Competition and Water Requirements of Cheatgrass and Wheatgrasses in the Greenhouse[1]

A. C. HULL, JR.

Range Conservationist, Crops Research Division Agricultural Research Service, U. S. Department of Agriculture, Logan, Utah

Cheatgrass (*Bromus tectorum L.*), a vigorous, introduced annual, covers millions of acres of abandoned cropland and depleted rangeland. Although cheatgrass provides considerable livestock feed, it varies greatly in production, dries up early, and is a fire hazard (Hull and Stewart, 1948). Plant hosts of the beet leafhopper such as Russian thistle (*Salsola kali* L. var. *tenuifolia* Tausch) occupy cheatgrass areas following mechanical or biological disturbances and fire (Piemeisel, 1938). Stewart and Hull (1949) stated that crested wheatgrass (*Agropyron desertorum* (Fisch.) Schult.) once established, restricted cheatgrass growth. Because cheatgrass competes with perennial grass seedlings it must be reduced for successful range seedings.

Dillman (1931) determined the water requirement of crested wheatgrass and many other species in North Dakota. The weighted mean water requirement of crested wheatgrass was 853. Some other species for comparison were Russian thistle 224, smooth brome (*Bromus inermis* Leyss.) 784, and western wheatgrass (*Agropyron smithii* Rydb.) 1,183.

Hunt (1962) obtained significant differences in water requirements of genotypes of in-

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termediate wheatgrass (*Agropyron intermedium* (Host) Beauv.) and Russian wildrye (*Elymus junceus* Fisch.). Intermediate wheatgrass had a lower water requirement and produced more forage than did Russian wildrye.

Keller (1953) found that orchardgrass (*Dactylis glomerata* L.) genotypes high in herbage yields were low in their water requirements and visa versa. Keller (1954) advised adhering to a single technique in water-requirement studies.

In the greenhouse Evans (1961) grew 18 plants of crested wheatgrass and four, 16, 64, and 256 plants of cheatgrass in containers one foot square and four feet deep. Cheatgrass at densities of 64 and 256 plants severely curtailed shoot and root growth and greatly increased mortality of crested wheatgrass. With 18 crested wheatgrass plants and 256 cheatgrass plants, soil moisture was depleted to 15 bars suction in nine weeks. The crested wheatgrass ceased growth after eight weeks and the cheatgrass after ten. These results suggest that cheatgrass is more efficient in the extraction of soil water or has greater drought resistance than crested wheatgrass.

The competitive ability of cheatgrass has been blamed for many unsuccessful crested wheatgrass seedings on cheatgrass-infested lands. The present study was to determine water requirements and some competitive relations of cheatgrass and wheatgrasses.

Procedures

Four studies with cheatgrass and wheatgrasses were carried out in the greenhouse:

1. Competition among different combinations of numbers of cheatgrass and crested, Fairway (*Agropyron cristatum* (L.) Gaertn.), and siberian (*A. sibiricum* (Willd.) Beauv.) wheatgrass seedlings grown in gallon cans with eight replications.
2. Same as study 1 except different seedling combinations of cheatgrass and crested wheatgrass.
3. Water use of cheatgrass and crested wheatgrass in different combinations in gallon cans with eight replications.
4. Top and root growth of cheatgrass and crested wheatgrass in different combinations in glass-faced boxes with three replications.

Soil was dried on greenhouse benches and 3,740 grams put in each can. The percent moisture was ascertained and thereafter water was added after weighing each can to determine water needs. Gypsum moisture blocks in some cans also helped determine moisture potential. Enough water was added to keep the plants growing well, but drainage was avoided.

