Competition Between Russian Wildrye Seedlings and Four Common Weeds

D. LYNN DRAWE AND I. G. PALMBLAD

Highlight: Russian wildrye was tested in the greenhouse for both interspecific and intraspecific competition using various densities of Russian wildrye, alone and in combination with cheatgrass, peppergrass, Russian thistle, and halogeton. With Russian wildrye alone, production and vigor first increased as plant density increased, then decreased at the highest density tested. Under interspecific competition, both survival and production were reduced at all weed densities tested. Combinations of species were more adverse to vigor and production of Russian wildrye than were single species of weeds.

Russian wildrye (*Elymus junceus* Fisch.) is a long-lived perennial bunchgrass introduced into North America from Siberia by the University of Saskatchewan in 1926 (Lawrence and Heinrichs 1966). It is now widely distributed throughout the Northern Great Plains and Intermountain Region.

Russian wildrye does well in the Northern Great Plains; but even though it is recommended for reseeding foothill ranges in the Intermountain area (Plummer et al. 1955), there are problems with its establishment in such habitats. Greenhouse studies of inter- and intraspecific competition with Russian wildrye were conducted to help ascertain why the species might be difficult to establish.

The fact that Russian wildrye is difficult to establish was noted by Lawrence and Heinrichs (1966) and by Cook (1966). Because Russian wildrye seedlings develop slowly, Canadian workers recommend control of weeds with cultivation or herbicides before seeding. Cook (1966) observed that seedlings of Russian wildrye were frail and subject to high mortality.

Research on interspecific competition with Russian wildrye is limited. Lawrence (1967) reported that wheat (*Triticum* spp.) sown at various spacings in rows parallel or at right angles to rows of Russian wildrye significantly reduced seed yields and seedling vigor of Russian wildrye the first 2 years. Russian wildrye seed yields decreased as wheat density increased.

Evans (1961) and Hull (1963) suggested that cheatgrass is more efficient in extracting soil moisture than are wheatgrasses. Hunt (1962) found that Russian wildrye produced less forage and used more water to produce a gram of dry matter than did intermediate wheatgrass (*Agropyron intermedium* (Host) Beauv.)

Methods and Procedures

Three greenhouse experiments were conducted. During these experiments, light, temperature, and humidity regimes were standardized to simulate field conditions and kept as comparable as possible across experiments.

Experiment #1: Competition Between Russian Wildrye and Four Weeds

Interspecific competition between Russian wildrye and cheatgrass (*Bromus tectorum* L.), Russian thistle (*Salsola kali* L.), halogeton (*Halogeton glomeratus* Bieb.) C. A. Meyer), and peppergrass (*Lepidium perfoliatum* L.) was studied in the greenhouse during winter 1968. A factorial randomized block design with four replications was used. Russian wildrye and four weed species were planted in 12″ × 10½″ × 12″ pots in sandy loam soil under both saline and nonsaline conditions. Russian wildrye was thinned to two plants per pot and the weeds were thinned to 0, 2, 10, and 50 plants per pot. The study was conducted under moisture conditions that were well below field capacity at all times to simulate moisture conditions found in the Intermountain Region.

Data collected for Russian wildrye seedlings included seedling emergence, vegetative dry weight per plant, average number of

During the research, authors were graduate research assistant, Range Science Department, and associate professor, Biology Department, Utah State University, Logan 84322. Drawe is now assistant dirctor, Welder Wildlife Foundation, Sinton, Texas.

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vegetative stems per plant, and average stem height per plant. All pots with saline soil were removed early in the experiment because of difficulty in keeping this soil properly watered.

Experiment #2: Competition Between Russian Wildrye and Combination of Weeds

During summer 1968 a study was conducted in which combinations of three weedy species were placed in competition with Russian wildrye. Watering was the same as that in the previous study. Only nonsaline soil was used. Four replications of each treatment were used. Treatments were: (1) cheatgrass, Russian thistle, and peppergrass at 2, 10, and 50 plants per pot; (2) cheatgrass plus Russian thistle, cheatgrass plus peppergrass, and Russian thistle plus peppergrass at 1, 5, and 25 plants of each species of the combination per pot; (3) cheatgrass plus Russian thistle plus peppergrass at 1, 4, and 17 plants of each species of the combination per pot; and (4) controls with 25 Russian wildrye per pot. Halogeton was not used because of prior difficulties in maintaining desired densities. Twenty-five Russian wildrye seeds were planted in a row across each pot in all teatments.

