THE PLANT

Production and maintenance of vegetation are of first consideration in management. Ranges are deteriorated because plants are killed. The ground space so vacated is taken over by other, usually less desirable plants—or remains bare and subject to erosion. The main problems of grazing management on western ranges center on perennial plants—particularly those that reproduce from seed. Management that maintains these plants invariably maintains plants that reproduce vegetatively. An understanding of why plants are killed by grazing is essential for development of satisfactory grazing methods and maintenance of the range resource.

Plants, like animals, require food for growth and sustenance. The food materials used for these purposes are carbohydrates, proteins, and fats. Animals obtain these substances by eating plants or other animals. Plants manufacture these substances; in other words, plants make their own food.

The plant first produces sugar glucose in the process of photosynthesis. Using this sugar as a building block, it then makes all the other food materials. Glucose is formed only in green cells and, principally, in leaves. The other compounds can be made anywhere in the plant, in the top or roots, or in green or nongreen cells. But because glucose is the basis of all food materials, the plant may be said to make its food in its green leaves.

In perennials, some of the food materials made by the plant each year are stored for future use. Carbohydrates, proteins, and fats are all stored, but the bulk of the material is starch. In herbaceous perennials, the materials are stored in roots and other underground parts and stem bases. In woody plants, they are stored above ground in stems, branches, twigs, and leaves as well as in underground parts. Some of these reserves are used to start growth in spring and to nourish the plant when it is not making food—in winter, for example, when the plant is dormant. Reserves are replenished regularly in normal growth.

Perennials store enough food to last for several years. So even if the plant is defoliated, as by grazing, for a year or two, it does not die. Under continuous close grazing year after year during the green period, however, the plant cannot make and replenish reserves. Consequently, reserves are ultimately depleted and the plant dies. As in the case of an animal, the plant becomes progressively weaker and smaller as it runs out of food. It can, in fact, starve to death.

Essentially then, the plant can make food only when it is green. The amount produced is controlled by such factors as light intensity, temperature, availability of water and soil minerals, and amount of chlorophyll in the plant, which is related to the size of the green plant. Some of these factors, such as availability of water and minerals and size of the green plant, are affected by grazing, and can be controlled by the range manager.

Respiration is continuous. Food materials are burned and energy liberated continuously even when the plant is dormant. Reserves can, therefore, be depleted by respiration alone.

To grow normally, the plant must contain adequate food materials to burn and adequate gaseous oxygen to effect burning. Vigorous growth depends on a high level of reserves in roots and a well aerated soil.

PLANT GROWTH

The seasonal growth and development of perennial plants is illustrated here with Idaho fescue (fig. 1). The growth pattern of this bunchgrass applies to other grasses and similar plants and to forbs and woody plants as well. Shoot growth of herbaceous plants and twig growth of woody plants are comparable. Plant growth stage is best expressed in terms of percentage growth and greenness of the shoot.

The elapsed time from start of growth to dormancy in Idaho fescue is 6 or 7 months. Shoot growth is completed in about 4 months. The plant loses greenness over a comparable period. The moisture content of the plant starts declining about the time the plant is half grown and starts slowing in growth. The total weight of the shoot declines late in the season because seeds shatter and plant parts dry out and disintegrate.

(The period of growth and development of different species on different sites may differ appreciably from that for this species. Some plants dry completely or shed leaves as they become dormant.)

Roots start growth before the shoot. Root growth is largely completed by the time the shoot is half grown. By then the plant is growing most rapidly and presumably has greatest need for a fully developed root system.

Approximately one third of the roots die each year. They start to die about the time root growth ends. A large amount of organic matter gets into the soil each year this way.

REGROWTH

Potential for the plant to regrow during the season is highest early in the season, and declines with advance of the season as soil moisture and the growth impetus of the plant decline (table 3). After the plant is half grown and starts slowing in growth rate, its regrowth is negligible. Grasses may