The soil was a sandy loam obtained near Bliss, Idaho, with the following characteristics:

pH (paste)	7.3
Sat. ext. (EC x 10^3)	1.0
Organic matter (percent)	1.1
P_2O_5 lbs/A	114.0
Moisture (percent)	
Saturation	38.0
⅓ atm.	15.6
15 atm.	7.3

Seeds were pregerminated and put in cans or boxes and covered with one-fourth inch of soil. Cheatgrass commenced germination in two days and germinated 100 percent in four days. The wheatgrasses started to germinate in four days and reached 80 percent in eight days. To get all seedlings started growing at the same time, germination of the wheatgrasses was started two days earlier than that of cheatgrass.

A plastic sheet was placed over all cans and boxes for three days after seeding to reduce water loss. Cans had a surface area of 0.20 square feet and boxes 0.24 square feet. Cans and boxes were rotated weekly. A board as high as the cans shaded the outer rows. Air temperatures at the plant level ranged from 60° to 88° F. during the day and 38°

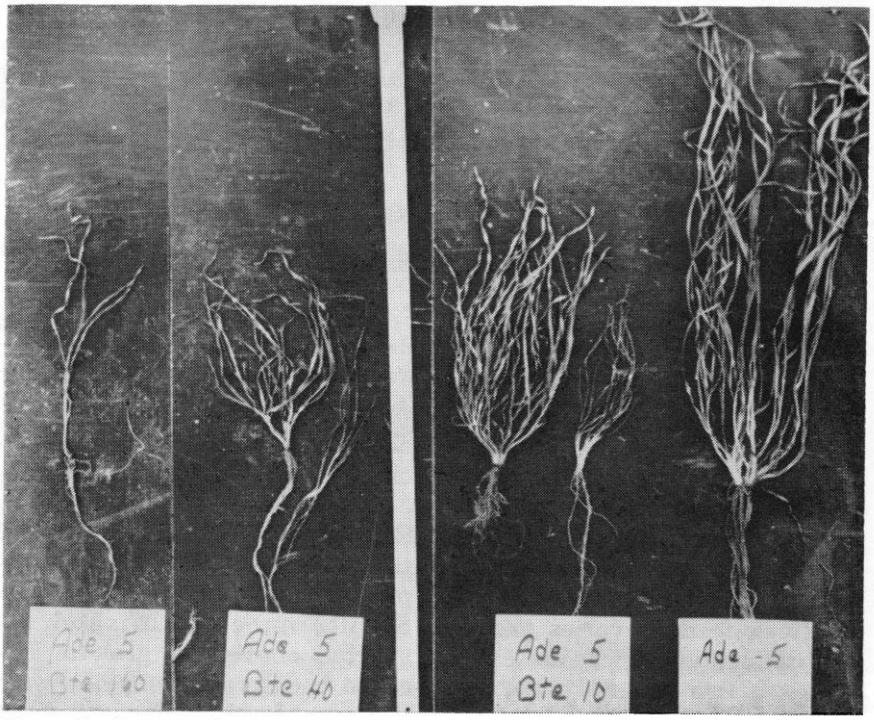

FIGURE 1. Top growth of plants from different combinations in the plant-competition study. The entire roots are not shown. Crested wheatgrass (Ade) is on the right and cheatgrass (Bte) on the left in the three combinations. Numerals represent the number of plants per can.

Table 1. Air-dry weight of tops and roots and water requirements for cheatgrass and wheatgrasses in competition and water-requirement studies.

Number of plants		Air-dry weight of tops			Water requirement
Wheatgrasses	Cheatgrass	Wheatgrass	Cheatgrass tops	All roots	
			(Grams)		(Grams water/ grams herbage)
1. **Competition study**					
5	0	3.9a[1]	-	5.1a	836a
5	10	.6b	7.5a	14.0b	436b
5	40	.4bc	8.0a	20.3c	502b
5[2]	40	.4bc	8.0a	21.4c	498b
5[3]	40	.4bc	7.8a	21.2c	537b
5	160	.2c	7.9a	21.9c	527b
2. **Competition study**					
10	0	4.9a	-	9.1a	818a
8	10	1.0b	7.4a	18.7b	486b
5	20	.4c	7.5ab	18.2b	519b
2	30	.1c	9.3bc	18.9b	450b
0	40	-	10.1c	17.7b	445b
3. **Water-requirement study**					
5	0	4.6a	-	4.8a	582a
5	5	1.5b	6.2a	10.0b	417b
0	5	-	8.1b	10.9b	385b

[1]A highly significant (one percent) difference exists between two means not followed by the same letter.

