Ecological Adaptation of Certain Forage Species on Shallow Muck Soils

B.O. Blair, C.L. Rhykerd, R.E. Mullen, W.O. Jones, and J.J. Vorst
Department of Agronomy, Purdue University
West Lafayette, Indiana 47907

Summary

Most of the million plus acres of muck soils in Indiana suitable for agriculture are used for corn, soybean or vegetable crop production. Continued production of these crops have, in many cases, introduced severe weed problems. Field operations necessary in culturing these crops in poorly drained fields often cannot be accomplished at the proper time and returns are marginal. Cold air drainage into these areas in early fall frequently results in killing forests which shorten the season as much as three weeks. In many cases it is necessary to harvest corn as silage and soybean yields are appreciably reduced.

These problems prompted an investigation at the Pinney Purdue Agricultural Center at Wanatah, Indiana, relative to utilizing these areas more profitable by seeding to forage grasses and legumes. The experimental area is shallow, due to a long history of wind erosion. The muck soil in this area varies from 45 to 100 cm in depth. A small plot study demonstrated that the water table at 70-85 cm prohibited the production of many commonly grown perennial forage species. *Bromus* and *Medicago* species, however, grow satisfactorily in surrounding areas.

This article reports on the successful conversion of a 50 ha muck area from warm-season annual crop production to a permanent pasture composed of Kentucky bluegrass (*Poa pratensis*) a cool-season perennial grass and birdsfoot trefoil (*Lotus corniculatus*), a warm-season legume with a shallow root system. In addition, it was found that a Kentucky bluegrass-birdsfoot trefoil mixture can be a highly productive alternative to corn or soybeans on shallow muck soils where adequate animal units are available for utilizing the early spring growth of Kentucky bluegrass and the later growth of birdsfoot trefoil.

Introduction

In Indiana, muck soils are estimated to occupy .5-.6 million ha most of which are in the northern third of the state. These soils were formed in low lying areas subject to frequent overflow or areas with perched water tables which supported *Carex*, *Juncus*, swamp grasses, and willow species, and vary from a meter to several meters in depth. The areas vary in size from a few hectares to as much as 1000 ha. The larger areas, when drained, are cultured to high income per/ha crops requiring special equipment and management techniques. Smaller areas are usually integrated into conventional cultural patterns common to the area. Although many areas are tile drained,

they are too wet in the spring for wheat production so they are usually planted to soybeans or corn. Weeds become a serious problem when corn and soybeans are grown continuously under these conditions. Yields of grain crops are often below average due to weed competition, late planting due to wet conditions, and early frosts resulting from cold air drainage. The growing season is shortened as much as three weeks compared to adjacent well drained areas which are only a few meters higher.

Owners and operators of smaller areas of muck continue to use these areas for production of corn and soybeans. However, forages may be a more profitable alternative on these muck soils if adapted grasses and legumes are selected. Establishment of legumes on such soils pose problems due to excess water, wind erosion during establishment, and frost heaving.

Preliminary small plot test trials in 1968-69 with 16 grasses and legumes at the Pinney Purdue Agricultural Center at Wanatah demonstrated that several cool-season grasses but only one legume, birdsfoot trefoil (*Lotus corniculatus L.*) are productive under these conditions.

Literature Review

Birdsfoot trefoil, (*Lotus corniculatus* L.), a low growing warm-season legume with a semi-branching taproot, has been found to be very competitive with grass species of comparable height. Test trials over several years at the Miller Purdue Agricultural Center at Upland showed it to be compatible with Kentucky bluegrass, (*Poa pratensis* L.), where it provides forage in the warm part of the season and also provides nitrogen for the bluegrass during the cool spring and late reported to grow in wet soils, after successful establishment, in many dairy producing areas in the Northeast (1). Although not as high yielding as alfalfa, it is very palatable, high in protein, and thus a very desirable species to include in a forage mixture (2).

