CRESTED WHEATGRASS AND BLUEBUNCH WHEATGRASS: HOW THEY COPE WITH GRAZING

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Research and field experience have strengthened our view that crested wheatgrass and bluebunch wheatgrass respond best to different management strategies. In the 1960s, Squaw Butte scientists found several characteristics in bluebunch wheatgrass that make it sensitive to grazing. These include weak basal internodes, stem bases deficient in food reserves through most of the growing season, and tillering potential which develops relatively late. Recent work in Utah by Caldwell and associates[1] supports and greatly adds to information providing us with a better insight as to why these species respond differently to management.

Both of these grasses are similar in many ways although they do respond differently to grazing. Their growth form, stem development, and ratio of reproductive to vegetative stems are approximately the same. They are most sensitive to grazing when leaf area is reduced to a minimum during the boot stage. Total above and belowground biomass is the same for equal size plants as is photosynthesis rate per unit leaf area.

Crested wheatgrass, first introduced from Russia in 1898, has been highly successful in the arid regions of western North America. Crested wheatgrass is easy to establish, well adapted to this environment, producing quality forage, and withstands heavy spring grazing. Although evolved under similar climate conditions as bluebunch wheatgrass, crested wheatgrass evolved under much greater grazing pressure.

If plants have been properly grazed in the previous growing season, crested wheatgrass will generally be preferred over bluebunch wheatgrass by cattle in the spring. Crested wheatgrass produces spring growth at a more rapid rate one to two weeks earlier and matures faster. However, later in the growing season cattle usually prefer bluebunch wheatgrass over crested wheatgrass. Both plants must be maintained in a cropped form to maintain palatability. However, light use of crested wheatgrass tends to become a more severe management problem, with uneven use causing the development of wolf plants.

[1] Much of the work reported here comes from Caldwell, M. M., J. H. Richards, D. A. Johnson, R. S. Nowak, and R. S. Dzurec. 1981. Coping with herbivory: photosynthetic capacity and resource allocation in two semiarid <u>Agropyron</u> bunchgrasses. Oecologia 5:14-24.

Although plants of equal size are also equal in production, crested wheatgrass has a higher total green (photosynthetic) surface area for intercepting sunlight and producing energy for plant growth. The increased surface area is generated by a higher density of tillers in the bunch of crested wheatgrass making the overall canopy thicker. However, the leaves on crested wheatgrass are thinner than bluebunch wheatgrass so aboveground yield for similar sized plants is the same. Thicker leaves in bluebunch wheatgrass means it must use more carbon and nitrogen per unit of green surface area produced (Figure 1).

Plants of similar size also have approximately equal root weight. However, crested wheatgrass roots are thinner in diameter and higher in density in the soil. This provides crested wheatgrass with a greater root surface area for absorption of water and minerals than bluebunch wheatgrass. As root diameters increase, root volume increases at a faster rate than surface area. This means bluebunch wheatgrass (which has thicker roots) must use more carbon and nitrogen per unit of root surface area than crested wheatgrass. The denser root system in crested wheatgrass also appears to be more effective in withdrawing water from the soil. This denser root system is probably one of the primary characteristics making crested wheatgrass more competitive against encroaching nondesirable plants.

The pattern of food reserves (non-structural carbohydrates) storage in crested wheatgrass is better adapted to grazing than is bluebunch wheatgrass. Replenishment of food reserves in crested wheatgrass occurs earlier and is maintained at higher levels than in bluebunch wheatgrass. At Squaw Butte, crested wheatgrass was found to accumulate 87 percent of the total stored food reserves by seedhead emergence. Other work showed bluebunch wheatgrass to have obtained only 25 to 65 percent of the total food reserves at this growth stage.

In most grasses, defoliation during the growing season increases photosynthesis rates on a unit leaf area basis, although the total is reduced because of a reduction in green surface area. The increase in photosynthesis rates is caused by an increased demand for sugars (photosynthethate material), reduced shading inside the bunch, and an increased level of new leaf material. In ungrazed crested wheatgrass, average photosynthesis rates per unit leaf area are lower than in ungrazed bluebunch wheatgrass. This is caused by internal shading in the bunch due to higher tiller density, thus a higher leaf density. Opening up the canopy through grazing increases photosynthesis rate to equivalent levels found in grazed bluebunch wheatgrass plants (Figure 2). However, total photosynthesis is greater in crested wheatgrass because of a higher green surface area.

Regrowth following defoliation was significantly greater on crested wheatgrass than on bluebunch wheatgrass. Photosynthetic capacity of wheatgrasses defoliated on April 20 was 20 to 90 percent greater in crested wheatgrass than bluebunch wheatgrass in May and early June, respectively. Several characteristics in crested wheatgrass allow it to more rapidly replace green leaf area following defoliation than bluebunch wheatgrass. Food reserves, essential for regrowth, are accumulated earlier and maintained at higher levels in crested wheatgrass. Before defoliation, both wheatgrasses allocate food resources to shoot growth and root growth. After defoliation, crested wheatgrass allocates the majority of its food or carbohydrate resources to aboveground growth while bluebunch wheatgrass directs the major flow of food resources to belowground growth. Also, crested wheatgrass is capable of producing a unit of green surface area and root surface area for a lower carbon and nitrogen investment than bluebunch wheatgrass.

