An Evaluation of Legumes for Western Oklahoma Rangelands

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Introduction

Several million acres in western Oklahoma and the Southern Great Plains should be maintained as high producing rangeland for conservation and best economic returns. Many of these acres have been plowed, are now abandoned, and should be reseeded to adapted grasses and/or legumes. Many other acres of seriously depleted native range need to be artificially revegetated. Research and extensive practice have shown that unproductive abandoned land can be profitably seeded to grass and that regrassing depleted ranges might be possible. Very little information however, is available about legumes for revegetation of such areas.

There has been considerable speculation about the desirability of legumes as a source of nitrogen in rangeland. In wet years a good response in range grass growth can be obtained with nitrogen fertilizer; in dry years fertilizer may actually be harmful. An adapted legume might provide a cheap nitrogen source, available and profitable in wet years and harmless in dry years. Little evidence for or against this assumption has been so far available in the Southern Great Plains area.

This report summarizes studies and observations of legumes which might have potential for range seedings. Since native ranges include a considerable number of legume species, consideration was given first to them, next to introduced species. In all cases major emphasis was placed upon perennials.

Methods

Seed sources and planting procedures

Legume seeds used in these studies were harvested by hand from native stands or obtained from other workers. First collections were made in 1951 and plantings in 1952. In most cases seed supplies were limited.

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Evaluations were made on seedlings which had been grown in the greenhouse and then transplanted to spaced nurseries in the field. Where larger amounts of seed were available, they were drilled in rows with a hand planter. Still larger plantings were made with a grass drill. Commercially available "dryland" alfalfas and *Astragalus cicer* in trial plantings were drilled at nine different locations in the Southern Plains area during the 1953 and 1954 seasons. These were 15 x 150 foot plots in two replicates at each location. Seeds were drilled in sorghum or sudan stubble cover. Plantings were made in March and September.

Inoculant was mixed with seed used in every planting, whether field or greenhouse. Commercial inoculant was used for alfalfa and sweet clover. Cultures for the various other species were prepared and provided by Dr. L. W. Erdmann.[1]

Evaluation procedures

Seed habits and stand establishment received particular attention since no species can be used successfully in reseeding if seed cannot be produced economically and stands obtained fairly consistently. Seed habit ratings were based on seed yield, adaptability to machine harvest, degree of shattering, evenness of maturity, susceptibility to insect damage, and hard seededness. The latter can be quite a factor in stand establishment, and many species were given low ratings because of it. Ragged germination, low germination, and very slow seedling growth characterize many species and were considered in ratings.

Nodulation ratings were based primarily upon nodulation of seedlings at time of greenhouse transplantings, but all available information was considered. Some data were obtained from digging older plants in the field, and tests of nodulation effectiveness of inoculants were made on several natives in greenhouse pot studies. Nodulation on roots of Illinois bundle-flower (*Desmanthus illinoensis*) and catclaw sensitive brier (*Shrankia uncinata*) seedlings grown from non-inoculated seed was compared in two soils. The first soil was a mixture dug around growing native plants of these species. The other soil came from a field on the Woodward station which had been under cultivation for well over 50 years. This field soil was used in a second study with nodules from the first test planted with the seed.

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Livestock-use ratings were based upon the author's own observations and upon information supplied him by other interested persons. Ratings of the native legume species were based upon their use in native range stands (except Illinois bundleflower, for which data were also available from a seeded pure stand on the Woodward station).

Results and Discussion

Native species

Most native legumes have very poor seed habits. Production is low. Few can be readily harvested by machine. Examples such as the very low growing western indigo (*Indigofera leptosepala*), ground plum milkvetch (*Astragalus crassicarpus*), catclaw sensitive brier (*Shrankia uncinata*), or the indeterminately ripening and quickly shattering daleas (*Dalea* spp.) demonstrate some of the difficulties involved in conventional harvest. Shrubby growth like that of lead plant (*Amorpha canescens*) and sand pea (*Tephrosia virginiana*) or heavy pods like those of the wildindigos (*Baptisia* spp.) or ground plum milkvetch also make difficulties. From the point of view of the seed producer and dealer, the very low germinations and high proportions of hard seed immediately after harvest in many species would be a marketing drawback. The more important species tested are rated in Table 1.

Of all species tested, Illinois bundleflower alone is well adapted for commercial seed production. Yields of seed are fairly high (yield in a production plot of Illinois bundleflower at Woodward in 1955 was 800 pounds per acre); seed can be combined easily and is often of good quality, germinating 40 to 50 percent at harvest. A related species, *Desmanthus leptolobus,* was rated similarly.

