Grass Seedling Response to Halogeton Competition[1]

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Highlight

Infestations of halogeton on arid rangelands compete rather severely with wheatgrass and Russian wildrye seedlings. Crested wheatgrass and Russian wildrye compete more effectively with halogeton than tall, pubescent and intermediate wheatgrasses.

Halogeton *(Halogeton glomeratus)*, an annual plant poisonous to livestock, has invaded many areas of the salt-desert ranges of the Great Basin area in Utah, Nevada, and Idaho. Control of this plant by chemical herbicides is expensive, and in many cases has actually increased its abundance by eliminating the native vegetation. It is generally agreed that halogeton can be controlled through natural rehabilitation of ranges by protecting the native plants. Introduced species of grass show promise as replacements for large areas of halogeton where rainfall is adequate and the soil is not too saline.

From 1957 to 1964 a study was conducted on semi-desert areas in northwestern Utah to determine the competitive effect of halogeton with grass seedlings during the first three growing seasons following planting.

Procedures

During 1956 two 40-acre areas supporting sagebrush and halogeton were fenced to exclude rabbits and livestock. During each of four years —1957, 1958, 1960, and 1961—a 20-acre area was summer fallowed and seeded in the fall. Four wheatgrasses, crested *(Agropyron cristatum)*, intermediate *(Agropyron intermedium)*, tall *(Agropyron elongatum)*, and pubescent *(Agropyron pubescens)*, and Russian wildrye *(Elymus junceus)* were used in the study. These five grass species were seeded separately in two replications each year. All species were seeded with equal numbers of viable seed per acre on the basis of 7.5 pounds of crested wheatgrass. Each seeded plot in each replication was about four acres. During each year, one half of each plot was treated with a herbicide (2,4-D butyl ester) at the rate of 1.5 lb/acre of acid equivalent during the middle of June to control halogeton and eliminate competition for the new seedlings (Fig. 1). The halogeton was about 2 to 3 inches high when the herbicide was applied. The herbicide was similarly applied during the second growing season to one half of each of the previously treated plots to control competition for the second growing season.

Average annual precipitation on the experimental areas from 1957 to 1964 was 10.6 inches. About 70% was received as snow from October to March. The remainder was received as rain during the spring, summer, and fall. June, July, and August were generally hot and dry with the exception of an occasional torrential shower which was generally ineffective in supplying available soil moisture.

FIGURE 1. Areas on the left were unsprayed. Area in lower right was sprayed during first growing season; note grass seedlings in drill rows. Area in upper right was sprayed during first and second growing seasons; dark area shows abundant grass clumps.

[1] *A cooperative project with the Utah State Experiment Station and the U.S. Bureau of Land Management.*

Inches of precipitation by years were as follows: 1957, 11.4; 1958, 9.1; 1959, 9.6; 1960, 8.2; 1961, 10.7; 1962, 8.9; 1963, 13.6; and 1964, 13.5.

Data were collected on the portion of each plot that was sprayed during the first growing season, sprayed for two consecutive years, and unsprayed. The data collected consisted of seedling survival at one, two, and three years of age, production of forage at the end of three growing seasons, root development of both grasses and halogeton at various stages of development, and soil moisture during the summer.

Seedling responses to halogeton competition were measured by counting the plants and harvesting the herbage on permanent plots and by excavating the entire root system from each species in each treatment. Seedling emergence was determined during the first of June following fall seeding.

Results and Discussion

Survival and Production.—Seedling emergence results are presented in Table 1 as averages over all treatment plots for each species. Emergence determinations showed that crested wheatgrass had significantly more seedlings ($P < .05$) at the start of the first growing season, and Russian wildrye had significantly fewer than the other species. During all four years of the study Russian wildrye produced fewest seedlings and had fewest plants per plot at the end of the first growing season regardless of treatment.