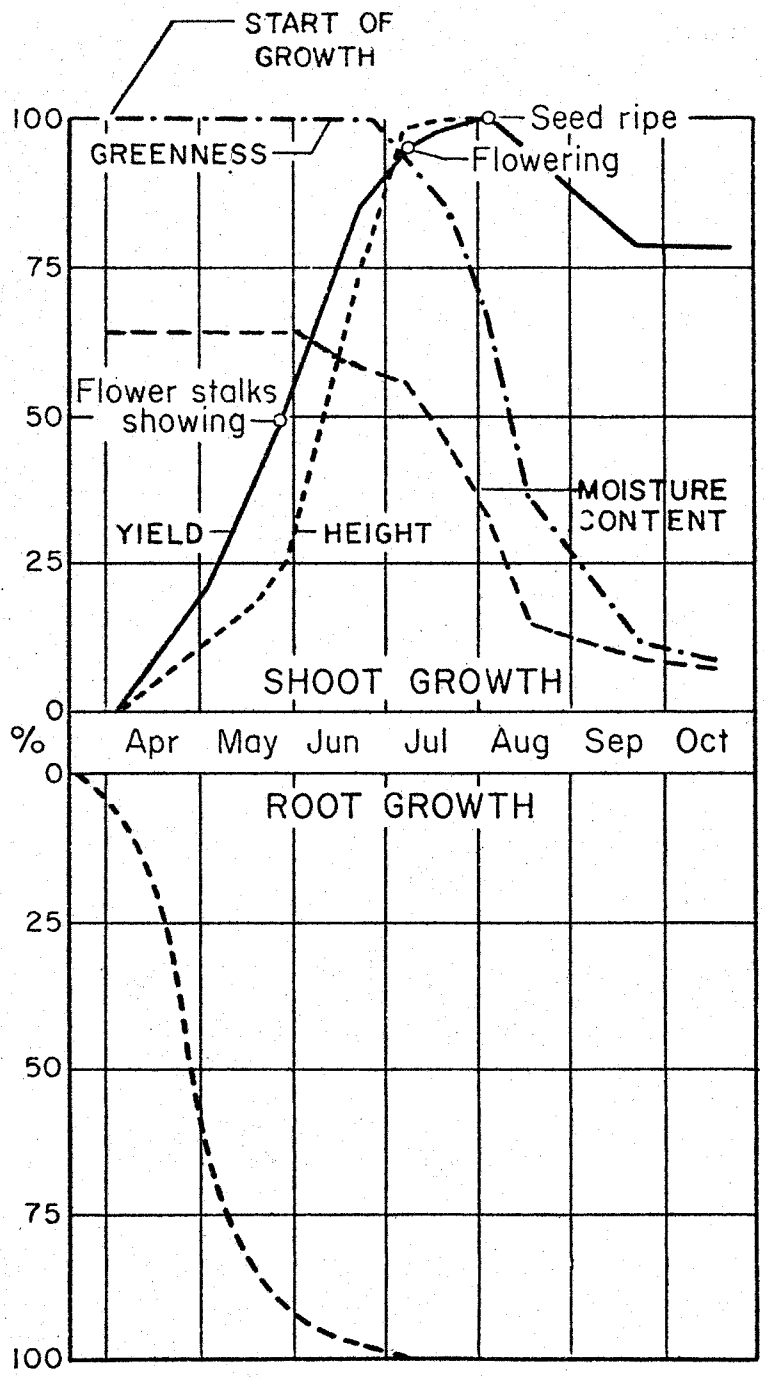

Figure 1.—Average seasonal growth and development of Idaho fescue. Shoot growth, based on data by Hormay and Talbot (1961), and general curve for root growth, based on information by Troughton (1957).

regenerate practically a full-size crown and produce appreciable viable seeds if defoliation or grazing is ended before the plant starts growing rapidly—before flower stalks are tall enough to be removed. Several weeks of grazing may be provided up to this time.

The combined yield of initial growth and regrowth from plants clipped early in the growing season is less than the yield of growth from unclipped full grown plants (table 3). Therefore, herbage production and grazing capacity during the season are reduced by early grazing. The amount of reduction is discussed later in the section on season of grazing.

Table 3.—*Yield of initial growth and regrowth of Idaho fescue clipped one to a 1.5-inch stubble at different growth stages; regrowth harvested when full grown*

Average date and growth stage at time of initial clipping	Initial growth	Regrowth	Initial growth and regrowth combined	
	Grams	*Grams*	*Grams*	*Percent*
May 1: Leaves about 3 inches tall	0.78	0.70	1.48	60
May 13: Flower stalks low in boot	1.09	.29	1.38	56
May 27: Flower stalks surpassing basal leaves	1.42	.20	1.62	66
June 17: Flower stalks two-thirds grown	2.16	.05	2.21	90
July 6: Peak of flowering	2.39	.01	2.40	98
July 9: Flower stalks full grown	2.41	.01	2.42	99
July 18: Seed in milk	2.45	0	2.45	100

TREND IN FOOD RESERVES

The plant starts storing food reserves when it is about half grown and begins slowing in growth (fig. 2). From then on it makes more food than it uses in growth and respiration. The excess is stored. The plant maintains vigor by maintaining a normal supply of food reserves.