The native lespedezas (*Lespedeza* spp.) could be handled fairly well by conventional methods and give fair seed yields. Seed yields of western indigo, hairy prairieclover (*Petalostemon villosum*), and catclaw sensitive brier might be sufficient to warrant some effort to overcome the various harvesting difficulties if seed were specially desired.

Establishment of most of the native species was difficult. Two factors, hard or poorly germinating seed and very slow initial growth, appear responsible. Probably only the bundleflower could be considered easy to establish, and young range stands of it have frequently been lost. Under nursery or seed increase conditions establishment was

Table 1.—Perennial native legumes whose potentials for range reseedings were studied at Woodward, Okla.

Species	Common name	Seed habits	Establishment	First-year growth	Nodules	Use by livestock
Amorpha canescens	Lead plant	Poor	Poor	Slow	Fair-good	Fair
Astragalus crassicarpus	Ground plum milkvetch	Fair	Poor	Slow	Poor	Good
Astragalus flexuosus	Flexile milkvetch	Poor	Poor	Fair	Good	Good
Astragalus mortoni	Morton milkvetch	Poor	Poor	Fair	Good	No data
Baptisia australis	Blue wildindigo	Very poor	Poor	Slow	Poor	Poor
Baptisia leucophaea	Plains wildindigo	Poor	Poor	Slow	Poor	Poor
Tephrosia virginiana	Sand pea	Very poor	Poor	Slow	Fair	Fair-poor
Dalea spp.	Daleas	Very poor	Poor	Slow	Fair	Fair
Desmanthus illinoensis	Illinois bundleflower	Excellent	Easy	Rapid	Good	Fair
Desmodium spp.	Tick clovers	Poor	Fair	Fair	Poor	Fair-good
Indigofera leptosepala	Western indigo	Fair	Fair	Fair	Good	Fair
Lathyrus decaphyllus	Pea vine	Very poor	Poor	Slow	Good	No data
Lespedeza capitata	Roundhead lespedeza	Fair	Good	Fair	Good	Good
Lespedeza stuevii	Stuve's lespedeza	Fair	Good	Fair	Good	Good
Lespedeza virginica	Slender lespedeza	Fair	Fair	Fair	Good	Good
Petalostemon candidum	White prairieclover	Poor	Poor	Slow	Poor	Fair
Petalostemon purpureum	Purple prairieclover	Poor	Poor	Slow	Poor	Fair
Petalostemon villosum	Hairy prairieclover	Fair	Fair	Fair	Poor	Fair
Shrankia uncinata	Catclaw sensitive brier	Fair	Poor	Fair	Good	Good

rapid and uniform. The native lespedezas again ranked next to the bundleflower. Few native legumes were vigorous growers, and even nursery propagation was difficult. Early spring planting appeared as effective as fall planting. The bundleflower, lespedezas, sensitive brier, and prairieclovers were all established in several spring plantings at Woodward, while two fall planted tests failed.

Nodules could be found on the roots of all the native species growing in the vicinity of Woodward and were produced in the greenhouse by inoculation of seed or seedling roots of all species tested. The extent of nodulation varied, however (Table 1). In most cases nodules were difficult to find on old plants in native stands.

It is probable that nodule bacteria for most of the native species are already in the soil, but it would be preferable to use appropriate inoculants in any legume seeding. Data in Table 2 for Illinois bundleflower and catclaw sensitive brier illustrate this point very well. There were approximately three times as many nodules in soil presumably naturally inoculated and in artificially inoculated soil as in soil from a cultivated field. Since the cultivated field in question was broken from native range some 50 to 75 years ago and has been under cultivation continuously since, it is surprising that any nodulation occurred in it at all without inoculant.

Livestock graze most native legumes, but usually very sparingly. All species, however, tend to decrease under heavy grazing. Use of species such as the wildindigos or the sensitive brier may be very heavy on young succulent growth but extremely limited on the dry, woody, mature plants. Most native legume species in western Oklahoma are summer growers, and their growth coincides with the major growth of the grass. This in turn affects their use, since an abundance of grass is available when they are most palatable. Exceptions are the milkvetches, which stay green in the winter or make very early growth.

Introductions

Of the many legume introductions which have been made the species listed in Table 2 probably offer the best reseeding possibilities for the area. Ratings of the principal introduced legumes are summarized in Table 3. None of the *Trifolium* group have proved hardy enough for western Oklahoma range conditions. The reseeding annual *Medicago* species such as bur or button clover seldom reproduce themselves at Woodward. Several attempts to establish birdsfoot trefoil met with

Table 2.—Average nodule numbers per seeding from roots of Illinois bundleflower and catclaw sensitive brier seedlings grown in pots in the greenhouse.