[2]*Agropyron cristatum* and [3]*A. sibiricum*. All other wheatgrasses are *A. desertorum*.

to 58° F. at night during the study.

When seedlings in the water-use study were one inch high, the soil surface was covered with one-half inch of fine gravel to reduce evaporation. The cans were then covered with a plastic sheet, perforated for each plant. However, the plastic caused heat damage and was removed after three days. A row of alfalfa plants in gallon cans and clipped to the same height as the grass plants formed a buffer strip for the outer rows.

Studies were begun February 27, 1961. Heights were measured weekly. By mid-April top and root growth had ceased in cans which had a high density of cheatgrass plants. Studies were ended on April 26 before roots commenced dying. Soil was carefully washed from the roots and air-dry weights of tops and roots were obtained. Significance of results at the one-percent level was determined by Duncan's (1955) multiple range test.

Results

Competition Between Cheatgrass and Three Wheatgrasses

Each treatment had five wheatgrass plants growing with 0, 10, 40, or 160 cheatgrass plants (Table 1). Only crested wheatgrass was grown alone and with ten cheatgrass plants. Five crested wheatgrass plants growing alone produced 3.9 grams of herbage but in competition with 10 cheatgrass plants only 15 percent of that amount was produced (Figure 1). Roots could not be accurately separated, but by observation cheatgrass competition reduced wheatgrass root yield as much as it reduced top yield. Differences in growth and water use among crested, fairway, and siberian wheatgrasses growing in competition with 40 cheatgrass plants were not significant.

Cheatgrass used water more efficiently than the wheatgrasses. Since there was more exposed soil in the wheatgrass cans there may have been slightly greater evaporation which would have increased the water requirement. Water requirement is the weight of water used divided by the weight of herbage produced. Soil in cans with no plants and no gravel cover used 24 to 33 percent as much water as soil with plants and no cover.

Competition Between Cheatgrass and Crested Wheatgrass

Results were similar to those in study 1. As cheatgrass plant numbers increased, the yield of crested wheatgrass decreased. Crested wheatgrass growing with 0, 10, 20, and 30 cheatgrass plants per can yielded .49, .13, .08, and .04 grams of herbage per plant. Cheatgrass used 54 percent as much water as did crested wheatgrass.

Water Use by Cheatgrass and Crested Wheatgrass

Five plants each of cheatgrass and crested wheatgrass were grown alone and in combination (Table 1). Five plants of crested wheatgrass without cheatgrass produced 4.6 grams, three times

Table 2. Top and root yields and growth of cheatgrass and crested wheatgrass in glass-faced boxes.

Number of plants		Air-dry weight			Root length	
Wheatgrasses	Cheatgrass	Wheatgrass tops	Cheatgrass tops	All roots	Wheatgrass	Cheatgrass
			(Grams)		(Inches)	
10	0	4.9a[1]	—	7.0a	16.7a	—
10	10	.9b	4.6a	9.9ab	16.1ab	28.2a
10	80	.2b	7.0a	12.3bc	12.2bc	30.2a
10	640	.1b	13.0b	13.0c	9.3c	28.9a

[1]A highly significant (one percent) difference exists between two means not followed by the same letter.