After 2 weeks, emergence data were taken. Final data collection was made in September. Measurements similar to the previous study were taken for Russian wildrye and the weedy species.

Experiment #3: Replacement Series and Intraspecific Competition

A study was conducted during spring, 1969, to determine intraspecific and interspecific competition with Russian wildrye and four weeds, using DeWit's replacement series described by Palmblad (1966). The replacement series consists of placing two species in competition and varying numbers of plants of each species while holding constant the number of plants per unit area. Treatments were combinations of Russian wildrye and either cheatgrass, halogeton, peppergrass, or Russian thistle as follows: (1) 0 Russian wildrye plus 50 weeds, (2) 13 Russian wildrye plus 37 weeds, (3) 25 Russian wildrye plus 25 weeds, (4) 37 Russian wildrye plus 13 weeds, (5) 50 Russian wildrye plus 0 weeds, and for baseline comparisons, (6) one Russian wildrye plant, and (7) one weed plant. In addition, Russian wildrye alone was planted at 1, 13, 25, 37, and 50 plants per pot.

A randomized block design was used with three replications and three samples per replication. Gallon sized cans were used for pots. Nonsaline sandy-loam soil was used. Data collection for all species in each pot was made after weed maturity for plant height, leaf length, number of leaves per tiller, number of tillers per plant, and weight of above-ground dry matter per pot.

Results

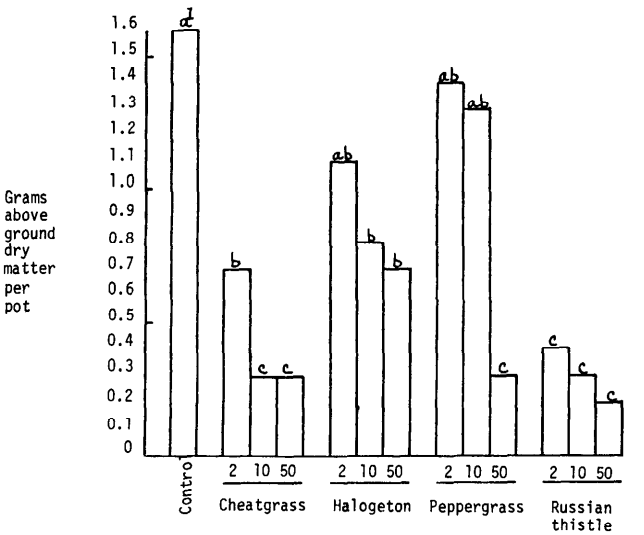
Experiment #1: Competition Between Russian Wildrye and Four Weeds

Salinity significantly reduced emergence of Russian wildrye from 77% on nonsaline to 33% on saline soils, and plant height from 18.3 cm on nonsaline soils to 11.6 cm on saline soils. Differences between other treatments were not apparent until the second data collection.

Russian thistle and cheatgrass caused greatest reductions in production of Russian wildrye (Fig. 1). Peppergrass at 2 and 10 plants per pot only slightly reduced production of Russian wildrye. Halogeton appeared not to be a severe competitor, but due to difficulty in maintaining the desired number of halogeton plants in each pot, these figures may not be representative. At 50 plants per pot, cheatgrass, peppergrass, and Russian thistle all reduced Russian wildrye production 90% or more.

Russian wildrye production was reduced to 50%, 33%, and 17% of that for controls by competition from 2, 10, and 50 weeds, respectively, when averaged over species.

Plant height was reduced significantly by competition from 50 weed plants (Table 1). Reductions in leaves per tiller, tillers per plant, and leaf length were not as drastic, but tillering was reduced significantly by all densities of weeds.



[1]A significant ($P < 0.05$) difference occurs between two means not followed by the same letter.

Fig. 1. *Production of Russian wildrye after 3 months growth when placed in competition with four weeds at 2, 10, and 50 plants per pot under greenhouse conditions.*

Cheatgrass and Russian thistle had the greatest effect on vigor of Russian wildrye (Table 2). Height of Russian wildrye was reduced most by cheatgrass competition. Tillering was reduced 50% by cheatgrass and Russian thistle competition, and was reduced significantly by peppergrass and halogeton competition. Peppergrass and halogeton had least effect on vigor of Russian wildrye.

Experiment #2: Competition Between Russian Wildrye and Combinations of Weeds

Combinations of two and three species caused greatest reductions in above-ground, dry matter production (Fig. 2) and vigor of Russian wildrye (Table 2). Russian thistle and cheatgrass were the most severe competitors in single species stands with Russian wildrye. Production of Russian wildrye was reduced

Table 1. Average vigor measurements of Russian wildrye seedlings growing alone and in competition with cheatgrass, halogeton, peppergrass, and Russian thistle. Data are average of all pots in each density class.

