Annual Grassland Forage Productivity

Ranchers and range managers in California depend heavily on annual production of natural forage, or herbage, from grasslands—but to best utilize this forage the seasonal productivity of the annual grassland ecosystem must be understood. Intensive studies carried out on the San Joaquin Experimental range during the 1970s led to the development of models which provide new insight into seasonal forage productivity. Typical patterns of forage production (grasses and forbs) can now be described which, while not all-inclusive, are generally correct and can be of great value in range management.

Four factors—precipitation, temperature, soil characteristics, and residue—largely control forage productivity and seasonal species composition. These factors also change the timing and characteristics of the four distinct growth phases: break of season, winter growth, rapid spring growth, and peak forage production. Management decisions may be guided by these patterns and as the season progresses, patterns become set and the outcome more predictable.

Weather Influences

The new fall growing season begins when rains start the germination of stored seed (see table). Young annual plants then grow rapidly if temperatures are warm but more slowly if cooler temperatures prevail. There is little growth during low winter temperatures. Rapid spring growth commences with warming conditions in late winter or early spring. Rapid growth continues for a short time until soil moisture is exhausted. Peak standing crop occurs at the point where soil moisture limits growth or when plants are mature.

Break of season follows the first fall rains that exceed 1 inch during a 1-week period. This may occur at any time from September 15 until January 1. Early false breaks may occur in summer or early fall, in which case emerged plants may not survive until the true break. Taprooted filaree (*Erodium* spp.) is one of the few exceptions that often survives a false break. Timing of the break dramatically affects forage production (figure, A-D).

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Forage species composition is usually established by December 1 and is largely determined by the dates of autumn rains and by autumn temperatures. In dry years or years of adequate but poorly-distributed rainfall, filaree usually dominates. High rainfall years and years with late spring rains result in grass dominance. Early rains coupled with evenly spaced, adequate rainfall generally produce clover years.

Winter growth period occurs as the fall break of season ends and is the result of cooling temperatures, shorter days, and lower light levels. Forage growth may be sparse during this period and dry-matter losses may occur (figure, E). Forage production is greater in mild winters (figure, F). A short or no winter growth period may occur if there are late breaks of season—under those circumstances, almost no new growth is apparent in the fall.

Rapid spring growth period begins with the onset of warming spring temperatures, longer days, and higher light intensities (figure, G, H). Normally this period occurs between February 15 and March 15 when average weekly temperatures exceed 45° F. The length of rapid spring growth varies considerably in California, from a month in dry southern regions to more than 3 months in wetter coastal regions.

Peak forage production occurs at the end of rapid spring growth (peak standing crop), which can be as early as April 1 in the southern San Joaquin Valley to as late as May 25 on the north coast. Late arrival of peak standing crop requires adequate rains in April or early May. The date of peak standing crop on the same site may vary widely among years and according to species composition. In years of filaree dominance, peak standing crop will be earlier than in years of grass dominance.

Moisture from summer thunder storms, although not important for plant growth, leaches nutrients from standing forage, and may speed decomposition. Standing residue frequently shatters into ground litter.

Site Influences

Available water for plants, mainly dependent on rainfall, is also dependent on soil depth, soil texture, aspect, and topography. Annual plants depend primarily on moisture available in the top 1 foot of soil. Filaree and summer annual forbs may make considerable use of water at greater depths.

Heavy clay soils hold moisture and provide a buffering effect when rains are widely spaced and as a result the rapid-growth period may be longer. These soils typically occur in swale areas which collect moisture from runoff. Conversely, upland slopes tend to be dryer because of high runoff and lighter-textured soils. Aspect is also a factor with south-facing slopes drying faster than north-facing slopes. Thus production curves illustrated in the figures may differ for adjacent sites and south-facing and north-facing slopes.

California soils vary tremendously in fertility. Nitrogen is generally the most limiting nutrient in California's annual grassland soils but phosphorus and sulfur may become secondary limiting factors. Where deficient, these nutrients can be added to substantially improve range productivity.

Species composiiton of legumes is influenced by soil pH. Annual grassland soil pH ranges from alkaline to acidic. Acidic soils tend to occur in high rainfall areas, whereas alkaline soils tend to occur in drier southern areas; pH may vary from 4.5 in high rainfall zones to 8.5 in lower rainfall zones.

