Effects of Clipping, Burning and Competition on Establishment and Survival of Some Native Grasses in Wisconsin[1]

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VARIOUS investigations over the past three decades have indicated that certain of the grasses native in the tall-grass prairies of the eastern Great Plains and the North Central States are outstanding in the fields of erosion control and the restoration of structure of cultivated soils. These grasses appear to be particularly useful in localities of high erosion hazard, on local droughty arcas and on soils of low fertility. The superiority of their foliage for protection against erosive forces of wind and rain, the soil-holding ability of their dense, fibrous roots and the large amount of organic matter produced from roots and top-growth have been shown in investigations of Boyd (1942), Cornelius (1946), Ward (1949), Weaver and Fitzpatrick (1932), and Weaver and Kramer (1935).

The establishment and maintenance of native grasses of the tall-grass prairies is believed by some to have been dependent on prairie fires of varying frequency, and the advisability of periodic burning has been subjected to considerable investigation. Hensel (1923) found that early spring burning tended to increase stands of little bluestem, whereas big bluestem and Indiangrass tended to increase under late spring burning. Aldous (1935), Curtis and Partch (1948) and Hensel found that burning was deleterious to bluegrass, while the prairie grasses in general were not injured.

Gernet (1936) and Biswell and Weaver (1933) found that the prairie grasses with an erect growth habit would not withstand close, frequent clipping or grazing as well as species with a more prostrate form, while Aldous (1938) and Anderson (1940) concluded that controlled grazing under deferred and rotational plans increased the carrying capacity of native grass pastures and provided better cover as compared with continuous grazing over the entire growing season.

Methods and Materials

The investigations reported were begun in 1949 to obtain information on the effects of burning, cutting and competition from bluegrass on seeded stands of native grasses on two infertile and run down fields in southern Wisconsin.

The seed of 20 species of native grasses was obtained from Soil Conservation Service nurseries at the following locations during the winter of 1948–1949: Ames, Iowa: Big bluestem (*Andropogon gerardi*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), Canada wildrye (*Elymus canadensis*) and Virginia wildrye (*Elymus virginicus*); Manhattan, Kansas: Little bluestem (*Andropogon scoparius*); Waterloo, Nebraska: Big bluestem, feather bunchgrass (*Stipa viridula*), sand dropseed (*Sporobolus cryptandrus*), sand lovegrass (*Eragrostis trichodes*) and sideoats grama (*Bouteloua curtipendula*).

The 10 species were planted in mixture, and each species was accorded one tenth of the given rate per acre for a single-species seeding. Acre-rates for big bluestem, little bluestem, sideoats grama, Canada wildrye, Virginia wildrye and Indiangrass were 20 pounds; feather bunchgrass, 15 pounds; switchgrass, 10 pounds; sand dropseed, 6 pounds; and sand lovegrass, 5 pounds. When bluegrass was included in the mixture, it constituted one half by weight of the total quantity of seed sown in the plot. The seed was broadcast, covered with a garden rake and cultipacked. A companion crop of one bushel of oats per acre was sown at the same time. In July of the seeding year, the companion crop and weeds were mowed and removed from the plots.

Equivalent experiments were begun on two separate, contrasting areas, one on the University West Hill Farm and one in the University Arboretum. The studies were set up as adaptations of the split plot design with four replications in each. Plot size was 10 x 40 feet.

University West Hill Farm

The experimental site selected for planting had a slight southeasterly slope and good surface and subsoil drainage. The soil was a badly eroded Miami silt loam, low in organic matter, of average pH 6.2 and contained 44 and 114 pounds of available phosphorus and potassium per acre, respectively. Sudan grass had been grown on the field the year preceding the start of the experiment. Prior to seeding, the land was plowed, double disked and harrowed. No fertilizer was applied.