Differences between the two wheatgrass species clearly point out that they respond most productively to different management strategies. Generally, crested wheatgrass is most productive if grazed early in the growing season with enough grazing pressure to maintain even use in the pasture. Bluebunch wheatgrass is most productive if grazed late in its growth cycle. In summary, differences between the two plants are:

1. Crested wheatgrass initiates rapid spring growth earlier.

2. Crested wheatgrass accumulates food reserves more rapidly in the early growth stages and maintains higher concentrations.

3. Crested wheatgrass uses less carbon and nitrogen per unit of green surface area and per unit of root surface area produced.

4. Crested wheatgrass roots are thinner and more dense, having a greater absorption area.

5. After defoliation, photosynthesis rates are more enhanced and regrowth more rapid in crested wheatgrass.

6. Tillering potential develops relatively late in bluebunch wheatgrass.

7. Crested wheatgrass shifts energy flow primarily to aboveground growth following defoliation while bluebunch wheatgrass maintains primary flow to roots after defoliation.

8. Bluebunch wheatgrass has weak basal internodes.

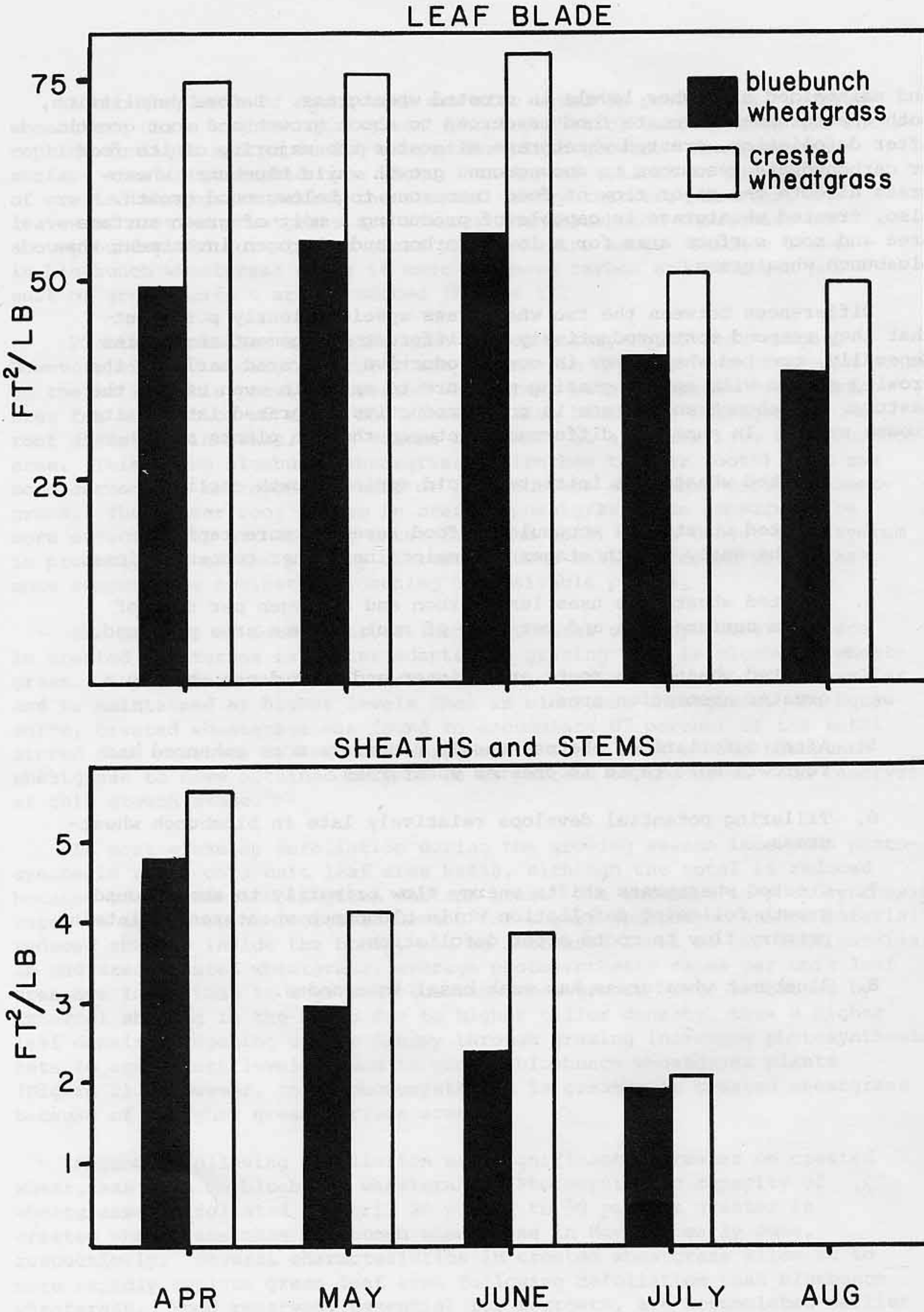

Figure 1. Surface area/dry weight ratios for leaf blades and stems and sheaths of bluebunch wheatgrass and crested wheatgrass at different times during the year (Caldwell *et al.*, 1981).