Birdsfoot trefoil is a difficult species to establish since the seed is small, germination is slow, and seedlings are weak. Very often competition from other species prevents its successful establishment. Therefore it cannot become established unless competition is reduced or eliminated by frequently clipping or use of herbicide (4). This species will establish and thrive on droughty soils, when protected by clipping. Thick stands have established along many roadsides in southern Indiana. Birdsfoot trefoil is a prolific seed producer under proper management and will reseed itself and spread to adjacent areas.

Methods and Materials

The continued struggle with weed competition, late planting and low grain yields on a 48 ha area along with a need for more forage for the cow herd at Pinney Purdue Agricultural Center prompted the authors to suggest an alternative program for this muck area.

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The results of a grass-legume test plot trial in the muck area showed that birdsfoot trefoil (*Lotus corniculatus* L.), is the only legume that can survive where the water table averages 1 m below the soil surface and its temperature year-round is 15-17°C. Several grass species including: orchardgrass (*Dactylis glomerata* L.), tall fescue (*Festuca arundenacea* Schreb.), reed canarygrass (*Phalaris arundinacea* L.), and Kentucky bluegrass (*Poa pratensis* L.), also show promise.

In the spring of 1971 birdsfoot trefoil was seeded at a rate of 4 kg/ha in early May on a 4 ha area on a better drained portion of the field. A very good stand of 75-200 plants per square meter emerged by mid-May. However, it was obvious that these tiny seedlings 2-4 cm tall would be shaded out by rapidly growing broad-leaved weed species which had attained a height of 10 cm. Therefore, the area was sprayed with 2,4-DB which successfully eliminated most of the broad-leaved weeds. A 5-week dry period followed which eliminated about half of the trefoil seedlings and another weed population emerged. During the remainder of that season, the area was clipped frequently to keep the weed stubble to 10 cm. In mid-August the area was overseeded with 12 kg/ha of Kentucky bluegrass which emerged by mid-September.

The weed stubble and trefoil stand prevented any surface wind erosion which is frequent on open muck areas during winter months. In fact, over the past 20 years, 30-40 cm of soil has been lost from this fall when birdsfoot trefoil is dormant (3). Birdsfoot trefoil has been area. These losses were most severe following soybeans.

By the spring of 1973 the original seeding of trefoil and bluegrass was established with trefoil roots penetrating to depths of 20 cm (Figure 1). Moderate grazing was encouraged during the spring; however, the area remained idle through that summer. By fall, bluegrass competition and lodging of larger trefoil plants further reduced the trefoil stand. This could have been prevented by clipping or grazing during the summer. Thus, overprotection during establishing can be detrimental.

In the spring of 1972, a second area of 4 ha was seeded with 4 kg trefoil and 10 kg of bluegrass per ha. However, this stand was lost due to a dry spring and subsequent wind erosion. In late August, a 12 ha area was seeded with bluegrass and trefoil at 8 and 4 kg/ha respectively and overseeded with 9 kg/ha of annual ryegrass (*Lolium multiflorum* Lam.). The ryegrass was needed for establishing a quick cover to reduce the probability of wind erosion. In the spring of 1973 the second seeded area lost the year before was again seeded with trefoil and bluegrass in the residue of weed stubble left from the previous years. In only the first seeding of 1971 was birdsfoot trefoil seeded first and independent of later grass seedings.

The success of these establishments will be reported in the results. The remaining 20 ha in the muck area was seeded to trefoil and bluegrass in late summer of 1973. Thus the entire muck area once subject to many weed problems, wind erosion, low cash crop yields, along with planting and harvesting problems in spring and fall now is

a lush meadow of bluegrass and trefoil. It now provides more spring forage than can be effectively managed with the present animal numbers available.

Results and Discussion

Only preliminary evaluations were made of the first planting in 1971 since it was an exploratory study. The vigor of two year old trefoil plants is shown in Figure 1 and illustrates the adaptation of this species in muck soils in competition with bluegrass.