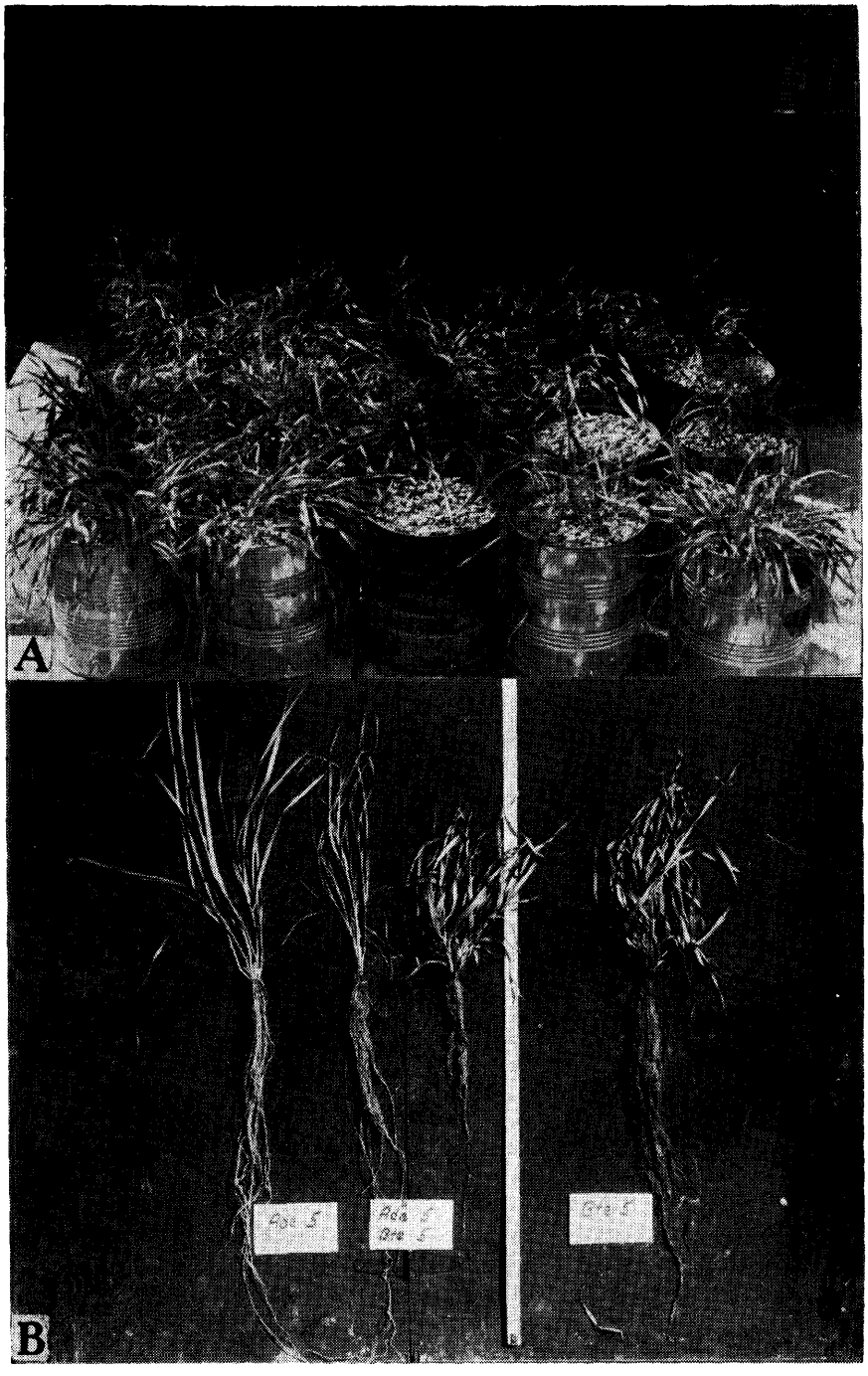

FIGURE 2. A. General view of water-use study with border rows of alfalfa removed. B. Typical top growth of plants. The entire roots are not shown. Crested wheatgrass (Ade) on left. Cheatgrass (Bte) on right. Numerals represent the number of plants per can.

as much herbage as five plants competing with five plants of cheatgrass. Crested wheatgrass produced 43 percent less top growth and 56 percent less root growth than cheatgrass (Figure 2).