Approximately half of the seasonal stores are deposited by the time the shoot is 90-percent grown. In grasses and plants of similar growth development, this is about flowering time. Most of the reserves are deposited by the time the shoot is full grown, or at seed-ripe time in grasses. But reserves continue to accumulate for several days or weeks, while the plant still has greenness, until the amount of food made in photosynthesis just balances the amount used in respiration. Then reserves decline throughout the dormant period because of respiration, and continue to decline as growth resumes—until the shoot is about half grown—because of both growth and respiration. Reserves are lowest when the shoot is about half grown.

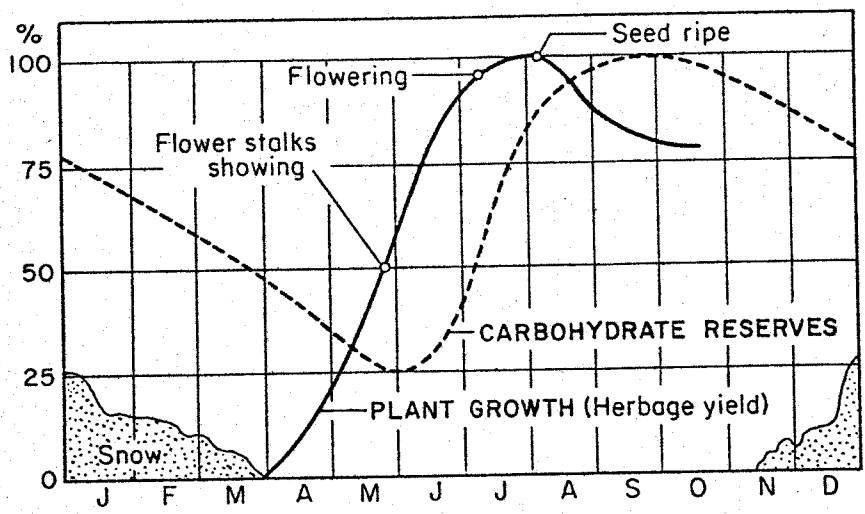

Figure 2.—Trend in carbohydrate reserves in relation to shoot growth. Shoot growth of Idaho fescue and based on data by Hormay and Talbot (1961). Carbohydrate curve, based on data by McCarty and Price (1951), is related to curve of Idaho fescue by plant growth stages.

EFFECT OF DEFOLIATION

Removal of the leaves of the plant anytime during the green period reduces the amount of food made and stored by the plant. As a result, the capacity of the plant to produce both shoot and root growth the next year is reduced. Defoliation is most harmful when reserves are lowest. This is about the time the plant is growing most rapidly.

However, defoliation of the plant anytime up to the time food storage is completed is harmful even at a relatively late growth stage (table 4). Plants vary in their ability to withstand defoliation. Wyethia, for example, withstands clipping better than other species because of greater food storage capacity and perhaps other reasons. Generally, close defoliation of the plant year after year—at almost any green growth stage—ultimately results in depletion of food reserves and the death of the plant.

Table 4.—*Change in size of four forage species clipped yearly to a 1.5-inch stubble at the seed-in-milk stage*

Year	Basal area				Fascicles[1]			
	Idaho fescue		Bottlebrush squirreltail		Longspur lupine		Woolly wyethia	
	Sq. in.	*Pct.*	*Sq. in.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*
1946	4.16	100	1.88	100	15.4	100	8.2	100
1947	2.16	52	2.22	118	5.0	32	7.7	94
1948	1.67	40	2.25	120	6.5	42	8.8	107
1949	1.39	33	.69	37	2.4	16	7.9	96
1950	.83	20	.71	38	1.4	9	6.9	84

[1] A fascicle is a group of leaves or leaves and stems that originate from a single bud.

Rhizomatous plants generally withstand grazing better than tufted plants. They are not grazed as completely because of their prostrate growth habit. They retain more greenness in the grazed-off stubble, and they usually have greater regrowth and food storage capacity.