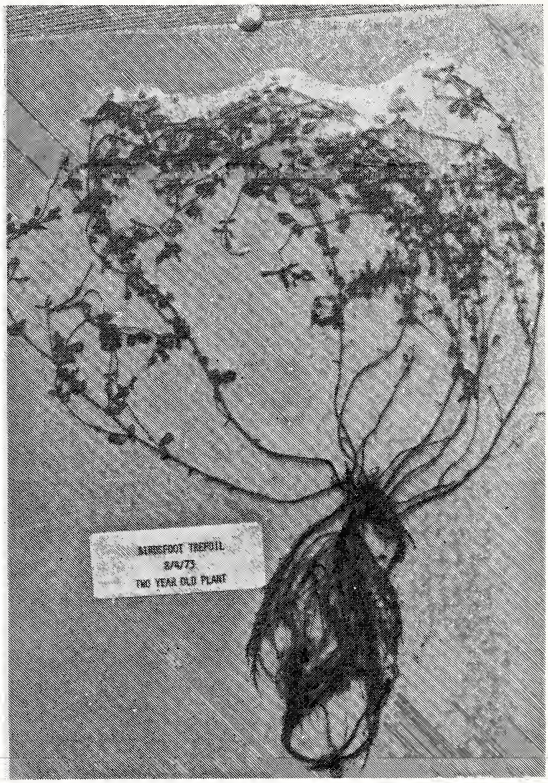

FIGURE 1. *A two year old birdsfoot trefoil plant taken from a dense stand of bluegrass. Both top and root development in these muck soils demonstrate capability to establish and compete successfully.*

The trefoil-bluegrass seedling population of the 12 ha area seeded in the fall of 1972 was extremely variable. Three m^2 quadrats were located in a line from the spoil bank ridge of a drainage ditch in this area, extending into the field at 30 m intervals and designated as replication 1, 2 and 3. In June 1973, seedling population on the well-drained spoil bank numbered 16. Over the summer, six seedlings were lost. Replications 2 and 3 extended into a more poorly drained area

with severe competition from ryegrass had only 1 and 3 trefoil plants per m^2, respectively. By September, all of these seedlings were lost from shading competition. However, a good stand of Kentucky bluegrass with scattered trefoil plants was established over the area on better drained areas of this field.

The second 4 ha area reseeded the second time in the spring of 1973 was studied in more detail. This area from north to south in general decreases in desirability for seedling establishment due to wetness. Six areas 20 x 50 cm. (.1 m^2) were located north to south in the area. Seedling counts were initiated in July and made monthly through November (Table 1).

The trefoil stand on the better drained area to the north supported a greater number of seedlings. The vegetation was clipped as needed during the summer to 10 cm to eliminate weed competition and reduce shading by the grass stand.

Birdsfoot trefoil seedlings in replication 5, a depressional area to the south, were lost early and stands in all replications were reduced except in replication 6 which increased. Replication 6, the farthest south, was located on a slight rise near the first field seeded in 1971. Total population dropped from 55 to 21 over the summer which shows that by November there still was an average 120 plants per m^2. This represents good establishment in view of competition from bluegrass, a vigorous competitor on muck, and weeds.

Due to excessive moisture, very little grazing was possible the following spring except on the first 4 ha area seeded in 1971. As a result, bluegrass in all areas grew to a height of 25 cm before it could be grazed or clipped. Shading competition resulted in a further reduction in birdsfoot trefoil population. In the last area seeded during the late summer of 1973, trefoil seedlings were sparse but they did establish in better drained areas of that field.

All fields were observed again in August 1976, (5, 4, and 3 years after seeding) and in all fields a solid stand of bluegrass was present, except in two small areas where ponding was frequent. Birdsfoot trefoil populations varied but flowering plants were present in all fields and plants in ungrazed areas produced seed. Non-grazed areas over all fields occurred on dung deposits and *Juncus* culms in ponded areas. Heavy seed production of birdsfoot trefoil was noted in these culms of *Juncus* which invaded and now thrive in depressions where water frequently stands, (Figure 2).

