# Cheatgrass and Its Relationship to Climate: A Review

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# CHEATGRASS AND ITS RELATIONSHIP TO CLIMATE: A REVIEW

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No annual grass species has received more attention from ranchers, range managers, and researchers than cheatgrass or downy brome (Bromus tectorum L.). Symposia have been devoted to the species (Bureau of Land Management, 1965) as have extensive reviews (Klemmedson and Smith, 1964). Cheatgrass arrived in the West in the late 1890s, and has become well established in all states. It filled a void caused by overgrazing which reduced and removed desirable perennials and today is the dominant species on thousands of acres of rangelands. Its widespread occurrence and relative abundance in many plant communities cause cheatgrass to be viewed both positively and negatively. This review highlights research studies and observations of cheatgrass related to climate to show why the species became so well established and why it probably will remain so.

In general, there are two types of annual plants, summer annuals and winter annuals. Summer annuals germinate in spring, make most of their growth during summer, and mature and die in the fall. Winter annuals germinate in fall or winter and usually mature seed in spring or early summer before the plants die (Klingman and Ashton, 1975).

Cheatgrass has become widely established throughout the United States and is especially abundant in the upper Great and Columbia Basins (Young et al., 1969). In Oregon, cheatgrass is dominant on about 10 million acres (Platt and Jackman, 1946). Cheatgrass usually is a winter annual but may act as a spring annual if too little fall moisture is available for germination (Stewart and Hull, 1949). It is the most abundant forage plant on many spring ranges and perhaps contributes more feed for livestock than any other range species during this period (Cook and Harris, 1952).

Ranges supporting annual grasses show considerable variation in forage production from year to year because of weather fluctuations. Bently and Talbot (1951) found production of air dry herbage from annual grasses and grass-like plants ranging from 390 to 1,400 pounds per acre over a 13-year period on the annual grasslands of the San Joaquin Experimental Range in central California. Hull (1949) reported cheatgrass yields ranging from 361 to 3,461 pounds per acre in Idaho. This represented a nine-fold variation in yield. At Oregon State University's Squaw Butte experimental range in Harney County, cheatgrass production in an average year was 260 pounds per acre. In the drought years of 1968 and 1977, it was 15 and 14 pounds (Sneva, 1969, 1979). These represent at least a 17-fold variation between the low and average production. Murray and Klemmedson (1968) found a three-fold increase in grazing capacity between poor and good forage years on southern Idaho cheatgrass range. Talbot et al. (1939), using the product of height and percent cover as an index of forage volume, estimated herbage production to be 193 times greater in 1935 than 1934 in California's annual vegetation. In contrast to these observations, Fleming et al. (1942) indicated that cheatgrass in Nevada was a more dependable forage source than Idaho fescue, Sandberg bluegrass, or bluebunch wheatgrass despite significant variations in amount and distribution of rainfall.

Many authors have correlated weather parameters to production of annuals. Murphy (1970) reported that initiation of fall growth on California's annual grasslands was dependent upon the first half inch of effective fall precipitation. He said yield was influenced by the amount of precipitation received by the third week in November and that by then, it could be determined whether the expected annual production would be low, medium, or high ($r = .70$). Duncan and Woodmansee (1975) found annual grass production best correlated with October, December, and May precipitation ($r = .67$). They surmised that precipitation must be adequately distributed throughout the key growing periods to insure abundant forage yields. This corresponded with Bently and Talbot's (1951) observation that growth of annuals depended more on rainfall distribution during critical growth periods than on total annual rainfall.

Hufstader (1976), using precipitation as the independent variable, found significant correlations with yields of several annual species. He felt that there were several factors operating during fall and winter which limited annual grassland production, but that water was most crucial for dominant species. Sneva (1971) found cheatgrass in Oregon showing positive correlations to September-November and March-June precipitation. In addition, there were negative correlations to February-April and May temperatures. These four variables accounted for 92 percent of the variation in yield.