In the late spring of 1950, before the warm-season grasses had started growth, the designated section was

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burned for the purpose of observing the effect on the native grasses and to injure the actively growing bluegrass as much as possible. The plots harvested at the pasture stage were cut four times during the 1950 growing season at 28-day intervals, the first cut being made the third week of June. The plots cut at the hay stage were mowed in the middle of August, when big bluestem, Indiangrass, switchgrass and little bluestem were in early or full bloom. Clippings were not removed from the plots. No cutting or burning treatments were applied to the control plots. Stand counts of the mature plants were begun about four weeks after burning. Depending upon the density, seedlings were either counted or estimated concurrently with counts of the mature plants but were not included in the density figures herein reported. A square-meter quadrat was used and five samples were taken in each plot. The plot sample consisted of the average of the five one-square-meter quadrats per plot. Burning and cutting treatments were repeated during the season of 1951. All of the plots were allowed to grow undisturbed during the summer of 1952, so that the condition of the various species following the two years of clipping and burning treatments could be ascertained. Late in the fall of 1952, botanical composition in each of the various plots was determined by use of a one-quarter-square-meter quadrat, and data were taken as frequent percentages.

In order that the 3-years' data might be comparable, the frequency data for 1952 were converted to density figures (Curtis and McIntosh, 1950) and expressed as the number of plants per one-meter-square quadrat. Feather bunchgrass, sand lovegrass and sand dropseed failed to become established or were present in extremely small numbers and were omitted from further consideration.

University Arboretum

An equivalent experiment was established at the University Arboretum at Madison on an infertile field which had not been cultivated for more than 10 years and which had been revegetated with Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*P. pratensis*) and quackgrass (*Agropyron repens*). This area was plowed and the seedbed prepared with no attempt being made to remove or kill the bluegrass and quackgrass rhizomes. The field was part of a typical lowland prairie site. The soil on the southern half was classified as a Crosby silt loam and that on the northern half as a Clyde silty clay loam. The soil pH was 5.9 and the available phosphorus and potassium contents were 16 and 112 pounds per acre, respectively. Organic matter was high and the seedbed was in good physical condition.

Burning and cutting treatments were the same as those imposed on the West Hill Farm field in 1950, with the exception that the first three cuttings of the pasture stage and the hay-stage clippings were removed because of the dense stand of weeds and grasses. The first pasture-stage cutting was made in the last week of June. In 1950, this field was severely infested with quackgrass and sweet clover (*Melilotus alba*), white clover, Alsike clover and medium red clover (*Trifolium repens*, *T. hybridum* and *T. pratense*, respectively) and ragweed (*Ambrosia elatior*). Bluegrass from the old sod developed extensively on the plots during the course of the growing season. On the plots harvested at the hay stage and on the control plots, the heaviest growths of weeds were cut with a hand sickle and removed, and all weed growths were then sprayed with 2,4-D. Subsequent burning and cutting treatments and the methods of botanical analysis were the same as those described for the West Hill Farm experiment.

Results and Discussion

The results of the experiments on the West Hill Farm and in the University Arboretum are presented in Table 1 and in Figures 1 and 2. The effects of the cutting treatments on the height and vigor of the mixed stands as compared with the controls or uncut plots are shown in Figure 3.

The weather conditions during the growing season of the seedling year (1949) were generally favorable for establishment. The June-July rainfall for both years (1949 and 1950) was excessive. The heavy rainfall in the spring and summer months of 1950 caused severe erosion of the fields. This was particularly true of the West Hill Farm, where the area was on a moderate slope, relatively bare of vegetation and low in organic matter. This erosion was most severe on the burned sections of both experimental areas.

The number of plants of the native species under all treatments was less in the Arboretum than on the Hill Farm in 1950 and 1951, in spite of the better moisture conditions and superior soil structure of the former area. This was

Table 1. Average number of plants of all species per square meter at West Hill Farm and University Arboretum under different treatments for 1950, 1951 and 1952

Year	Treatment				
	Stage of growth at cutting				
	Control	Pasture	Hay	Burned only, 1950 and 1951	Seeded with bluegrass[1]
West Hill Farm					
1950	32.0	26.8	33.6	22.0	14.1
1951	44.0	45.6	49.1	29.5	19.1
1952	38.6	34.4	27.4	34.5	26.1
University Arboretum					
1950	16.3	20.9	22.2	17.8	14.3
1951	26.5	31.3	32.7	28.3	17.8
1952	30.1	23.3	27.2	30.4	21.9

[1] No burning or cutting treatments were applied to these plots.

