Competition Between Forbs and Grasses

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Competition is occurring all the time among plants of the same as well as those of different species. However, little is known about how much the results of competition affect the production of grass. There is very little literature available concerning competition between native forbs and grasses. Weaver (1942) has described competition of western wheatgrass (*Agropyron smithii*) with relict vegetation but there is no discussion of competition between forbs and grasses as such.

Probably one of the most comprehensive accounts pertaining to plant competition was afforded by Clements, Weaver, and Hanson (1929). Hopkins (1951) felt that forbs decrease the production of grass, but that this reduction is compensated for by the yield of forbs, even though they may be lower in palatability.

Weaver and Clements (1938) stated that competition always occurs where two or more plants make demands for light, nutrients, or water in excess of the supply. Competition is essentially a decrease in the amount of water, nutrients, or light available for each individual.

The present study was conducted in an area near Hays, Kansas, that has been free from grazing or other unnatural disturbances for many years. The area, a big bluestem (*Andropogon gerardi*) type, was described by Albertson (1937) as a little bluestem (*Andropogon scoparius*) type. However due to the drought of the 1930's, big bluestem has largely replaced little bluestem. Big bluestem alone comprised over 60 percent of the vegetation (Tomanek and Albertson, 1953). The chief associates with this dominant were side-oats grama (*Bouteloua curtipendula*), 9.4 percent, and little bluestem, 26.6 percent.

The study began at the close of the growing season in order to obtain the results of a full season's growth. Big bluestem alone was used for the yield determinations.

Plan and Method

The object of the study was to determine the amount various forb species reduced the yield of big bluestem. The assumption was made that competition between the forb and grass was the only factor involved in the reduction. The square-foot method was employed to measure how forbs growing in close contact with big bluestem affected the production of the grass.

It was intended that the competition be limited strictly between the grass and a single forb species; therefore, the areas were selected. Selecting a sample involved finding an area where big bluestem was growing with the forb under study. This square foot had no other forb species present. In addition to this quadrat, another comparable area was selected near-by as a control and was represented by a pure stand of big bluestem. A total of ten such samples and controls were taken for each forb species studied.

These square-foot areas were clipped to within one inch of the ground and the forbs and grasses separated. Air-dry weight of clippings from both quadrats was compared in an effort to measure the degree of competition.

Scientific names of the plants cited in this study are in agreement with those found in Gleason (1952). Common names are taken from *Standardized Plant Names* (1942).

Results

Rhizomatous Forbs

Of the 5 rhizomatous forbs studied, heath aster (*Aster ericoides*) caused the greatest reduction in grass yield. An average of 19 asters was present in each square foot sampled. The weight of the asters averaged 13.3 grams per square foot (Table 1). The big bluestem produced an average of 28.5 grams of foliage per square-foot plot in pure stands, but only 9.1 grams in competition with heath aster. The reduction in grass yield averaged 68.1 percent.

This great reduction is easily explained when the underground structure is observed. The rhizomes are tough and woody, and are intricately interlaced among the rhizomes of big bluestem. In the upper 4 inches of soil, competition is very severe since the rhizomes of the two opposing plants are in direct contact with each other.

Stiff goldenrod (*Solidago rigida*) is a robust plant which has very short rhizomes. These rhizomes bunch together forming a large heavy crown that often produces as many as 12 plants. An average of 6 plants occurred in each sample. The average decrease in grass due to competition was 53.2 percent. Competition for space, in this case, was a factor in decreased grass production since the goldenrod often exclusively occupied as much as 16 square inches of the square-foot plot.