Residue and Grazing Influences

Residue, the dry forage component remaining at the end of the dry season, is a major manageable factor governing productivity and composition. Residue, acting as a mulch, influences germinating plants and soil organic matter. To maintain desired forage production, therefore, it is useful to set *minimum* residue standards (see UC Leaflet 21327, "Guidelines for Residue Management on Annual Range"). These standards vary from 200 pounds of dry matter per acre in the south to 1250 pounds per acre on north coast steep slopes. Retaining greater amounts of residue does not enhance total forage productivity but may be desirable for other management objectives.

Low amounts of residue in fall encourage higher proportions of the following species: silver hairgrass (*Aira caryophyllea*); turkey mullein (*Eremocarpus setigerus*); little quakinggrass (*Briza minor*); nitgrass (*Gastridium ventricosum*); broadleaf filaree

(*Erodium botrys*); burclover (*Medicago polymorpha*); redstem filaree (*Erodium cicutarium*); clover (*Trifolium* spp.).

High amounts of residue in fall encourage dominance by slender wildoats (*Avena barbata*); soft chess (*Bromus mollis*); wild oats (*Avena fatua*); medusahead (*Taeniatherum asperum*); ripgut brome (*Bromus diandrus*).

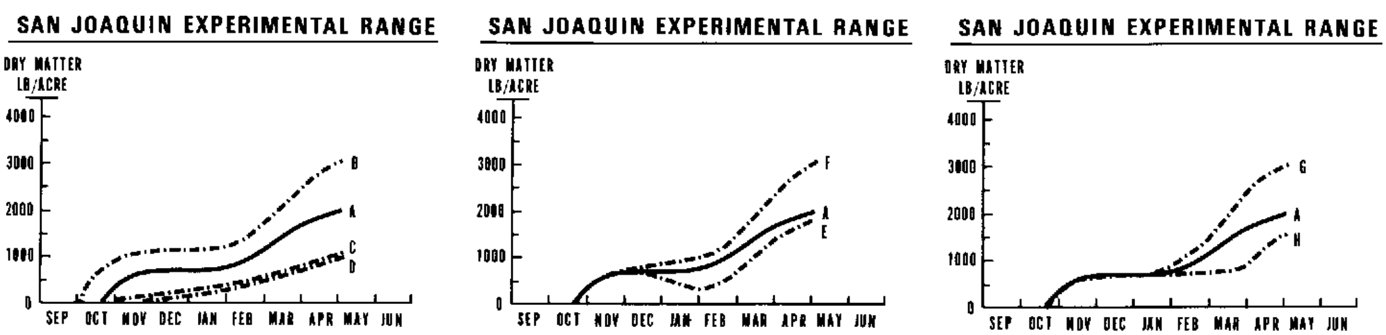
Shading understory forbs provide a competitive advantage to grass in California's annual grassland ecosystems and so grass most often dominates, particularly in an ungrazed situation. Grazing decreases this advantage by opening the canopy, increasing forb or legume occurance. On a moderately-utilized range, livestock do not graze heavily enough to make complete use of available forage; therefore, a patchwork of grasses and forbs is apparent.

Influence of normal weather variations on timing of seasonal dry matter (DM) forage productivity in California's annual grassland ecosystem.

	Break of season	Onset of winter growth		Onset of rapid spring growth		Peak standing crop		
Curve in Figure	**Date**	**Date**	**DM (1b/A)**	**Date**	**DM (1b/A)**	**Date**	**DM (1b/A)**	**Weather pattern**
A	Oct 23	Nov 7	600*	Feb 1	700†	May 1	2000‡	Average fall, winter, and spring
B	Oct 1	Nov 7	1000	Feb 1	1100	May 1	3000	Warm, wet fall, average winter and spring
C	Oct 23	Oct 23	—	Feb 1	300	May 1	1000	Cold, wet fall, average winter and spring
D	Nov 15	Nov 15	—	Feb 1	300	May 1	1000	Dry fall, average winter and spring
E	Oct 23	Nov 7	600	Feb 1	300	May 1	1500	Average fall, cold winter, average spring
F	Oct 23	Nov 7	600	Feb 1	1000	May 1	3000	Average fall, mild winter, average spring
G	Oct 23	Nov 7	600	Jan 15	700	May 1	3000	Average fall, short winter, early spring
H	Oct 23	Nov 7	600	Apr 1	700	May 1	1500	Average fall, long winter, late spring

*Forage production from break of season to onset of winter growth (Oct. 23-Nov. 7 in this example).
†Forage production from break of season to onset of rapid spring growth (Oct. 23-Feb. 1 in this example).
‡Forage production from break of season to peak standing crop (Oct. 23-May 1 in this example).

Range forage production curves (A-G in table) showing influence of eight different weather patterns.



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