Cheatgrass required 66 percent as much water to produce a gram of dry matter as did crested wheatgrass. Evaporation from soil in cans with a one-half inch gravel cover and no plants was ten percent that of the combined use and loss from soil with a gravel cover and plants. Evaporation was ignored in calculating water requirements.

Top and Root Growth of Cheatgrass and Crested Wheatgrass

Ten plants of crested wheatgrass were grown with 0, 10, 80, and 640 cheatgrass plants in 2 x 17 x 36-inch glass-faced boxes (Table 2). Ten plants of crested wheatgrass yielded 4.9 grams of tops. Ten plants of crested wheatgrass growing with ten plants of cheatgrass yielded 0.9 gram of tops. Increasing cheatgrass plants to 80 and 640 per box further reduced wheatgrass yields.

Root length of wheatgrass plants decreased significantly as the number of cheatgrass plants increased. Cheatgrass roots elongated more rapidly and were longer, finer, and spread wider than wheatgrass roots (Figure 3).

Discussion

Cheatgrass is a severe competitor with other grasses. Even a small number of cheatgrass plants reduced growth of wheatgrass to between 1/7 and 1/3 of that produced without cheatgrass. Cheatgrass is also a strong competitor with itself. Increasing plant numbers decreased the weight of individual plants. Where cheatgrass numbered 10, 40, and 160 plants per can, individual plants weighed .75, .20, and .05 grams.

Cheatgrass seeds germinated more rapidly and the tops and roots elongated faster than those of crested wheatgrass. It could thus compete severely with crested wheatgrass for light and moisture. Cheatgrass roots occupied a wider and deeper soil area and the roots were finer with more roots for a given weight than for crested wheatgrass. Cheatgrass could thus absorb water and plant nutrients from a larger soil volume than could crested wheatgrass seedlings. Studies by Evans (1961) suggested that cheatgrass is more efficient in the extraction of soil water than crested wheatgrass.

In the water-requirement study crested wheatgrass re-

quired 582 grams of water to produce a gram of dry matter. Cheatgrass required 385 grams or 66 percent as much as crested wheatgrass. Efficiency in water use or water extraction might make a major difference in plant growth and competition. In the competition studies crested wheatgrass required 836 and 818 grams to produce a gram of dry matter. The lower amount of 582 grams in the water-requirement study was undoubtedly the result of a half-inch gravel layer on top of the soil. Mulches and shading by plants reduce evaporation from the soil surface, which in turn may be of great importance to plants competing for soil water.

Summary

Cheatgrass, a vigorous annual, is a strong competitor with perennial grass seedlings and often causes failures of range seedings. Cheatgrass and three wheatgrasses were grown together in gallon cans and in glass-faced boxes in the greenhouse. The shoots and roots of cheatgrass elongated more rapidly than those of crested wheatgrass. Also cheatgrass roots were finer, spread more, and occupied the soil mass more completely than did crested wheatgrass roots.

Cheatgrass grown in varying densities with wheatgrasses reduced the top growth of wheatgrass to between 1/7 and 1/3 of that produced without cheatgrass. Although roots were not separated, the root growth of the wheatgrasses appeared to have been reduced by a similar amount.

Cheatgrass produced up to twice as much top growth and required only 66 percent as much water to produce a gram of dry matter as did crested wheatgrass.

Differences in top and root growth and water use among the three wheatgrasses growing with cheatgrass were not significant.

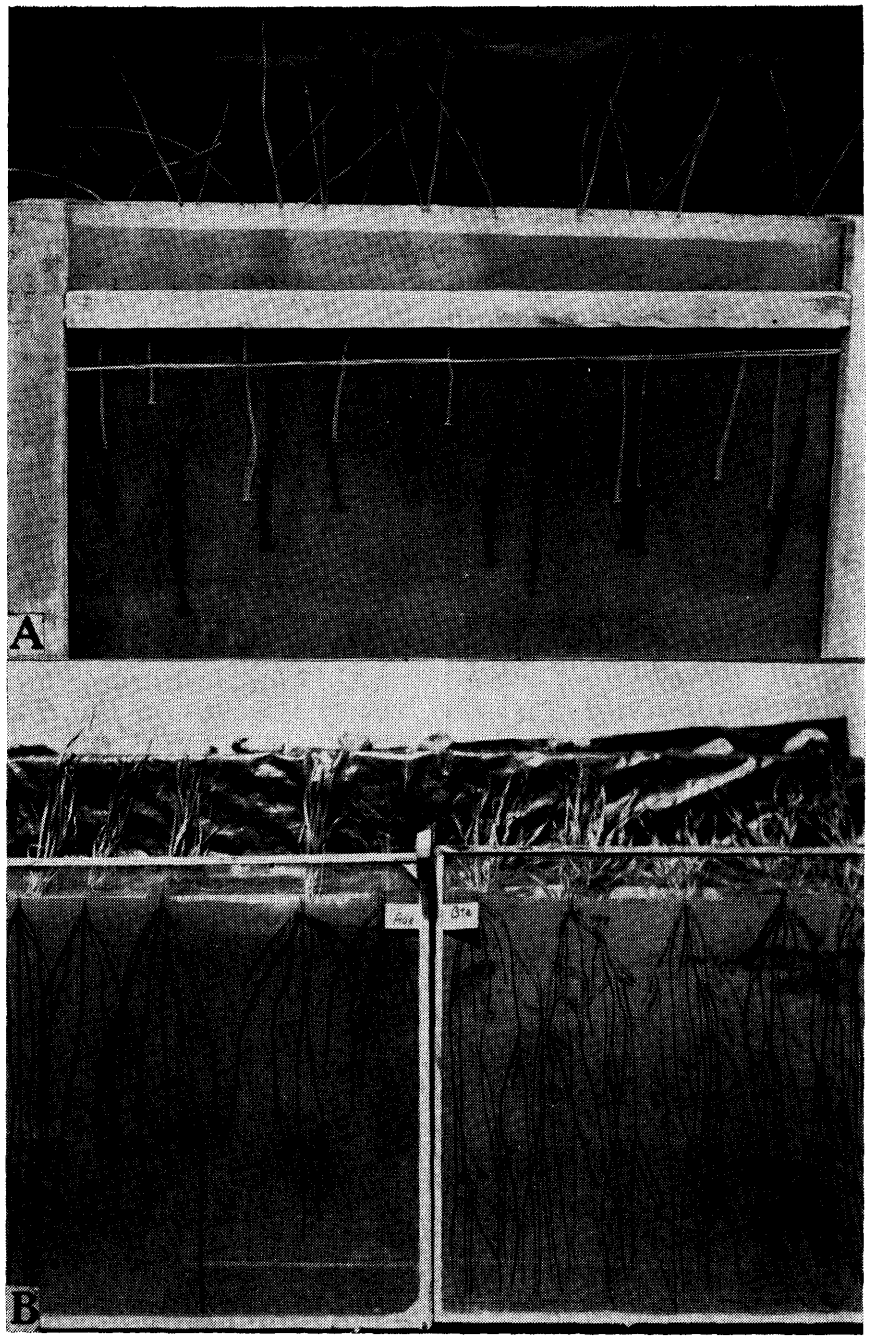

FIGURE 3. Cheatgrass roots elongate more rapidly and spread more than wheatgrass roots. A. Cheatgrass (dark crayon) and wheatgrass eight days after planting pregerminated seed. B. Left—five plants of wheatgrass (Ade); right—five plants of cheatgrass (Bte) 41 days after planting.

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