Treatment	Plant height (cm)	No. leaves/ tiller	No. tillers/ plant	Leaf length (cm)
Experiment No. 1[1]				
No weeds	23.3	4.0	5.2	19.3
2 weed plants	21.0	3.6	4.0	17.2
10 weed plants	19.5	3.5	3.3	16.9
50 weed plants	18.1	3.3	2.5	15.5
Experiment No. 2[1]				
No weeds	18.9	4.2	4.1	14.8
2 weed plants	14.9	4.3	2.4	11.7
10 weed plants	14.0	4.2	1.8	11.0
50 weed plants	12.3	3.8	1.4	9.8
Experiment No. 3— Replacement Series[2]				
13 – 37[3]	13.7	5.0	1.1	11.0
25 – 25	13.4	5.1	1.0	10.8
37 – 13	12.5	5.0	1.0	10.1
13 – 0	15.6	5.0	2.5	13.2
25 – 0	11.6	5.0	1.3	10.0
37 – 0	13.2	5.0	1.0	10.8

[1] Experiments 1 and 2 used 0.96 ft² pots.
[2] Experiment 3 used 6-inch diameter pots.
[3] Number of Russian wildrye plants followed by number of weed plants.

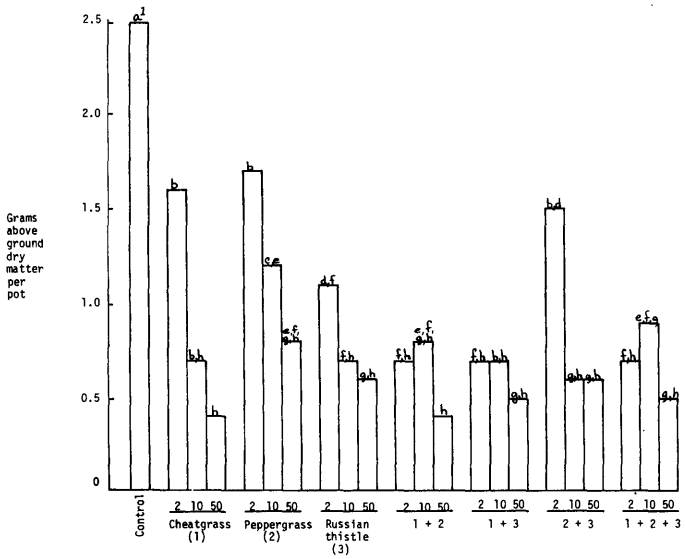
Table 2. Average vigor measurements of Russian wildrye seedlings grown alone and in competition with each of four weed species or combinations thereof. Data are averages of density classes in each experiment.

Treatment	Russian wildrye vigor measurements			
	Plant height (cm)	No. leaves/ tiller	No. tillers/ plant	Leaf length (cm)
Experiment No. 1[1]				
No weeds	23.3	4.0	5.2	19.3
Cheatgrass	17.4	3.2	2.4	14.7
Halogeton	20.5	3.6	3.9	17.0
Peppergrass	21.8	3.8	3.9	18.2
Russian thistle	19.1	3.2	2.7	16.2
Experiment No. 2				
No weeds	18.9	4.2	4.1	14.8
Cheatgrass (1)	14.1	3.9	2.0	11.3
Peppergrass (2)	15.3	4.5	2.3	12.4
Russian thistle (3)	13.6	4.1	1.8	10.7
1 + 2	13.3	4.1	1.7	10.6
1 + 3	13.6	4.1	1.5	10.2
2 + 3	13.6	4.3	2.0	10.9
1 + 2 + 3	12.7	3.9	1.7	9.6
Experiment No. 3— Replacement Series[2]				
No weeds	13.5	5.0	1.6	12.6
Cheatgrass	10.3	5.0	1.0	7.7
Halogeton	17.2	5.2	1.2	14.3
Peppergrass	12.8	5.2	1.0	9.9
Russian thistle	12.2	4.9	1.0	10.1

[1] Experiments 1 and 2 used 2, 10, and 50 weed plants and 2 Russian wildrye plants in 0.96-ft^2 pots.
[2] Experiment 3 used varying densities of Russian wildrye and weed plants in 6-inch diameter pots.

61% by competition with two species, and 72% by competition with three species of weeds. Combinations containing cheatgrass caused the greatest reductions in above-ground, dry matter production. Peppergrass and Russian thistle combined at two plants per pot caused less reduction in production than Russian thistle alone at the same density.