Utilization of forage during the growth period also affects total production (Klemmedson and Smith, 1964). Hulbert (1955) determined that cheatgrass plants clipped five times from April 21 to June 23 produced only 45 percent of their unclipped potential. Fleming et al. (1942), however, found regrowth exceeding original growth when cheatgrass was clipped in the dough stage. This was mainly attributed to ample moisture during the regrowth period.

Germination of seed also affects productive potential in a given season. Under optimum conditions, germination as high as 99.5 percent has been reported for freshly harvested caryopses (Hulbert, 1955). Wilson et al. (1974) proposed that the longer the seed's exposure to field conditions, the more rapid the subsequent germination. Young et al. (1969) found that given years of above average precipitation and desirable distribution of spring precipitation, a larger percentage of cheatgrass caryopses germinated than during years of below normal precipitation. They also noted that relatively small differences in precipitation amounts and distribution can result in large differences in the periodicity of cheatgrass germination and population density.

Piemeisel (1938, 1951) observed that germinated cheatgrass may fail to survive a warm, dry period in late autumn. Harris (1967) observed a similar occurrence in eastern Washington. Young et al. (1969) documented spring mortality of cheatgrass following low precipitation after March. They also noted that in years of severe moisture stress, the mean caryopsis production per plant may drop below one. According to Hulbert (1955), cheatgrass requires vernalization if flowering is to be normal. Panicles produced by spring plantings were only a fraction of the number produced by fall plantings. Stewart and Hull (1949) found that cheatgrass plants are capable of setting sufficient seed to insure plants for the following year. Indeed, mature cheatgrass plants with fully developed seed stalks, but with a total height of only 1 1/4 inches, have been observed during severe spring growing conditions (Klemmedson and Smith, 1964). In addition, investigations have shown that viable cheatgrass seeds may persist in the soil for more than one season (Finnerty and Klingman, 1962; Young et al., 1969; Hull and Hansen, 1974). Seed production normally is high so even with more than 99 percent germination of fresh seed some remained ungerminated. Thus, survival of the species is assured despite an occasional poor growth year.

An additional cheatgrass survival mechanism is the plant's response to reductions in density or intra-specific competition. Hulbert (1955) demonstrated that low density populations produced more caryopses than more dense populations. Increases were credited to more fertile florets per spikelet, more spikelets per inflorescence, and a greater number of tillers per plant. Low density plantings also were capable of depleting soil moisture to the same degree and with the same rapidity as high density plantings. He also found that plants growing in higher densities matured earlier. Harris (1967) and Fleming et al. (1942) observed that on droughty sites, cheatgrass may produce a single culm, 2 to 4 inches tall, bearing a single spikelet. On better sites, where there were no apparent limiting factors, an individual plant may produce 15 or more culms, each 20 to 30 inches tall, and bear hundreds of spikelets per culm (Harris, 1967).

Cheatgrass appears to be quite efficient in absorbing soil moisture within its rooting zone, and is especially competitive with seedlings of other species. One of its competitive assets is its rate of root development (Hironaka, 1961; Hull, 1963). By the time spring emergence of perennial species occurs, annual grasses have their root systems well advanced towards full development (Hironaka, 1961). With fall germination, cheatgrass roots begin growth at a more rapid rate than bluebunch wheatgrass and continue growth all winter (Figure 1). Soil temperatures average from two to three degrees warmer at cheatgrass root tips than at shallower depths where wheatgrass roots were found (Harris, 1967). Harris found that cheatgrass roots grew in soil at temperatures as low as 37° F, but the minimum for bluebunch wheatgrass root growth was in the range of 46 to 50° F.

Cheatgrass roots penetrate to a depth of approximately three feet (Hironaka, 1961; Harris, 1967). When compared to crested or bluebunch wheatgrass, cheatgrass roots are smaller in diameter, weaker in tensile strength, very noticeably more diversely branched, and have more and longer root hairs (Hull, 1963; Harris, 1967). Harris observed that cheatgrass root systems in competition with bluebunch wheatgrass seedlings showed no reduction in root elongation. The shortest cheatgrass roots were found where the least density of bluebunch wheatgrass was present. This suggests that intra-specific competition was more heavily felt by cheatgrass than inter-specific competition.