Seedling survival the first year for all species was greater on sprayed than unsprayed plots (Table 1). Sprayed plots had an average of 1.7 more plants per 9.6 ft^2 circular plot ($P < .05$). There were greater differences in the number of plants per plot between the areas treated only once and those treated two consecutive years for tall, pubescent, and intermediate wheatgrass than for crested wheatgrass and Russian wildrye. The seedlings from all species competed about the same with halogeton during the first growing season, but during the second growing season both Russian wildrye and crested wheatgrass competed much more effectively than the other species. During the third growing season the number of crested wheatgrass plants actually increased in all the areas that had been sprayed previously. During the second and third growing season, tall, pubescent, and intermediate wheatgrass plots lost more than one-half their plants per plot on the unsprayed areas, but crested wheatgrass and Russian wildrye were reduced only slightly.

At the end of the third growing season over all four seedings crested wheatgrass and Russian wildrye produced significantly more forage ($P < .05$) than tall or pubescent wheatgrass on the unsprayed plots. Intermediate wheatgrass was between the other species in herbage yields on plots where halogeton was not controlled (Table 1). Sprayed plots produced significantly more herbage for all grass species ($P < .05$) than unsprayed plots, and plots sprayed twice had significantly greater yields of grass than plots sprayed only once. Benefits from a second spraying were more marked for intermediate, tall, and pubescent wheatgrass than for crested wheatgrass or Russian wildrye.

Root Growth.—A total of 1260 root systems were exposed and measured, (Fig. 2). There were 30 root systems from each treatment for each species at three different ages.

During the first growing season following seeding, the grasses and the halogeton had about the same numbers of secondary roots and the root systems reached about the same depths (Table 2). However, the halogeton roots had about three times greater radial spread than did the grasses. Plant heights for grasses and halogeton were about the same at the end of the first growing season when root samples were taken.

Table 1. Average emergence in spring after fall seeding, survival after one year and after three years, and production at the end of three growing seasons for five species seeded near Snowville during four years and at four locations with two replications at each location.

Species	Survival 1st year				Survival 3rd year				Production 3rd year			
	Emergence	Sprayed	Unsprayed	Ave.	Sprayed once	Sprayed twice	Unsprayed	Ave.	Sprayed once	Sprayed twice	Unsprayed	Ave.
	(Plants/plot)								(lb/acre)			
Tall wheatgrass	27.8	9.3*	7.5	8.4	2.0	5.5**	1.2	2.9	118.4	338.5**	85.0	180.6
Intermediate wheatgrass	24.3	9.2	8.4	8.0	5.2*	11.4**	3.9	6.8	332.1*	629.0**	254.2	396.1
Crested wheatgrass	33.3	11.5	10.7	11.1	16.7**	17.8**	10.3	14.9	617.9*	786.7*	517.1	640.6
Pubescent wheatgrass	21.3	7.7*	6.2	5.8	4.5*	8.2**	3.1	5.3	102.6	303.0*	99.6	174.4
Russian wildrye	13.5	6.2	5.1	5.6	5.1	4.7	4.3	4.7	445.7	468.0*	386.6	433.4
Average	24.0	8.8*	7.1	7.8	6.7*	9.5**	4.6	6.9	404.2**	505.0**	268.5	438.3

* Significantly different from the unsprayed at the .05 level of probability.

** Significantly different from the unsprayed at the .01 level of probability.

Table 2. Average depth and radial spread in inches, and number of roots of seeded grasses and halogeton on sprayed and unsprayed areas. Seedings were made in the fall of 1957 and root measurements were taken in the fall of 1958, 1959, and 1961 after being treated with herbicides in June, 1958, to control halogeton.