Western ragweed (*Ambrosia psilostachya*) is one of the most common forbs of the prairie. Its dense societies were very effective in reducing the yield of big bluestem an average of 55.7 percent. The rhizomes of ragweed

Table 1. Species of rhizomatous forbs studied, forb and grass weights, and percent reduction in yields of grass with forb competition.*

Species	Weight of Forb	Wt. of Grass in Quadrat With Forb	Wt. of Grass in Quadrat Without Forb	Average Percent Decrease Due to Competition
	gm.	gm.	gm.	%
Heath aster	13.3	9.1	28.5	68.1
Stiff goldenrod	38.8	10.2	21.8	53.2
Western ragweed	16.2	11.3	25.5	55.7
Aromatic aster	6.2	10.0	20.4	51.0
Velvety goldenrod	17.6	13.2	24.6	46.4

* All differences were significant at the 5 percent level.

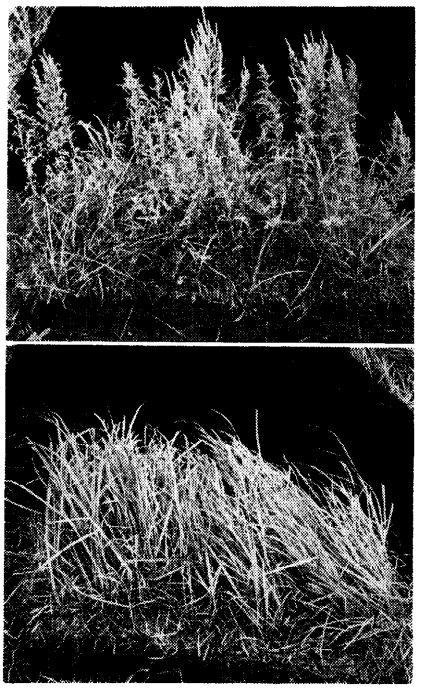

FIGURE 1. One-half meter sods 4 inches deep of western ragweed in competition with big bluestem *(above)* compared with one-half square meter of pure big bluestem *(below)*.

were strongly intermingled with those of big bluestem and frequently, even grew through the heavy root crowns of the grass. There was an average of 6 plants per quadrat.

Although aromatic aster *(Aster oblongifolius)* is rather small in above-ground stature, its underground structure seemed to be very effective, since the yield of big bluestem was reduced 51.0 percent in plots where the aster was present. There were usually 16 plants represented in each quadrat. The rhizome growth characteristics of the aromatic aster greatly resemble those of heath aster. However, the former's rhizomes are a lighter tan in color and not as woody.

Velvety goldenrod *(Solidago mollis)*, one of the less common goldenrods of the area, was rather robust in growth, usually around 15 inches in height, and an average of 11 plants were found in each sample. The rhizomes were dichotomous in nature, the older branches giving rise to many young shoots. There was an average decrease in the weight of the grass of 46.4 percent in the ten samples clipped. Unlike the short rhizomes of stiff goldenrod, the rhizomes of this forb were quite long, often with 4 or 5 plants attached to a single underground stem. These plants then sent out other rhizomes from the base of the shoot. Thus, with such a network of underground stems functioning to serve the numerous above-ground shoots, it is easy to understand the great reduction in grass yield.

Taprooted Forbs

Five taprooted forbs were chosen for study as a contrast to the rhizomatous plants.

Slimflower scurfpea *(Psoralea tenuiflora)* is a common inhabitant of the mixed prairie. The taproot is quite heavy on a mature plant—usually 2 or 3 inches in diameter immediately below the soil surface. It often extends to a depth exceeding 16 feet in a soil with a deep profile. This is far below the reach of prairie grasses and reduces competition between the plants. The weight of big bluestem clipped from the quadrat with the scurfpea averaged 20.4 grams while the plot with a pure stand of bluestem produced 23.2 grass. This represents a loss of only 12.8 percent (Table 2).

Blacksampson *(Echinacea angustifolia)* was widely scattered over the study area and there was seldom more than one plant in each sample. The quadrats containing this species produced only 18.9 percent less grass yield than those with pure big bluestem.

Broom snakeweed *(Gutierrezia sarothrae)*, a semi-woody plant with a heavy taproot, had an average weight of 12.5 grams per quadrat. It caused an average decrease in grass production of 12.4 percent.