Plant height and leaf length were reduced by competition from 50 weed plants (Table 1). Tillers per plant were reduced to 50% and 33% of that for controls by competition from 2 and 50 plants, respectively.



[1] A significant ($P<0.05$) difference occurs between two means not followed by the same letters.

Fig. 2. *Production of Russian wildrye when placed in competition with three weed species and combinations of weed species at densities of 2, 10, and 50 plants per pot in the greenhouse.*

Experiment #3: Interspecific Competition Using the Replacement Series

Russian wildrye alone produced significantly more herbage than when grown with a weed (Table 3). The most severe reduction in production, 75%, was caused by cheatgrass. Halogeton, peppergrass, and Russian thistle caused 37%, 37%, and 19% reductions in Russian wildrye production, respectively. At 37 plants per pot, Russian wildrye in competition with 13 Russian thistle plants produced more than 50 Russian wildrye plants alone. These findings result from the similar rates of root growth and root growth patterns of Russian wildrye and cheatgrass during the seedling stage (Drawe 1970). Halogeton and peppergrass tended to put out a greater mass of roots earlier in the upper soil layers, and Russian thistle put down a tap root more rapidly with less elaboration of roots in the upper soil layers.

Table 3. Above-ground, dry matter production (g) of Russian wildrye in competition with four weeds in the greenhouse, using the replacement series.

Species	Number of plants				Average
	50 – 0[1]	37 – 13[1]	25 – 25[1]	13 – 37[1]	
Control[2]	1.5	2.0	1.4	1.4	1.6^{a_3}
Cheatgrass		0.7	0.4	0.2	0.4^{d}
Halogeton		1.1	1.1	0.9	1.0^{c}
Peppergrass		1.3	1.0	0.8	1.0^{c}
Russian thistle		1.7	1.3	0.8	1.3^{b}
Average	1.5	1.2^{x_3}	1.0^{x}	0.7^{y}	

[1] Number of Russian wildrye plants followed by number of weed plants.
[2] Number of Russian wildrye indicated, with no weeds.
[3] A significant difference ($P<0.05$) occurs between two means not followed by the same letter.

More reliable data were obtained on halogeton competition in this experiment because densities of halogeton were maintained as prescribed in the methods section. Plant height, leaf length, and number of leaves per tiller were greater on Russian wildrye plants grown in competition with halogeton than with no weed plants at all (Table 2).

Increased weed plant density resulted in increases in Russian wildrye plant height and leaf length, thus making a thinner, less robust plant that resulted in lower total weight (Table 1). When compared to the controls without weeds, however, marked decreases occurred on all vigor measurements except leaves per tiller, indicating that competition reduced Russian wildrye plant vigor and production per plant decreased with increased weed plant density.

Discussion

Effect of Density

There was an inverse relationship between weed plant density and vigor of Russian wildrye. The effect of weed plant density was apparent from all competition studies. Production and vigor of Russian wildrye were reduced as weed plant density increased. Increased weed plant density reduced production of Russian wildrye in the replacement series but resulted in a taller, more elongated plant.

Effect of Species

Russian wildrye was a strong competitor with itself. Optimum production was obtained at a density of 37 plants per 6-inch pot. However, production per plant was optimum at one plant per pot and declined sharply with the slightest increase in density.

The combination of three weed species caused greatest reductions in vigor of Russian wildrye. Combinations of two weed species caused more reduction in vigor than any single species at the same density. As single species, Russian thistle caused greatest reduction in vigor of Russian wildrye, cheatgrass caused the next greatest reduction, and peppergrass caused least reduction in vigor.

Field Application

Data obtained in these studies reemphasize that, with intensive use of the land, careful attention must be paid to effects of weed competition during the establishment phase of a crop. This investigation was directed at the problems involved with establishment of Russian wildrye on foothill ranges in Utah. One problem with establishment of these frail seedlings is weed competition. The importance of a weed-free seedbed was pointed out through these greenhouse studies.

Competition from any of the four common Intermountain weed species tested can cause reductions in Russian wildrye survival. Since a combination of weed plants caused greatest damage to Russian wildrye establishment, a weed-free seedbed is necessary for successful establishment of the plant on Intermountain ranges. Use of a preemergence herbicide is expensive, but perhaps less expensive than the loss of a complete seeding from weed competition. Use of a broad-leaf weed killer after planting is precluded because of susceptibility of young Russian wildrye seedlings to these herbicides and their ineffectiveness on cheatgrass.

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