Species	Non-inoculated seed		Nodule inoculated seed
	Soil 1*	Soil 2*	in Soil 2*
Illinois bundleflower	1.90	.53	1.93
Catclaw sensitive brier	.77	.29	.85
Average	1.34	.41	1.39

*Soil 1 from around native growing plants of these species, Soil 2 from an old continuously cultivated field.

failure. Perennial *Vicia* and *Lathyrus* spp. grew very poorly in greenhouse and nursery and were dropped. Serecia lespedeza (*L. cuneata*) does not live through western Oklahoma winters.

Chinese milkvetch and sicklepod milkvetch (*Astragalus chinensis* and *A. falcatus*) made vigorous coarse growth under nursery conditions. Data on livestock use and field adaptation were not obtained, but rabbits avoided these two in nursery stands, suggesting possible toxicity. *Astragalus cicer* has proved highly desirable in all respects but the key one—establishment. Results have been extremely erratic and in most cases disappointing. Where established, this species has been very tough and long-lived, withstanding severe drouth and hard winters. It is relished by cattle. Most of the trials made by the author, both spring and fall, resulted in only a few very slowly growing seedlings. A seed increase planted at El Reno one fall, however, produced an excellent stand the following spring, as did one test at Woodward.

A volunteer stand of crown vetch (*Coronilla varia*) maintained itself for many years in a closely mowed blue grama sod on a terrace used as a roadway on the Woodward station. This source and others were run through nursery trials with disappointing results. Early growth was slow and young plants were susceptible to winter killing in dry years.

Several alfalfa types are grouped together in Table 3 as *Medicago* spp. Most of the accessions grown in field or nursery had variegated flowers and could have been classified as *M. media* (having varying amounts of germplasm from both the common blue flowered *M. sativa* and the yellow flowered *M. falcata*). Some accessions of *M. falcata* and one of *M. gaetula* were also grown. All accessions from this species complex proved easy to establish with varying subsequent survivals.

Table 3.—Principal introduced legumes whose potentials for range reseeding were studied at Woodward, Okla.

Species	Common name	Seed habits	Establishment	First-year growth	Nodules	Use by livestock
Astragalus chinensis	Chinese milkvetch	Fair	Fair	Fair	Good	No data
Astragalus cicer	Manchurian milkvetch	Fair	Poor	Slow	Good	Good
Astragalus falcatus	Sickle pod milkvetch	Fair	Fair	Fair	Good	No data
Coronilla varia	Crown vetch	Fair	Fair	Fair	Good	Poor
Medicago spp.	Alfalfas	Fair-good	Excellent	Rapid	Excellent	Excellent
Melilotus spp.	Sweet clovers	Good	Good	Fair	Excellent	Good
Onobrychis spp.	Sainfoin	Fair	Excellent	Rapid	Good	Good

Under range conditions, varieties like Nomad with a tendency to branch rootedness and semi-prostrate growth lived longer than did the upright taprooted common "hay" types. Nomad had a slight survival advantage both in the 1953 and 1954 tests and in a grazed pasture on the Southern Plains Experimental Range near Fort Supply, Oklahoma. All of these tests were under severe drouth conditions. Drouth, grasshoppers, and gophers finally eliminated stands of all varieties.

There seems little prospect for alfalfa on hard land ranges but it should be possible to develop varieties for sandy lands. One of the chief hazards on these ranges is the pocket gopher. Taprooted types are particularly vulnerable. In both nursery and field plantings gophers gradually eliminated the taprooted plants while branchrooted types survived very well. Certain branchrooted plants even seem to be avoided by gophers as measured by relative mounding activity in their vicinity. Another factor in range survival is rapid recovery after defoliation. Alfalfa provides early forage and can be easily overgrazed by rodents and insects as well as by livestock. The branchrooted, semi-prostrate "pasture" types tend to go dormant when grazed closely. Hay types, in contrast, may "grow themselves to death."

Sweet clovers (*Melilotus* spp) are excellent forage producers in some years. They also fix significant amounts of nitrogen. Their seed will live over in the soil until particularly favorable years come along. Under range conditions, however, they cannot be counted on as regular contributors. The Madrid variety of yellow sweetclover (*M. officianalis*) is probably best for western Oklahoma. Of the various species tested in nurseries, none approached the growth of the common biennial yellows or whites (*M. alba*).

Sainfoin (*Onobrychis* spp), although not altogether attractive as a seed producer because of the single-seeded pods, seemed to offer a lot of promise when first tested. Stands were easy to obtain, and the plants were quite drouth-resistant and winter-hardy. Even nursery plants, however, tended to be short-lived, perhaps because of susceptibility to various soil organisms. For this reason testing of this species complex was discontinued. Accessions under several species names (*O. armenica, chlorissanica, sativa, transcaucasica, viceaefolia*) seemed to react similarly, although considerable variation in vigor existed among various accessions and among plants within accessions.