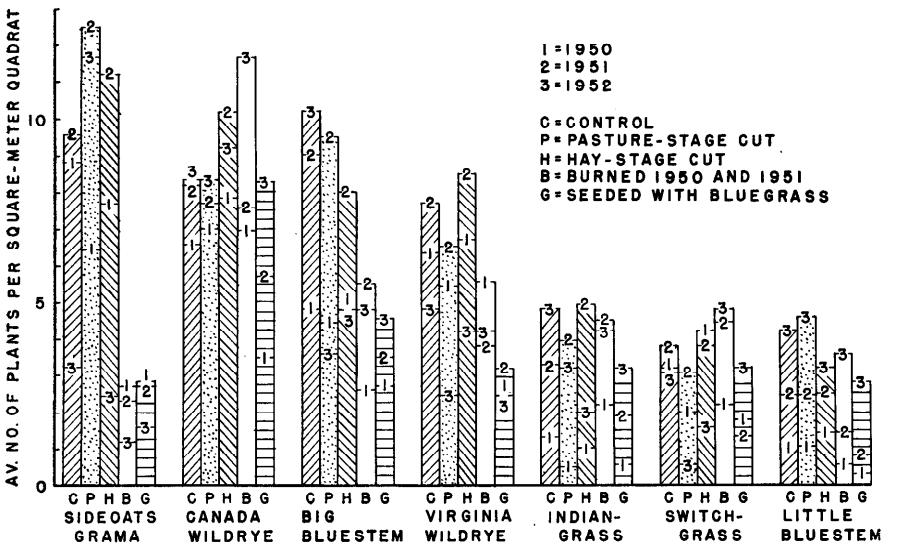

FIGURE 1. Average number of plants per species per square meter on the West Hill Farm under different treatments for 1950, 1951 and 1952.

probably due to the high degree of competition from the grasses regenerated from the old bluegrass and quackgrass sod and from invading clovers and weeds. The tendency for leveling out of these differences by 1952 may have been the result of the advantage given by these better environmental factors once dominance was established by the native species.

Spring growth was approximately 2 weeks later in starting in the Arboretum than on the Hill Farm due to the location of the Arboretum plots on low-lying, poorly drained land which remained frozen somewhat later in the spring. The plants on the Hill Farm were probably closer to the breaking of dormancy at the time of burning than those in the Arboretum which may account for the apparently harmful effects of burning on the native plants in the former area. An indirect cause of injury from burning on the Hill Farm lay in the severe erosion of the burned areas, which in many instances resulted in exposure of much of the crown and many roots of these plants.

Of the native species, the wildryes were most easily and rapidly established, due to a relatively high seed germination and vigorous development of root and top growth at low temperatures of early spring (Robocker *et al.*, 1953). By 1952, however, Virginia wildrye was much reduced in numbers and Canada wildrye had ceased to evidence increase. This observation was further substantiated by observations in the 1953 season, when both species had almost disappeared from the plots or were greatly reduced in vigor. The apparent injury to the wildryes from burning, indicated by small basal areas of both species and by a decrease in density of Virginia wildrye, was probably due to the fact that by the time the bluegrass was sufficiently advanced to be affected by burning, the wildryes had begun growth and were therefore also subject to injury. The warm-season grasses seemed to suffer little direct damage from fire prior to dormancy break in the spring. The increase in density in all except sideoats grama probably resulted from reduction in competition from the strongly regenerated bluegrass sod.

The generally adverse effects resulting from clipping the tall-growing native prairie species are in agreement with findings of previously mentioned investigators. Switchgrass and big bluestem seemed particularly sensitive to clipping and showed a greater relative reduction in density under pasture-stage cutting than did the other species. Sideoats grama, which strongly increased under this cutting level and decreased in the uncut

