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J. M. Aikman
Iowa Agricultural Experiment Station

Robert E. McDermott
Iowa Agricultural Experiment Station

COMPARISON OF DOMINANT PRAIRIE GRASSES AS INTERPLANTING GROUND COVERS ON ERODED SOIL

J. M. AIKMAN AND ROBERT E. MCDERMOTT

Experiments were initiated in 1938 for the purpose of studying vegetative ground covers. This series of investigations was undertaken as the basis for studies in the integration of herbacious and woody plants which constitute an important phase of the research in progress at the Floris Field Station of the Iowa Cooperative Hillculture Project. The herbaceous plants used at the station in these studies of integration with woody plants may be classified in three groups: natural weed covers, legumes and grasses.

The most effective organization of integrated herbaceous and woody plants seems to be the bench-like plowed contour strip on which the woody plants are established with the interplanting strip of varying width covered with soil-building and soil-holding herbaceous covers. Although the value of natural weed covers and especially of selected legumes has been well established in these studies, grass covers are especially effective, surpassing weed covers in holding the soil against erosion as well as in the rate of soil-building, and surpassing legume covers in holding the soil. Of the grasses used in these experiments, the prairie grasses from the beginning seemed to offer the most promise. The purpose of this paper is to describe the behavior of selected dominant species of both the upland and lowland native prairie in two planting sites comparable in plant growth characteristics to typical upland and lowland native prairie.

In establishing plantations of grapes, plums, nut trees, post trees, sumac for tannin production and other woody plants of high economic value, the common procedure in 1938 was to prepare the plowed contour strips for planting the woody plant material in whatever herbaceous plant cover was present on the slope at the time. This original herbaceous cover of the interplanting strips between the rows of woody plants was later modified by seeding experiments to provide the most nearly adequate cover possible in terms of soil-holding and soil-building properties. On sites having adequate or almost adequate herbaceous cover this method still seems to be advisable for most planting of woody plants.

In the two experiments described in this paper the procedure was reversed by giving attention first to the establishment of the interplanting vegetative cover on the almost bare soil and later to the establishment of woody plants on bench-like plowed contour strips between the interplanting strips. In the spring of 1939 two sites were selected on eroded Lindley loam of approximately 15 to 25 per cent slope. The first of these, Site I, with a south facing slope of 15 per cent, was an area which might have been considered as a site for a grass waterway except that it was extremely wide and received less runoff water from

the drainage basin above than most such waterways. When the planting strips for the grasses were prepared, sufficient water was received from the slope above to make this site comparable to a lowland prairie site in abundant water supply and deficient soil drainage. Site II with a southeast facing slope of 25 per cent was an extremely dry slope. Erosion here had been extreme leaving a top soil depth (A horizon) of 0 to 4 inches. In contrast the depth of the top soil remaining on Site I varied from 4 to 8 inches.