When compared to crested wheatgrass, cheatgrass appears to be very efficient in its utilization of water. Hull (1963) reported that cheatgrass required only 66 percent as much water to produce a gram of dry matter as did crested wheatgrass. Cline et al. (1977), however, emphasized that cheatgrass does not utilize deep soil moisture which is available to well established, more deeply rooted perennials.

Cheatgrass is considered adequate forage when it is actively growing, however, nutrient content and digestibility decrease markedly as plants approach maturity (Cook and Harris, 1952; Murray et al, 1978) (Tables 1 and 2). Platt and Jackman (1946) indicated that dry, mature cheatgrass loses more of its nutrients to fall and winter precipitation than do perennials. Fleming et al. (1942) found that cattle gained on cheatgrass until August, maintained weight until August 20, and then begain to lose. Murray (1971) reported daily sheep gains on cheatgrass ranges comparable to bunchgrass types when grazed during the green feed period from early April to mid-May. Yearling cattle gained approximately 1.5 pounds per day in late spring, 1.2 pounds in summer and 1.0 pounds in September and October at 3 acres per animal unit month stocking rate in southern Idaho (Murray et al., 1978). In general, cheatgrass compares favorably in nutrient values to perennial grasses at comparable stages of growth and maturity (Fleming et al., 1942).

Hull (1949) examined growth periods of cheatgrass and seven seeded species (Figure 2). He found that wheatgrasses provided at least an additional month of green forage relative to cheatgrass. This would indicate that cheatgrass forage quality begins to decline at least one month before wheatgrass and that animal performance probably would decline more rapidly on cheatgrass.

## SUMMARY

Cheatgrass is a main source of forage on many rangelands from east of the Sierra Nevada and Cascade Mountains to the Rockies. It is estimated to dominate about 10 million acres in Oregon. Cheatgrass is the most abundant forage on many spring ranges and contributes more feed for livestock than any other range species during this period. The species is known for its extreme production fluctuations. Yearly differences of 10 to 12 fold are common with much more difference when drought years are included.

Numerous authors have correlated weather parameters to cheatgrass production. In general, the fall and spring precipitation periods are most influential. The species dependency on a relatively shallow moisture supply during germination and subsequent growth permits average annual production if small amounts of moisture occur in intervals during spring. Moisture shortages at these critical times, however, severely hinder herbage production.

Utilization or clipping of cheatgrass during the growing period typically reduces total herbage production. If moisture is available for subsequent regrowth, however, production may exceed that of ungrazed plants.

Cheatgrass seed may have as high as 99.5 percent germination. Under field conditions, however, this is not typically the case as precipitation and temperature are not always optimum. In years of severe moisture stress there usually is sufficient seed carryover to adequately stock the subsequent year's stand. If conditions are such that a site is not occupied to its potential, cheatgrass plants will tiller and thereby produce more herbage, flowers, and seeds.

A large portion of cheatgrass competitive ability is derived from its fall germination and rapid root growth. By the time active spring growth begins, the plant has almost its full complement of roots. Thus, while other plants are striving to reach deeper moisture, cheatgrass is already in position and operating. Cheatgrass is also very efficient in its utilization of soil water. It requires only two-thirds as much water to produce a pound of dry matter as does crested wheatgrass.

Cheatgrass is considered adequate forage when it is actively growing, and is comparable to other range grasses at equivalent stages of growth. Its habit of withering and dying a month or more before perennial grasses, however, means that forage quality begins to deteriorate much earlier. Palatability of the plant also decreases markedly when it reaches maturity. Its quality can decline more rapidly in summer and fall than the quality of perennial species because of leaching and weathering.