Catclaw sensitivebriar *(Schrankia uncinata)*, is a spine-covered plant whose decumbent growth characteristics had little

Table 2. Species of taprooted forbs studied, forb and grass weights, and percent reduction in yields of grass with forb competition.*

Species	Weight of Forb	Wt. of Grass in Quadrat With Forb	Wt. of Grass in Quadrat Without Forb	Average Percent Decrease Due to Competition
	gm.	gm.	gm.	%
Blacksampson	2.9	18.9	23.3	18.9
Scurfpea	5.2	20.4	23.2	12.8
Broom snakeweed	12.5	14.9	17.0	12.4
Sensitivebriar	4.2	19.4	21.8	11.1
Prairieclover	5.3	12.7	14.1	9.9

* No significant difference at the 5 percent level.

effect on the surrounding vegetation. Usually 2 or 3 plants were present in each sample.

No distinction was made between purple or white prairie-clover (*Petalostemon purpurea* or *P. candidum*) due to their similarity in form and growth habits. This plant usually consisted of 3 stems about 18 inches tall arising from a root crown. Grass production in quadrats containing these forbs was only 9.9 percent less than in pure grass quadrats.

The differences were tested for the taprooted forbs and found not to be significant at the 5 percent level. However, the decreases found due to the presence of rhizomatous forbs in the quadrats were all highly significant.

Roots and rhizomes

The object of this part of the study was to determine the reduction in roots and rhizomes of big bluestem due to the competition from rhizomatous forbs. Sods, one-half square meter in area by 4 inches deep, were removed. The sod containing rhizomatous forbs in competition with the grass was compared with a sod exhibiting a pure stand of big bluestem (Figure 1). These sods were taken within a few feet of each other. Water spray was used to remove the soil and reveal the underground parts. The roots of the forbs and grass were carefully separated and air-dry weight determinations made of each.

The sod containing heath aster revealed an amazing mass of interlacing rhizomes when the soil was washed away. These rhizomes tend to occur between the root crowns of big bluestem and the soil surface (Figure 2). No area existed in the one-half square meter which was free of aster rhizomes.

There were 167.4 grams of heath aster roots and rhizomes and 237.1 grams of big bluestem (Table 3). The control quadrat produced 600.1 grams of big bluestem roots and rhizomes. The loss incurred by the grass roots due to competition from heath aster was 60.5 percent.

Aromatic and heath asters were growing closely enough together that a single control quadrat of pure bluestem was used as a comparison for both. Roots and rhizomes of aromatic aster weighed 98.6 grams, and the bluestem roots produced in this same quadrat weighed 371.6 grams. In the control, 600.1 grams of roots occurred. The decrease of grass roots and rhizomes was 38.1 percent.

The rhizomes of western ragweed were found to be mostly below the crowns of big bluestem. Although the weight of ragweed was small, 70.2 grams, the reduction in the grass roots was 53.6 percent.

Velvety goldenrod's roots and rhizomes weighed 69.7 grams and the grass roots with it weighed 387.5. The pure stand of bluestem in the control plot with it produced roots weighing 508.8 grams. The percent loss of grass roots and rhizomes due to competition from the forb was 23.8.

Summary

The purpose of this study was to determine the loss in weight suffered by big bluestem (*Andropogon gerardi*) as a result of competition from both rhizomatous and taprooted forbs.

The results obtained readily reveal that in all but one in-

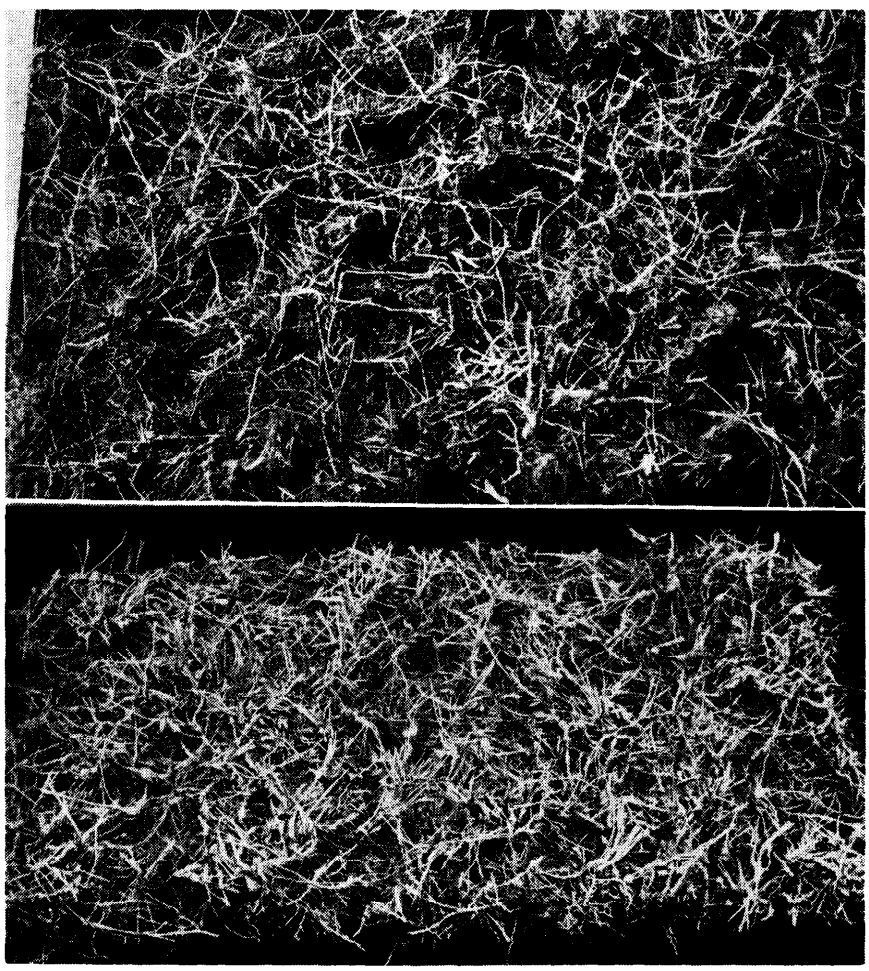

FIGURE 2. One-half square meter of heath aster and big bluestem roots and rhizomes *(above)* compared with one-half square meter of pure big bluestem roots and rhizomes *(below)*. Note lighter colored rhizomes of the aster intermingled in the sparse bluestem rhizomes *(above)*.

Table 3. Weights in grams of roots and rhizomes in one-half square meter sods and percent decrease in big bluestem roots and rhizomes with competition.

Plant	Sods With Forbs			Sods Without Forbs	Percent Decrease of Roots and Rhizomes of Grass
	Forb	Grass	Total	Grass	
Heath aster	167.4	237.1	404.5	600.1	60.5
Western ragweed	70.2	332.1	402.3	717.4	53.6
Aromatic aster	98.6	371.6	470.2	600.1	38.1
Velvety goldenrod	69.7	387.5	457.2	508.8	23.8

stance the plants with rhizomes decreased the production of big bluestem over 50 percent. Heath aster *(Aster ericoides)* caused the greatest decrease in yield, both aboveground and in the roots and rhizomes of the grass belowground. Competition from velvety goldenrod *(Solidago mollis)* was the least effective of plants with rhizomes in reducing grass production.

A possible explanation for the reduction in grass yield might be that the rhizomes of the two competing plants are in direct contact with each other in the surface 4 inches of soil. The roots strive to satisfy mutual needs which, for the most part, are obtained from the surface layer. When demands are made in excess of the supply, reduced production is the only alternative.

None of the taprooted forbs studied caused a significant decrease in grass yield. These plants utilize moisture and nutrients below the roots of the grasses, thus reducing competition below-ground to a minimum.

Competitive effects of rhizomatous forbs on big bluestem roots and rhizomes were great. Even the combined weights of roots and rhizomes of the opposing plants did not equal the weight of the bluestem in pure stands.

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