Summing Up

Much of the information obtained in these studies dealt with difficulty or ease of propagation. Most of the native species and many of the introductions can be eliminated from consideration because of poor seed habits and difficulties in establishment. One rather large group of species, the scurfpeas (*Psoralea* spp.), were not even included in trials because of their poor seed habits and apparent limited value for seeding purposes. They are present on many native ranges in Oklahoma and Kansas.

Further information is needed as to range value of species which can be handled fairly easily. The amounts and values of nitrogen provided by legumes under range conditions in the Southern Great Plains are unknown. Repeated observations and discussions with range technicians have failed to uncover a single clearcut case of improved grass growth near a perennial native legume compared with growth away from it. One annual species, trailing wild bean, *Strophostyles leiosperma,* (in certain years locally abundant) seems to contribute nitrogen enough to improve the grass in association with it. Establishing initial stands of this or of the other important annual, partridge pea, *Chamaecrista fasciculata,* is difficult. Seed habits are very poor and growth is uncertain. Several years may elapse between useful crops of the wild bean, and contributions of the more predictable partridge pea appear to be limited.

Several times during the severe drouth years 1952 to 1956, tests designed to measure legume effects were attempted at Woodward but the attempts resulted in stand failures of either grass or legume. Such a trial was finally established in 1959 and it is hoped will provide quantitative data as to the merits of various legumes grown with grass under western Oklahoma dryland conditions.

In one test Illinois bundleflower seemed to hurt rather than help grass growth, probably because of moisture competition during extreme drouth. Sweet clover and alfalfa both apparently fix nitrogen in useful quantities, and some observations of improved native grass in association with them have been made. *Astragalus cicer,* in the only established range seeding known to the author (made by Soil Conservation Service personnel many years ago north of Shattuck, Oklahoma), seemed to improve the palatability of sideoats grama and sand lovegrass associated with it. Cattle grazed out the cicer and grass block. Grass outside the block was left virtually ungrazed.

Soil Conservation Service personnel have naturally been very much interested in the possibilities of legumes for range revegetation and the author is indebted to many workers who provided seed, information, and suggestions. A study similar to that at Woodward was initiated by M. D. Atkins[2] at the Soil Conservation Service Nursery at Manhattan, Kansas, in 1948. As complete as possible a survey of native and introduced legumes was conducted. After several years, Illinois bundleflower, two lespedezas, and *Astragalus cicer* were considered of best promise, but seed yields were not outstanding and stands were difficult to obtain under range conditions. In a letter to the author about these studies and referring to the native species, Mr. Atkins concluded, "Perhaps there is a practical way to make use of them although I have been pessimistic about them being of sufficient value to justify their cost in seedings. I would also like to see more work with so-called spreading or low-growing types of alfalfa. Some of these *M. falcata* and hybrid types have persisted in the wild from early plantings made more than 50 years ago in the Northern Great Plains. Alfalfa as a standard has been pretty difficult to equal, but we do not have the types of alfalfa that will grow in a compatible association with grass."

Most of the species tested have shown little variation and hence little promise for improvement by breeding. It is possible that some of the native *Astragalus* spp. might have untested material of greater promise and a survey of the *Lespedeza* spp. could possibly also lead to better lines. The bundleflower accessions grown have been remarkably alike. In contrast, a tremendous array of promising types is available in alfalfa. Alfalfa is a known crop which can be easily handled. It has definitely proved nitrogen fixing ability and makes good early spring growth, when green forage is particularly valuable. Most of the natives, in contrast, grow only when the grass grows. On sandy ranges, some evidence of adaptation with grass under grazing has already been shown by a planting on the Southern Plains Experimental Range at Fort Supply, Oklahoma, and plantings near Fargo and Laverne, Oklahoma.

A considerable number of sources of the variegated types of alfalfa sometimes classified as *Medicago media* have been grown in Woodward nurseries. Some of these have shown the creeping root habit found in the Canadian variety Rambler (several being related to Rambler), most have had spreading crowns like Nomad, and all have had branching

[2]Presently, Plant Materials Technician for the Great Plains States, Soil Conservation Service, Lincoln, Nebraska.

roots. Resistance to gopher attack has been shown by most lines, and some instances of apparent lack of palatability to gophers have been noted. This same type of material has within it a considerable degree of resistance to the alfalfa aphid and can survive under rather severe grasshopper infestation. From this material, which includes origins as diverse as Turkey, India, Russia, Siberia, France, and Portugal, several clones have been selected and a breeding program is underway.

Conclusions

With presently available information there seems little justification for attempts to use native legumes for reseeding purposes. A breeding program aimed at developing an alfalfa for pasture and range use in western Oklahoma has good chances for success, and its product could be an important contribution to the agricultural economy of the area.

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