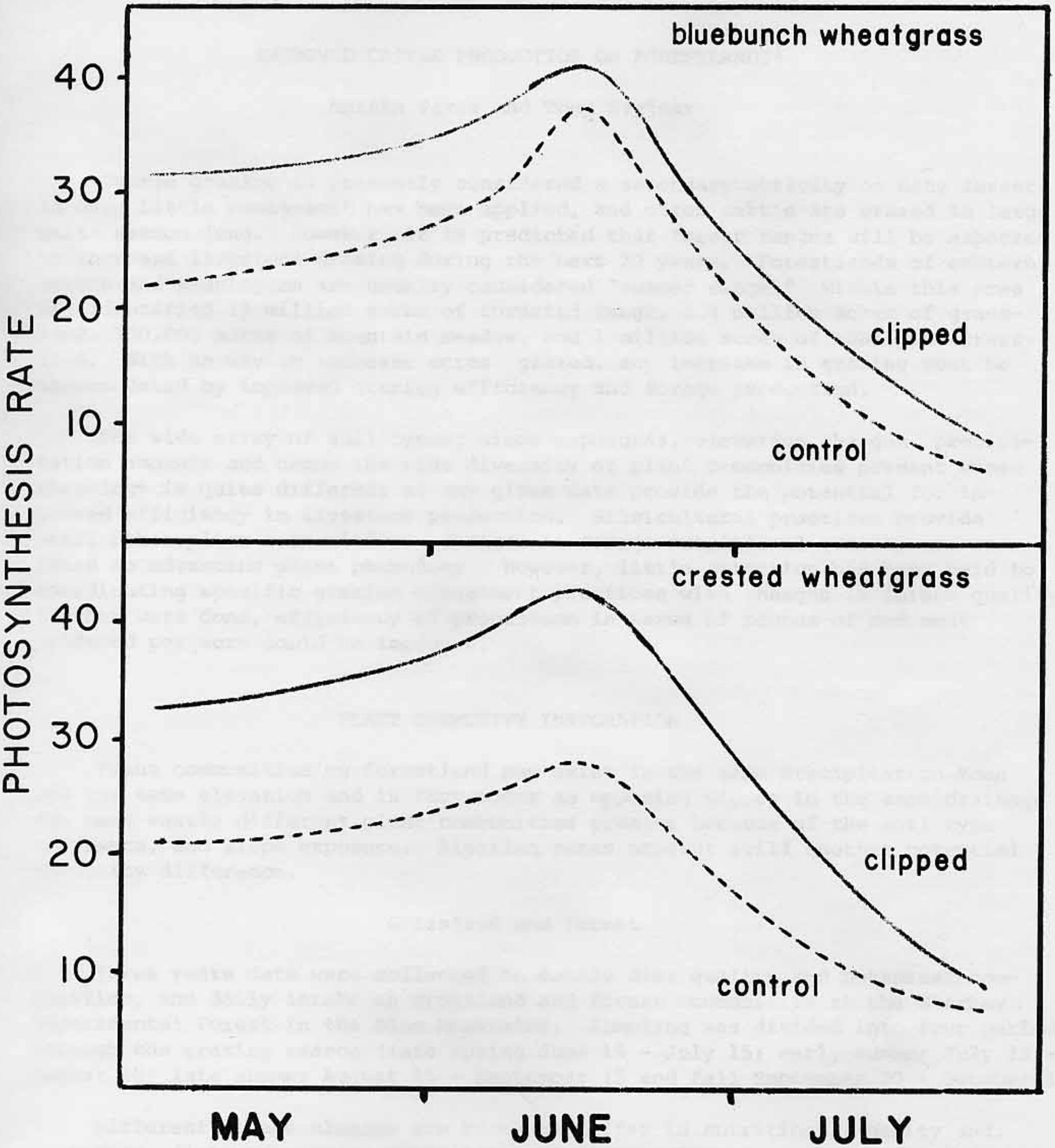

Figure 2. Photosynthetic capacity (μ mol.m^{-2}.s^{-1}) on a unit area basis of control and regrowth bluebunch wheatgrass and crested wheatgrass leaf blades determined at light saturation, temperature optimum for photosynthesis (70-81^{o}F), and cuvette CO_2 concentration of 300-330 ppm (Caldwell *et al.*, 1981).