The greatest enemy for increasing trefoil population after establishment appears to be competition from bluegrass which results from lack of aggressive management practices. Low grazing pressure early in the spring due to lack of numbers of animals or wet field conditions prevented grazing bluegrass to a height of 10 cm which is necessary to maintain good stands. This past season the area was heavily grazed during late April and early May due to unusually dry conditions and consequently 3-4 trefoil plants were present per m^2 in the first three areas seeded, (Figure 3).

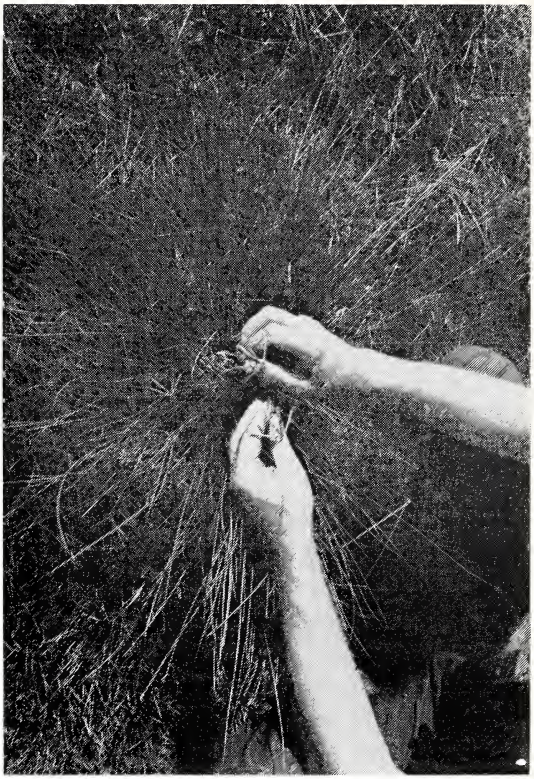

FIGURE 2. *Healthy birdsfoot trefoil plants surviving among culms of unpalatable juncus which protects them from grazing in ponded areas. These protected plants provide a continuous seed source for these areas.*

Increasing animal numbers and subdividing the entire muck area into paddocks of 4 to 5 ha will permit heavier grazing and the excess forage in ungrazed paddocks can be harvested as hay or silage. This will have a beneficial effect on increasing trefoil population.

The change of this muck area cultural practices from cash crops to a grass-legume mixture has been well accepted by the farm manager. If a problem now exists it is an over supply of forage in the spring which tends to decrease the birdsfoot trefoil population in the pastures. Further studies, to include intensive clipping of bluegrass in early spring and summer, should be initiative to determine if birdsfoot population could be appreciably increased.

FIGURE 3. *Heavy grazing, especially in early spring, is a benefit for successful competition of birdsfoot plants.*

Conclusion

A Kentucky bluegrass-birdsfoot trefoil mixture can be successfully established on muck soils with a capability of providing forage or hay equivalent to 12 tons per ha where root systems of both species reach a permanent water table.

This study shows that birdsfoot trefoil will persist in association with bluegrass on muck soils if properly grazed. Numerous trefoil plants appear to survive among the non-palatable *Juncus* culms and in isolated ungrazed clumps of bluegrass resulting from dung or urine deposits. These trefoil plants are able to mature, producing seed to continuously re-establish the birdsfoot trefoil.

The shift from cash grain crops to a birdsfoot trefoil-bluegrass mixture on these muck soils eliminates many weed problems, concern for soil tillage at planting, wind erosion, harvesting in wet conditions, and low crop yields due to early frosts in these low lying muck areas. In addition, the high yields of high quality forage can be very profitably utilized to feed sheep, beef or dairy cattle.

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