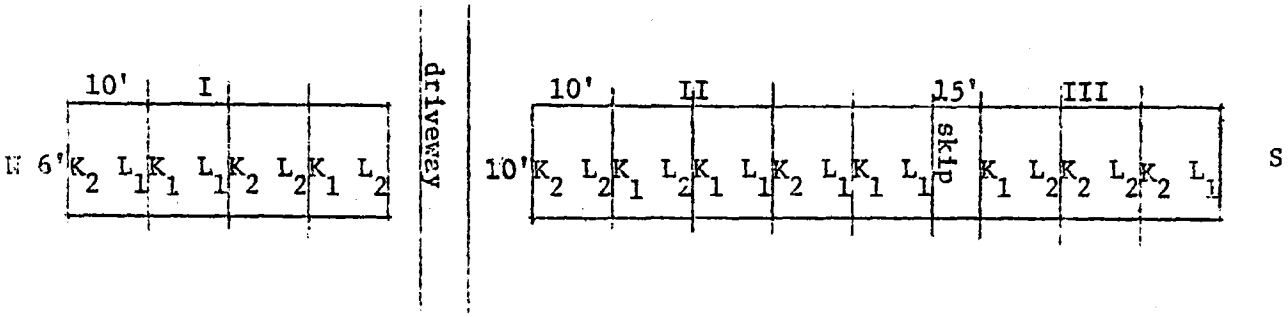
All plots layed out to 10' wide strips to top of slope and received crwonvetch @ 20 lbs/A; 15-30-15 @ 667 lbs/A; lime @ 2 T/A; straw @ 1.5 T/A; woodfiber @ 750 lbs/A.

Title: Renovation experiment with variable lime and potassium rates, Route 628, Prince Edward Co.

Objective: Assess whether lime and potassium have a special importance for establishment of crownvetch in the southern Piedmont region of Virginia

Site: 0.9 miles north of Route 360 on Route 628, Prince Edward Co. Mixed micaceous - heavy clay B horizon material sloughed from upper portion of old road cut, west facing.

Properties: pH - 5.2; Ca - L-; Mg - L; P - L-; K - L.




Treatments:

$K_1$ = 100 lbs/A $K_2O$ as KCL

$K_2$ = 200 lbs/A $K_2O$ as KCL

$L_1$ = 1 ton/A ground dolomitic limestone

$L_2$ = 2 tons/A ground dolomitic limestone

All plots received:

20 lbs/A crownvetch
50 lbs/A Ky 31 fescue
5 lbs/A annual ryegrass
100 lbs/A N as $NH_4NO_3$
200 lbs/A $P_2O_5$ as consuper
1500 lbs/A woodfiber

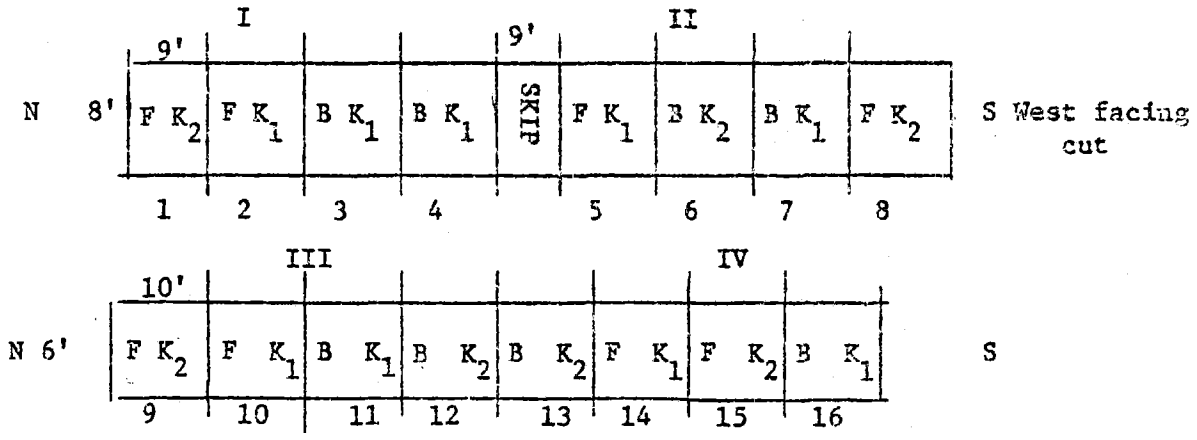
Title: Renovation experiment with variable grass companion species, and potassium rates, Route 628, Prince Edward Co.

Objective: Assess whether velvet bentgrass and higher rates of K may enhance establishment of perennial sweet pea/ flat pea mix in the southern Piedmont as compared with usual fertilization rates and Ky 31 as companion grass species.

Site: 4.0 miles north of Rt. 360 on Rt. 628, Prince Edward Co. Sloughing, bare, old road cut, west facing.

Properties: pH - 5.4; Ca - L; Mg - H-: P - L-; K - M.

Established: 4 April 1978




Treatments: B= velvet bentgrass @ 30 lbs/A
F = Ky 31 fescue @ 50 lbs/A + annual ryegrass @ 5 lbs/A
$K_1$ = $K_2O$ as KCL @ 100 lbs/A
$K_2$ = $K_2O$ as KCL @ 200 lbs/A

All plots received: N as $NH_4NO_3$ @ 100 lbs/A
$P_2O_5$ as consuper @ 200 lbs/A
ground dolomitic limestone @ 1 ton/A
woodfiber @ 1500 lbs/A

Hydroseeding: 7 seconds of fescue on treat plots I & II
Rep III, $FK_2$ got 5.5 seconds, $FK_1$ got 4.5 seconds
Rep IV fescue got 3 seconds