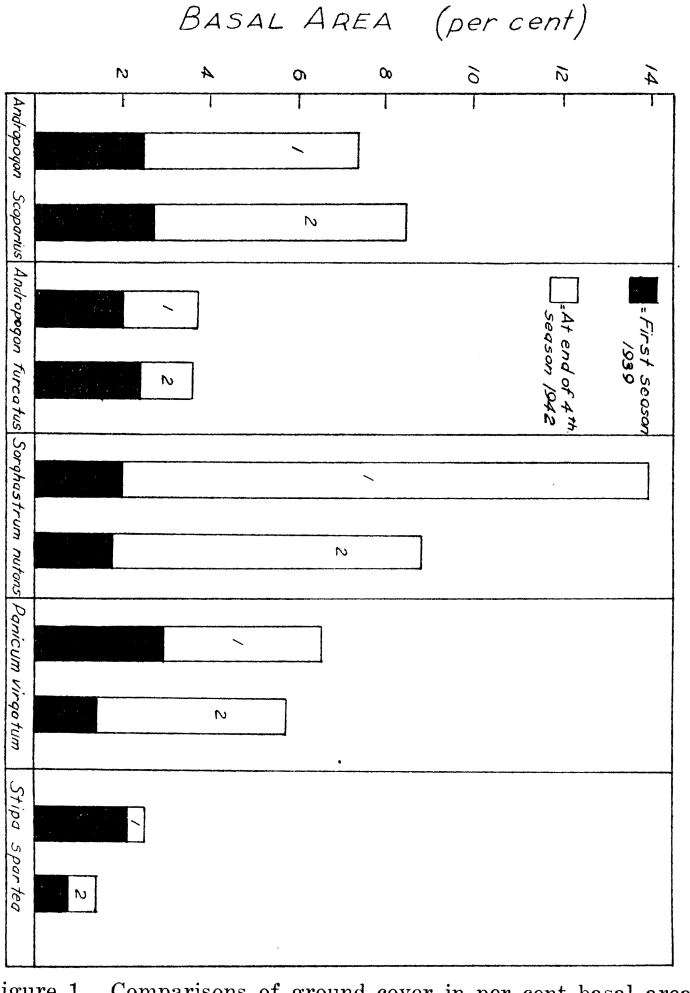

Figure 1. Comparisons of ground cover in per cent basal area of prairie grasses grown on contour strips, on eroded land in southern Iowa, 1939, 1942. The numbers in the bars signify the strip locations 1, 2.

The planting strips prepared for the prairie grasses in the two sites were established on the exact contour at an average interval of 26 feet from the center of one planting strip to the next. Since the center of each prairie strip was on the exact contour, this interval varied from approximately 20 feet to 33 feet. The seed bed for the prairie grasses was prepared by plowing a back furrow strip approximately 13 feet in width, disking it thoroughly and then harrowing until a good seed bed was obtained. The seed was drilled with 2½ foot drill or broadcasted depending on the cleanness of the seed. The quantity of seed used was determined on the basis of previous seed tests with the aim of having a comparable number of viable seed on a given area.

When the strips were prepared on planting sites I and II they seemed comparable in soil moisture conditions to lowland and upland prairies sites respectively. Soil moisture determination made later after the establishment of the grasses, verified this first impression as did the response of the prairie grasses established on the two sites. Even though the soil of Site II had much lower fertility than that of well established upland prairie, establishment and later growth was very satisfactory as was also establishment and growth on Site I. Site I had a treatment of 2 tons of lime per acre in 1936 and Site II had not been limed.

The grasses used in the test were three species of upland or true prairie grasses: *Andropogon scoparius* Michx., Prairie beardgrass or Little bluestem; *Stipa spartea* Trin., Porcupine grass; *Bouteloua curtipendula* (Michx.) Torr., Side-oats grama and three species of lowland or subclimax prairie grasses: *Andropogon furcatus* Muhl., Blujoint turkeyfoot or Big bluestem; *Sorghastrum nutans* (L). Nash., Indian grass and *Panicum virgatum* L., Switchgrass. Of these six species, the side-oats grama is not included in the graph and table showing basal area and weight-list results. Although this species is established much more readily in pure seeding plantings than might be expected from its behavior in native prairie communities, it does not usually provide adequate ground cover for protective interplanting strips. *Sporobolus heterolepis* A. Gray., Prairie dropseed and *Koeleria cristata* (L.) Pers., Junegrass, the two remaining upland prairie dominants, were not included in the test. Although plot tests under our conditions with Junegrass show that it does not afford adequate cover for interplanting strips, tests with Prairie dropseed seem to indicate that it would afford adequate cover. Of these three true prairie dominants not included in the graph and table, Side-oats grama and Prairie dropseed give promise of being valuable grasses to include in prairie grass mixtures on interplanting strips. Two lowland prairie dominants, not included in the test, are *Elymus canadensis* L., Canada wild-rye and *Spartina pectinata* Link., Prairie cordgrass or slough grass. The former of these two should have been included on the basis of plot tests which have since been completed. This species is especially valuable if selections showing strong vegetative growth and resistance to disease are used. Plot tests with Prairie cordgrass show that estab-

lishment from seed is almost impossible. For this reason, and because it is a grass of extremely wet, undrained habitats, Prairie cordgrass should probably not be used on interplanting strips except in extremely wet sites where it would seem advisable to establish it by sodding.