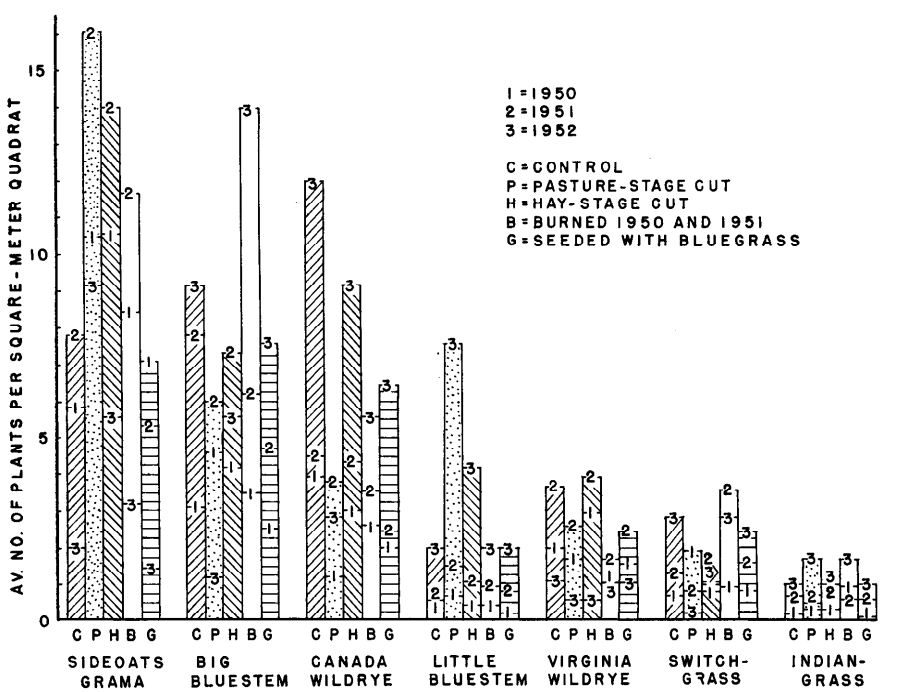

FIGURE 2. Average number of plants per species per square meter in the University of Wisconsin Arboretum plots under different treatments for 1950, 1951 and 1952.

FIGURE 3. Appearance of plots on the West Hill Farm after 2 years of cutting treatments and a summer's rest. *Left.* Plot on the left cut once each year at the hay stage; (uncut control plot) on the right. *Right.* Plot on the left an uncut control; plot on the right cut four times each summer. Photographed August, 1952.

and hay-stage cutting plots during the three seasons, apparently benefited from the reduction of shade and competition from the tall species. Little bluestem showed no deleterious effects from cutting and even increased under pasture-stage cutting, possibly due to the reduction in the competition for light afforded this shade-intolerant species by the taller species. The small change or slight increase of the wildryes under cutting at the hay stage may be explained by the fact that this cutting was done at the early bloom stage of the warm-season grasses, at which time the earlier wildryes were matured.

Summary

The effects of fire, cutting and competition from bluegrass and weeds on the establishment and survival of big bluestem, little bluestem, sideoats grama, Canada wildrye, Virginia wildrye, switchgrass and Indian-grass were studied in the years 1949 through 1952. Field experiments were conducted on an infertile, badly eroded soil on the University West Hill Farm and on a field of low fertility, vegetated with a dense sod of bluegrass, quackgrass and perennial forbs in the University Arboretum at Madison, Wisconsin.

Burning appeared to be injurious to Canada and Virginia wildrye, which started growth early in the spring, and to big bluestem, little bluestem and sideoats grama on areas in which erosion was extensive. Switchgrass and little bluestem increased under burning, and big bluestem increased under burning in areas where competition from bluegrass and other plants was severe. Indiangrass also tended to increase and sideoats grama showed no real effects on density from burning.

Cutting at the hay stage had an adverse effect on big bluestem, Indiangrass and switchgrass. Canada wildrye increased, and Virginia wildrye and sideoats grama showed little effect when compared with the controls. Little bluestem increased under cutting at the hay stage.

Cutting at the pasture stage, or four times at monthly intervals during the growing season, beginning one year after seeding, caused decreases in vigor and density of big bluestem, switchgrass and Virginia wildrye. There was little or no decrease of Indiangrass, and little bluestem increased from such cutting during the duration of this experiment. Sideoats grama increased greatly under cutting at the pasture stage.

Competition from established bluegrass and quackgrass sods and dense stands of other perennial and annual weeds was detrimental to the vigor and establishment of the native grasses.

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