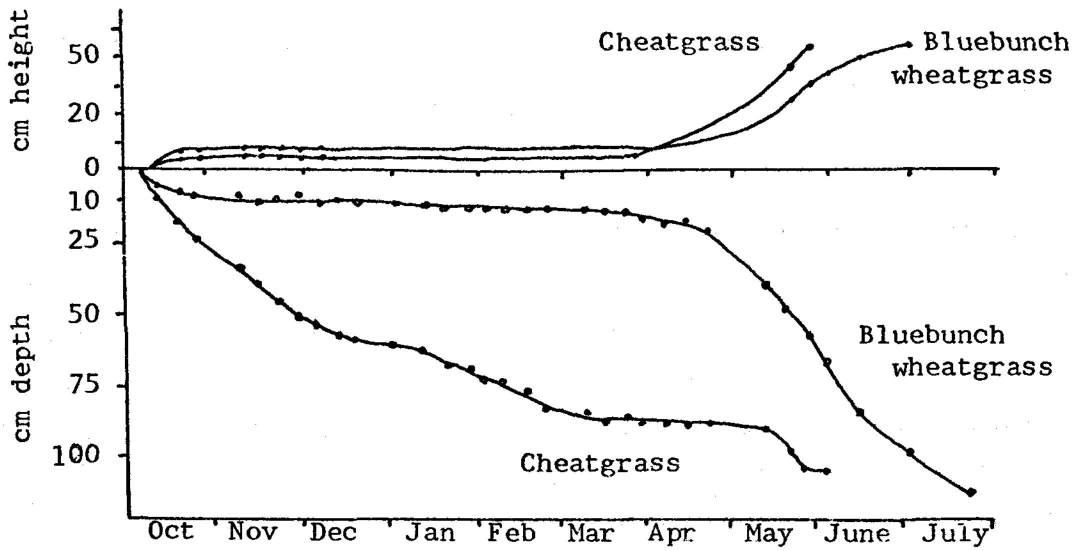


Figure 1. Seasonal leaf and root growth of bluebunch wheatgrass and cheatgrass in glass tubes in the field 1963-1964. From Harris 1967.

Table 1. Chemical composition of the foraging sheep's diet while grazing cheatgrass 1/

| Stage of growth | Ether extract (%) | Total protein (%) | Lignin (%) | Cellu-lose (%) | Other carbo-hydrates (%) | Total Ash (%) | Calcium (%) | Phos-phorus (%) | Gross energy (kcal/lb) |
|---|---|---|---|---|---|---|---|---|---|
| Cheatgrass | | | | | | | | | |
| boot | 2.7 | 15.4 | 4.1 | 27.4 | 40.2 | 10.2 | .64 | .36 | 1964 |
| head | 2.1 | 11.1 | 4.4 | 30.6 | 41.5 | 10.3 | .60 | .32 | 1973 |
| dough | 1.8 | 8.2 | 6.3 | 33.4 | 39.8 | 10.5 | .53 | .27 | 1914 |
| early seed | 1.6 | 7.4 | 8.4 | 28.3 | 43.6 | 10.7 | .51 | .26 | 1805 |
| late seed | 1.3 | 6.1 | 10.4 | 32.4 | 38.8 | 11.0 | .56 | .21 | 1878 |

1/ From Cook and Harris, 1952.

Table 2. Dry matter consumed daily and apparent digestibility of cheatgrass by sheep 1/

| Stage of growth | Dry matter consumed (lbs) | Digestion coefficients (percent) | | | | | | Digestible protein (%) | Digestible energy (kcal/lb) | Total digestible nutrients (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Ether extract | Total protein | Cellulose | Other carbohydrates | Dry matter | Gross energy | | | |
| Cheatgrass | | | | | | | | | | |
| boot | 3.3 | 24.8 | 67.9 | 77.9 | 83.5 | 67.4 | 70.8 | 10.5 | 1391 | 66.9 |
| head | 2.8 | 45.0 | 65.0 | 76.3 | 80.7 | 65.4 | 71.7 | 7.2 | 1415 | 66.2 |
| dough | 2.3 | 41.0 | 46.4 | 63.9 | 68.4 | 51.0 | 56.6 | 3.8 | 1083 | 54.0 |
| early seed | 2.1 | 16.0 | 38.3 | 47.8 | 73.6 | 46.4 | 47.9 | 2.8 | 865 | 49.0 |
| late seed | 2.0 | 12.6 | 16.1 | 51.3 | 58.5 | 38.7 | 44.4 | 1.0 | 834 | 40.7 |

1/ From Cook and Harris, 1952.