Of several criteria used as a basis for evaluating the relative behavior on interplanting contour strips of the grasses investigated, the two selected as most effective from the standpoint of soil-holding and soil-building were degree of ground cover as shown by basal area measurements on a percentage basis, and yield of aboveground parts as obtained by weight-list determinations. The relationship between percentage of the ground covered at the base of the grass plants and the protection against soil erosion at this critical level is exceptionally high. Another reason that this is an important measurement is the fact that, although there is not much variation in the root systems of these several grasses which contributes to soil protection in the upper few inches of soil, there is a wide variation among them in the protection afforded at the ground level. The weight-list determinations in terms of pounds per acre is very definitely related to the rate of soil-building by the incorporation of organic matter at the soil surface and to the protection afforded the soil by the mulching effect of organic matter from previous years' growth.

In figure 1 are shown the basal area data obtained by means of area-list quadrat studies. Although area-list quadrat measurements were made at the end of the growing season each year, for the purpose of special emphasis only the values of 1939 and at the close of the four-year period in 1942 are included. These data show that there was not much difference in basal area among the species at the end of the first growing season. This fact is important because it shows that there was quite adequate protection to the soil the first year following planting especially of those grasses which can be established. The degree of protection is usually augmented by the presence of weeds in the grass cover the first year.

The basal area of three of the species seem adequate in view of the fact that they are almost if not quite equal to like values of native prairie which is composed of a mixture of several prairie grasses and forbs. The basal area value of *Andropogon furcatus* is comparatively low as it is in native stands. Even where it forms bunches, the bunch effect does not extend above ground and so the area at ground level is low although it makes very luxurient growth. It is excellent in mixtures with other grasses but can also be used in pure stands because the low basal area value seems to some extent to be compensated for by the high yield of above ground parts because of the protection which the heavy grass cover affords the soil from beating rains, and because of the protection from the action of water at the soil surface afforded by the mulching effect of the abundant dead grass. *Stipa spartea* however does not form an adequate cover at the soil surface and also has a very low yield as shown by weight-list determinations in table I. For the three lowland prairie grasses, especially for *Sorghastrum nutans*,

the basal area at the end of the fourth season was greater in Site I than in Site II. This difference is in line with the sod forming habit of these grasses in lowland sites which are their native habitat. *Stipa spartea* was bunch-forming on both sites but the basal area gave a greater total the first year in Site I because of the greater water supply. With exception of the *Stipa spartea* strips which gave a bare appearance, all of the strips were seemingly well covered and protected from both runoff and erosion, and afforded adequate protection to the intervening strips on which trees were planted in the spring of 1941.

Table I. Yield data from weight-list permanent quadrat determinations made at the close of seasons 1940, 1941 and 1942 on contour strips planted on eroded Lindley loam in April, 1939.

Species	Site	Average yield in pounds per acre 1940	1941	1942
Andropogon scoparius	1	5200		14600
	2	9600	15800	12200
Andropogon furcatus	1	8200	9600	15200
	2	8000	12800	8800
Sorghastrum nutans	1	6400	11400	13800
	2	8200	10000	7600
Panicum virgatum	1	9600	15800	16600
	2	2600	4800	7800
Stipa spartea	1	2600		low
	2	1600	1600	260

The quantitative yield data obtained from weight-list quadrat determinations are shown in table I. These data show that for Site I, comparable to a lowland prairie site, *Panicum virgatum* has the highest yield, yet it yielded only about half as much in Site II. In contract, *Andropogon scoparius* had the highest yield in the dry site but yielded even more pounds per acre in Site I. However the four species were very nearly equal in average yields for the two sites. These yield data would seem to indicate that the three lowland prairie dominants are suitable for planting on sites with an abundance of soil moisture but do not give as good results when planted in pure seedings on dry areas. However prairie grass mixtures, containing these species, which were planted on the two sites gave excellent results in yield as well as in basal area. Little bluestem was a very impotrant constituent of such mixtures on both sites. *Stipa spartea* is not suitable for planting alone in either type of site. It does have a place however in mixtures of true prairie grasses for upland planting.

In selecting species for use in interplanting strips or for other critical soil conserving practices, attention must also be given to the cover provided by the plant at the ground level. *Sorghastrum nutans* is a very valuable ground cover species as is shown by its behavior in both sites. The data in figure I show that on the dry site *Andropogon sco-*

parius ranked approximately as high in basal area. These two species should probably be more generally used than any others in planting mixtures of prairie grasses made to order for specific critical sites.

BOTANY AND PLANT PATHOLOGY SECTION,
IOWA AGRICULTURAL EXPERIMENT STATION AND SOIL CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE.