GROWTH AND WATER RELATIONS OF THREE BIG SAGEBRUSH SPECIES

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Big sagebrush (Artemisia tridentata) dominates 90 million acres in the western United States. Available soil moisture and phenology are probably the two most important factors determining the level of sagebrush kill with application of 2,4-D. This paper will discuss the correlation between plant growth, internal plant water stress and soil water over a two-year period (1981 and 1982).

EXPERIMENTAL PROCEDURES

Wyoming big sagebrush (A. tridentata subsp. wyomingensis), basin big sagebrush (A. tridentata subsp. tridentata) and mountain big sagebrush (A. tridentata subsp. vaseyana) sites were studied at Squaw Butte in eastern Oregon. The three study sites are characterized in Table 1.

Table 1. Site characteristics for the three locations studied

Habitat type	Soil depth (in.)	Elevation (ft.)	Shrub canopy (%)	Herbage production (lb/a)
Wyoming big sagebrush/ Thurbers needlegrass	30	4620	15	560
Basin big sagebrush/ basin wildrye	40	4620	20	570
Mountain big sagebrush/ Idaho fescue	60	5115	15	630

Long term average precipitation for Squaw Butte is 11.8 inches. However, both 1981 and 1982 growing seasons were wetter than normal, reflected by soil moisture content 140 percent of normal in both years.

Plant growth, internal water stress and soil moisture were measured on the same day every two weeks during June and July and monthly during August through November in 1981 and 1982 and twice in May 1982.

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Phenological development was recorded in both years. In 1982, stem elongation and leaf fall were also measured. Several hundred overwintering leaves were marked in March with a non water-soluble ink. Just prior to leaf fall in August a leaf trap made out of cheese cloth was placed over individual branches to measure the proportion of leaves lost during this period. Internal water stress was measured with a pressure chamber at pre-dawn and 2 p.m. Soil moisture was measured gravimetrically.

RESULTS AND DISCUSSION

The following data were collected in two consecutive years of above-average soil moisture. We acknowledge that above average moisture could increase productivity and the duration of rapid growth into the summer.

Due to high levels of available soil water on all three sites in 1981 and 1982, initiation and rate of growth in the early spring were probably controlled by atmospheric influences. The rapid growth period was characterized by cool to warm temperatures and soil water ranging from field capacity down to -2.0 bars. During this period leaf growth for Wyoming and basin big sagebrush was initiated in early May followed by stem elongation approximately two weeks later (Figures 1 and 2). Leaf and stem growth of mountain big sagebrush followed a similar pattern but were initiated in mid-May and late May, respectively (Figure 3). Reproductive stems were recognizable by mid-June for all three subspecies.

Soil water tension dropping below -2.0 bars coincided with termination of vegetative growth and a sharp decrease in plant water potential (Figures 1, 2, and 3). Reproductive stem elongation continued for approximately two more weeks and terminated by August 1. During the later part of July, ephemeral and perennial leaves began turning yellow. By August soil water tension had been below -2.0 bars for approximately two weeks and plant water potentials were at or below -20 bars.

During August, which was characterized by hot temperatures, low soil water and high plant water stress, 53 percent of the total leaf biomass dropped off the plants. The pattern was similar for all three subspecies. Wyoming big sagebrush and basin big sagebrush began to shed their leaves by the first of August. Mountain big sagebrush followed about 10 days later. Leaf fall was made up of two kinds of leaves. The entire crop of perennial leaves produced in 1981 that persisted through the winter fell with ephemeral leaves produced in 1982. The majority of leaf fall occurred in a three-week period. After this intensive leaf fall period a small percentage of ephemeral leaves continued to die into the fall.

Although plants were under high water stress during the late summer, green leaf tissue persisted on the plant and reproductive effort continued.

CONCLUSION

Although big sagebrush is well adapted to growing in arid environments, active vegetative growth is dependent upon moist soil conditions. Active leaf and stem growth occurred at soil water tensions between field capacity and -2.0 bars. This represents approximately 30 percent of the total water found in the soil profile. Once soil water decreased below -2.0 bars and internal plant water potentials approached or passed -20 bars, active growth was terminated and drought avoidance mechanisms initiated. In August, the plant reduced its transpiration surface by over one-half. This included large ephemeral leaves and perennial leaves produced during the previous growing season. Based on one year of data, perennial leaves persisted for only two growing seasons and one winter. In both 1981 and 1982 all three subspecies were capable of continuing development of reproductive tissue under extreme levels of internal plant water stress and very limited soil water.

Although the timing and duration of certain phenological stages will vary from site to site, and year to year, the pattern or sequence is not likely to change. In years when soil moisture remains below or above -2.0 bars for only a short period during the growing season, only limited growth will occur, probably. However, this study will be conducted in a year of limited soil moisture to verify this hypothesis.

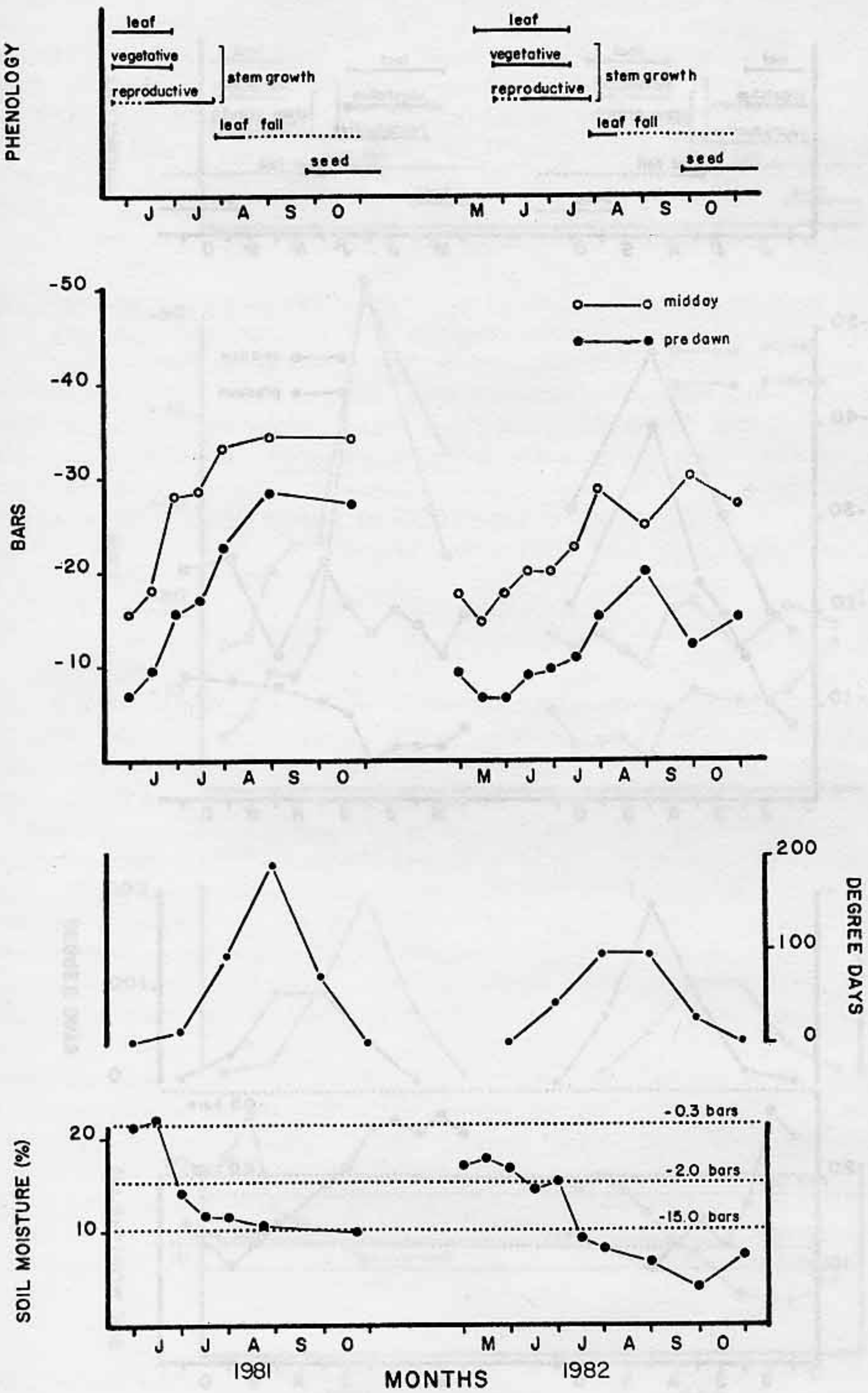

Figure 1. Phenology and xylem potential (bars) for Wyoming big sagebrush, and degree days and soil moisture on the site for the two growing seasons. For plant phenology (-----)reproductive stems could not be separated from vegetative stems and leaf fall minimal and restricted to ephemeral leaves.

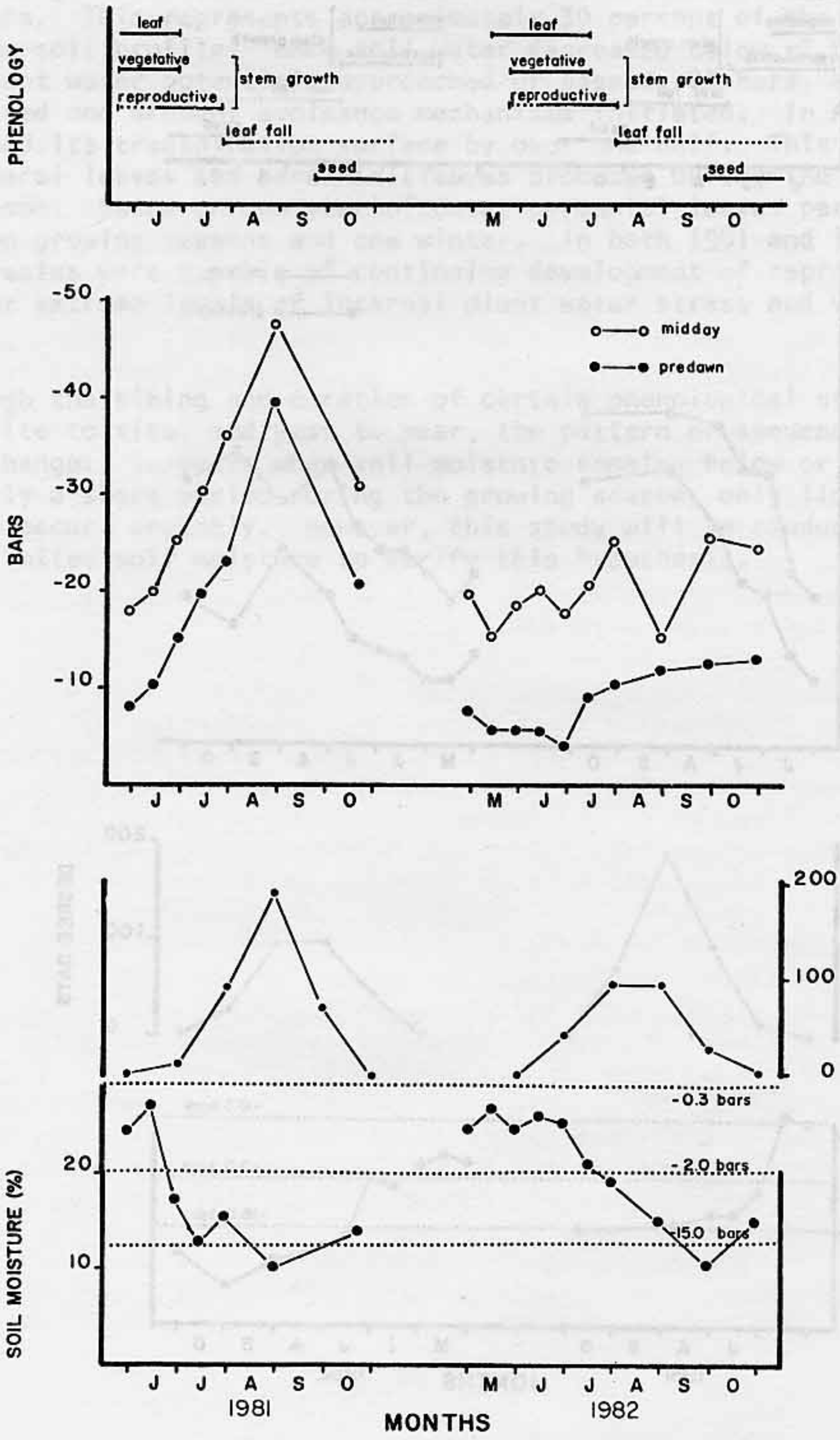

Figure 2. Phenology and xylem potential (bars) for basin big sagegrush, and degree days and soil moisture on the site for the two growing seasons. For plant phenology (----) reproductive stems could not be separated from vegetative stems and leaf fall minimal and restricted to ephemeral leaves.

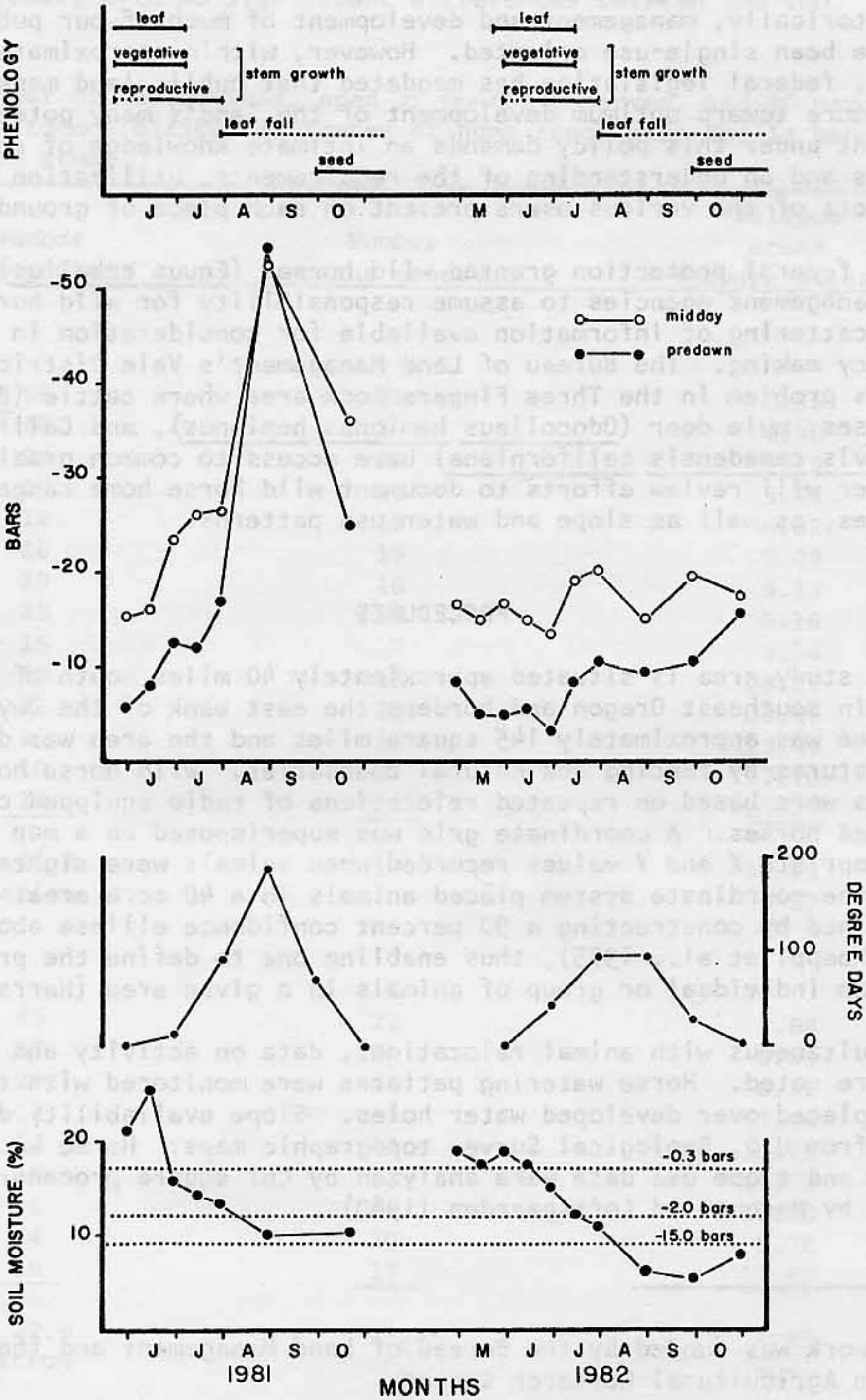

Figure 3. Phenology and xylem potential (bars) for mountain big sagebrush, and degree days and soil moisture on the site for the two growing seasons. For plant phenology (----) reproductive stems could not be separated from vegetative stems and leaf fall minimal and restricted to ephemeral leaves.