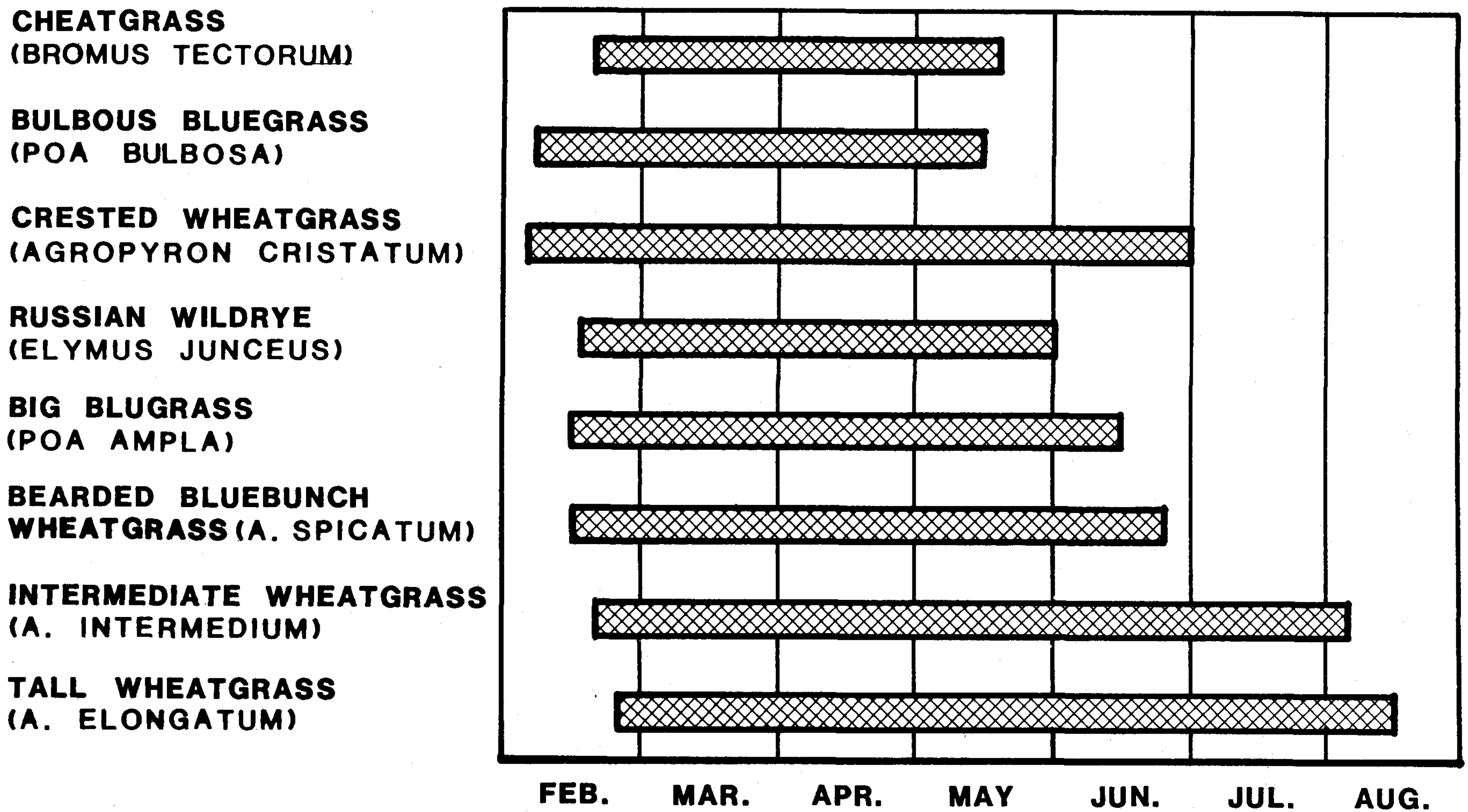


Figure 2. Growth periods of cheatgrass and 7 seeded species at Regina, Idaho, 1947. From Hull 1949.

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