Species	Sprayed				Unsprayed			
	Roots			Plant height	Roots			Plant height
	Depth	Radial spread	No.		Depth	Radial spread	No.	
Data collected 1958	Seedlings 1 year old							
Tall wheatgrass	10.6	6.4	7.2	6.9	9.9	3.4	11.5*	9.8*
Intermediate wheatgr.	21.5**	2.9	9.8	6.4	11.0	4.2**	11.5	7.7
Crested wheatgrass	11.7	3.5	9.0	9.4	11.6	3.6	13.2**	9.7
Pubescent wheatgr.	12.8**	3.6	17.5*	7.2	9.9	4.1*	12.0	7.6
Russian wildrye	9.9	3.5	14.5	3.9	9.7	1.6	14.5	6.6*
Grass average	13.3**	4.0	11.6	6.8	10.4	3.4	12.5	8.3
Halogeton	—	—	—	—	9.6	10.0	9.1	8.5
Data collected 1959	Seedlings 2 years old							
Tall wheatgrass	15.3	6.3*	31.0**	7.6	16.3	4.7	24.2	7.0
Intermediate wheatgr.	13.3	6.1*	49.2*	8.9	12.4	4.4	43.0	6.5
Crested wheatgrass	13.4	6.0	43.2	7.0	12.1	5.9	44.0	8.9
Pubescent wheatgr.	16.0**	5.3	52.4**	11.2*	11.7	5.7	43.2	6.9
Russian wildrye	11.3	6.3	43.4	5.3	11.2	6.5	56.3*	3.6
Grass average	13.9*	6.0	43.8	8.0	12.8	5.4	42.1	6.6
Halogeton	11.5**	11.4**	8.6	7.4**	6.9	5.3	9.0	5.2
Data collected 1961	Seedlings during fourth growing season[1]							
Tall wheatgrass	42.5	30.6	37.2	47.9	41.4	27.1	35.3	42.5
Intermediate wheatgr.	43.8*	32.8	48.3	39.5	35.9	33.8	45.0	47.6*
Crested wheatgrass	37.1*	39.3*	37.3	39.1	34.7	25.1	36.5	42.8
Pubescent wheatgr.	32.2	31.2	43.2	38.1	30.4	31.8*	37.0	44.4
Russian wildrye	39.6	44.8	38.8	47.0	40.0	45.2	43.2*	58.4
Grass average	39.0*	35.7	41.0	44.1	36.5	32.6	41.4	47.1
Halogeton	15.8*	8.0	9.0	13.0*	13.8	8.3	8.7	7.4

*Significantly different from the appropriate comparison at the .05 probability level.

**Significantly different from the appropriate comparison at the .01 probability level.

[1] Measurements for this seedling age were made on grass plots where halogeton had been controlled two consecutive years, 1958 and 1959, compared to control plots that were never sprayed.

Control of halogeton during the first growing season aided grasses in producing a significantly deeper root system, but varied in its effects upon the number of roots on the grass plants. Pubescent wheatgrass plants had significantly more roots under sprayed conditions, but the other three wheatgrasses and Russian wildrye were either unaffected in this respect or unsprayed plants produced somewhat more roots.

Most grass plants two years of age on areas that had been sprayed only once the year before produced deeper roots than the same age grass plants on unsprayed plots. Two-year old tall, intermediate, and pubescent wheatgrass plants had greater numbers of roots on sprayed plots while crested wheatgrass and Russian wildrye had somewhat higher numbers of roots on plots left unsprayed for two years (Table 2). Radial spread of roots of tall and intermediate wheatgrass plants was significantly greater on areas that had been sprayed the previous year, but radial spread of roots for the other three seeded species was somewhat greater on the unsprayed areas.

The halogeton plants on unsprayed areas were larger and had more extensive root systems during the first year after grass was seeded than they did on the same unsprayed area during the following year. Unsprayed halogeton plants growing on areas sprayed the previous year (data collected in 1959 on sprayed areas in table 2), were about the same size and had about the same depth and spread of roots as halogeton plants measured the previous year that grew on summer-fallowed and unsprayed areas.

Data collected when the grass plants were in their fourth growing season showed that all wheatgrass species on areas sprayed for two consecutive years had deeper root systems than plants on unsprayed areas. Crested wheatgrass roots had substantially wider radial spread but substantially fewer roots on sprayed areas compared to unsprayed areas. Otherwise, few differences were apparent in number and spread of roots for the seeded grasses under sprayed and unsprayed conditions at four years of age.

Plant Vigor.—During the fourth growing season grass plants were more abundant per unit area and halogeton plants were fewer on previously sprayed areas than unsprayed areas. Since grass plants were less dense on unsprayed areas after 3½ growing seasons, these plants were somewhat taller and more robust compared to grass plants on sprayed areas (Table 2). Halogeton plants were less abundant but were taller and more vigorous on sprayed than on unsprayed areas.

The stands on all plots seeded in 1957 and 1958 were evaluated during the summers of 1963 and 1964. The plots seeded to tall and pubescent wheatgrasses were being reoccupied by dense stands of halogeton and dead grass clumps were abundant. Intermediate wheatgrass stands showed a slight decrease in density

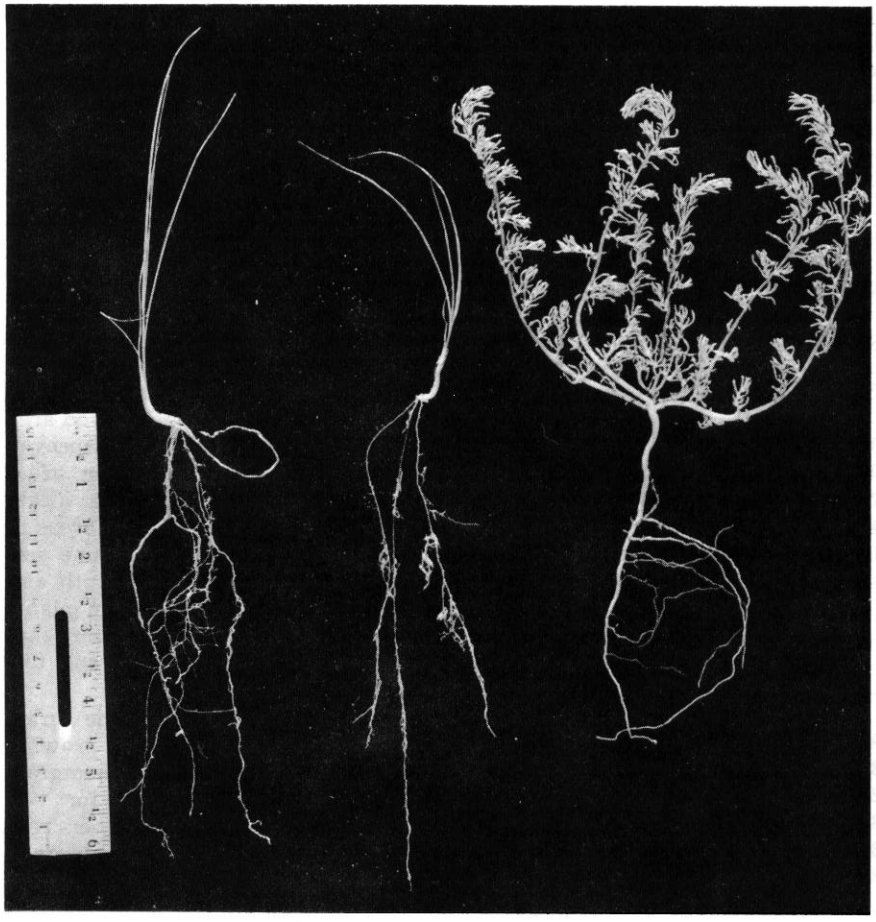

FIGURE 2. Root systems of tall and intermediate wheatgrass and halogeton from unsprayed areas at the end of the first growing season.

Table 3. Average soil moisture percentage for the three summer months on areas sprayed for two successive years following seeding compared to unsprayed areas on 4 separate seedings during 4 separate years from 1957 to 1961.[1]

		1st year		2nd year		3rd year	
Date	Treatment	0-6	6-12	0-6	6-12	0-6	6-12
July 1	Sprayed	8.1	13.5	12.3	13.3	9.5	13.7
	Unsprayed	6.7	11.8	12.4	13.4	9.4	13.1
	Difference	1.4*	1.7*	-0.1	-0.1	0.1	0.6
August 1	Sprayed	7.6	12.6	4.8	8.9	5.1	8.1
	Unsprayed	5.1	9.1	3.9	7.1	4.3	6.4
	Difference	2.5*	3.5**	0.9	1.8*	0.8	1.7*
Sept. 1	Sprayed	5.9	13.3	8.6	8.0	5.4	7.1
	Unsprayed	4.3	8.6	7.2	7.6	6.0	6.0
	Difference	1.6*	4.7**	1.4*	0.4	-0.6	1.1*

[1] The wilting coefficient for the 0-6 inch depth is 8.27 and for the 6-12 inch depth 9.10%.

* Significant at the .05 level of probability.

** Significant at the .01 level of probability.

since the 1960 and 1961 readings. Halogeton was present in all open areas where grass clumps were dead.

None of the pastures seeded to crested wheatgrass and Russian wildrye showed indications of stand decreases or halogeton invasion. In all cases crested wheatgrass stands had thickened, even on the unsprayed portions of the plots. This increase in stand was attributable to larger plant clumps and more plants through natural seedling establishment. Increases in stands where Russian wildrye was planted were mainly attributable to larger clumps since only a slight increase was noted in number of plants resulting from natural seedling establishment.

All data clearly indicate that of the species studied crested wheatgrass and Russian wildrye are best adapted to low rainfall areas and compete more efficiently with halogeton infestations.

Salt Tolerance.—Analysis of the soil in some areas where poor stands of grass occurred even when halogeton competition was controlled, showed that only crested wheatgrass and Russian wildrye would grow on saline-alkali soils. Even these two species tolerated far less salt in the soil than did halogeton. Crested wheatgrass did not grow well in soils that had more than 4 milliequivalents of exchangeable sodium per 100 gr of soil in the surface 6 inches, and Russian wildrye did not grow well in soils that had more than 5 milliequivalents. Both species survived on areas where the soil below the first 6 inches contained as much as 7 milliequivalents of exchangeable sodium per 100 gr of soil and the saturation extract conductivity exceeded 15 millimhos/cc. Stands in these areas, however, did not appear thrifty, and considerable increase in halogeton occurred at the expense of grass plants during the 3-year establishment period.

Soil Moisture.—The moisture conditions during the first two growing seasons determined the benefit obtained from the application of herbicide. In most cases, the soil moisture was higher in sprayed plots than in unsprayed areas (Table 3). These differences in favor of sprayed areas were still apparent during the third year even though halogeton was controlled only for the first two years.

Summary and Conclusions

A study was conducted on semidesert areas in northern Utah to determine the competitive effect of halogeton with grass seedlings.

During each of four years—1957, 1958, 1960, and 1961—a 20-acre area was summer fallowed and seeded to crested, intermediate, tall, and pubescent wheatgrasses, and Russian wildrye grass. One half of each seeding plot was treated with 2,4-D during June to eliminate competition of halogeton with the seedlings. Portions of each plot were treated as follows: (1) sprayed the first growing season, (2) sprayed for two consecutive growing seasons, and (3) unsprayed.

Seedling survival for all grass species was greater on sprayed plots. These differences were more pronounced for tall, pubescent, and intermediate wheatgrass than for crested wheatgrass or Russian wildrye.

Herbage yields at the end of the third growing season were significantly higher for grasses on sprayed plots and yields of grasses from plots sprayed for two consecutive years were higher than from plots sprayed only during the first growing season. Crested wheatgrass and Russian wildrye produced more herbage on unsprayed plots than did the other grasses studied.

It is concluded that crested wheatgrass and Russian wildrye are better adapted to low rainfall areas and compete more effectively with halogeton than tall, pubescent, or intermediate wheatgrasses.

Control of halogeton during the first growing season aided grasses in producing relatively deep root systems, but when control was extended for two growing seasons even deeper root systems resulted. In most respects, little difference in number and spread of roots for seeded grasses could be noted between sprayed and unsprayed areas.

In most cases soil moisture was higher in sprayed plots. These differences were present during the third year even though halogeton was controlled only for the first two years.