The growth of herbaceous plants is not affected significantly by grazing after reserves are stored. The reserves and growing points on the plants are out of reach of animals. In woody plants, however, reserves and growing points are exposed, and grazing after reserves are stored and during the dormant period can harm these plants. Removal of growing points does the most damage.

The effect of defoliation is proportional to the amount of crown removed from the green plant. Studies show that 60 percent and more can be removed from some species without interfering with the future normal growth of the plant. Apparently, the plant can make adequate food with less than a normal size crown. The portion of the crown that can be removed safely is called the *proper-use amount.*

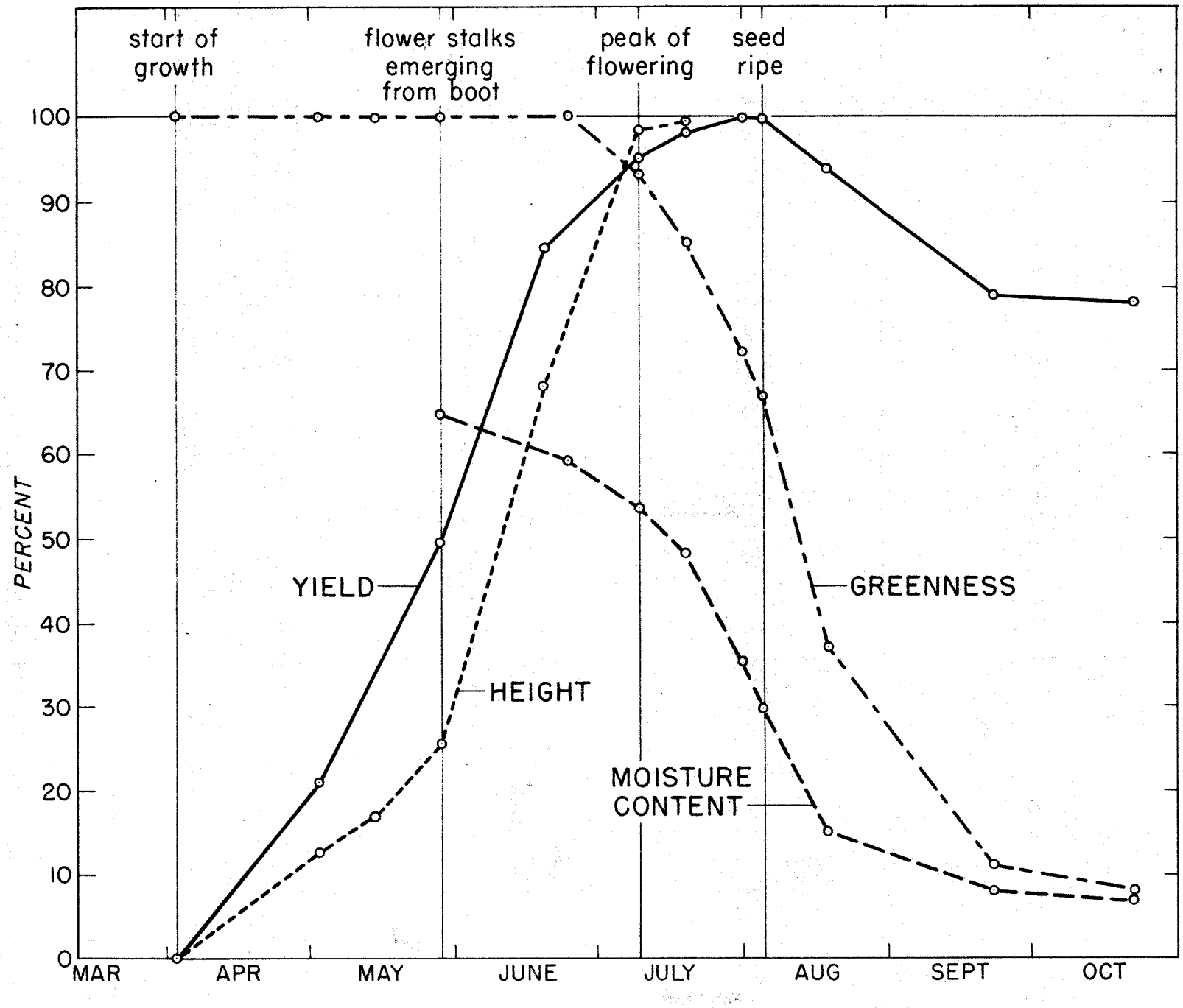

Figure 11.—Average seasonal growth and development of Idaho fescue.

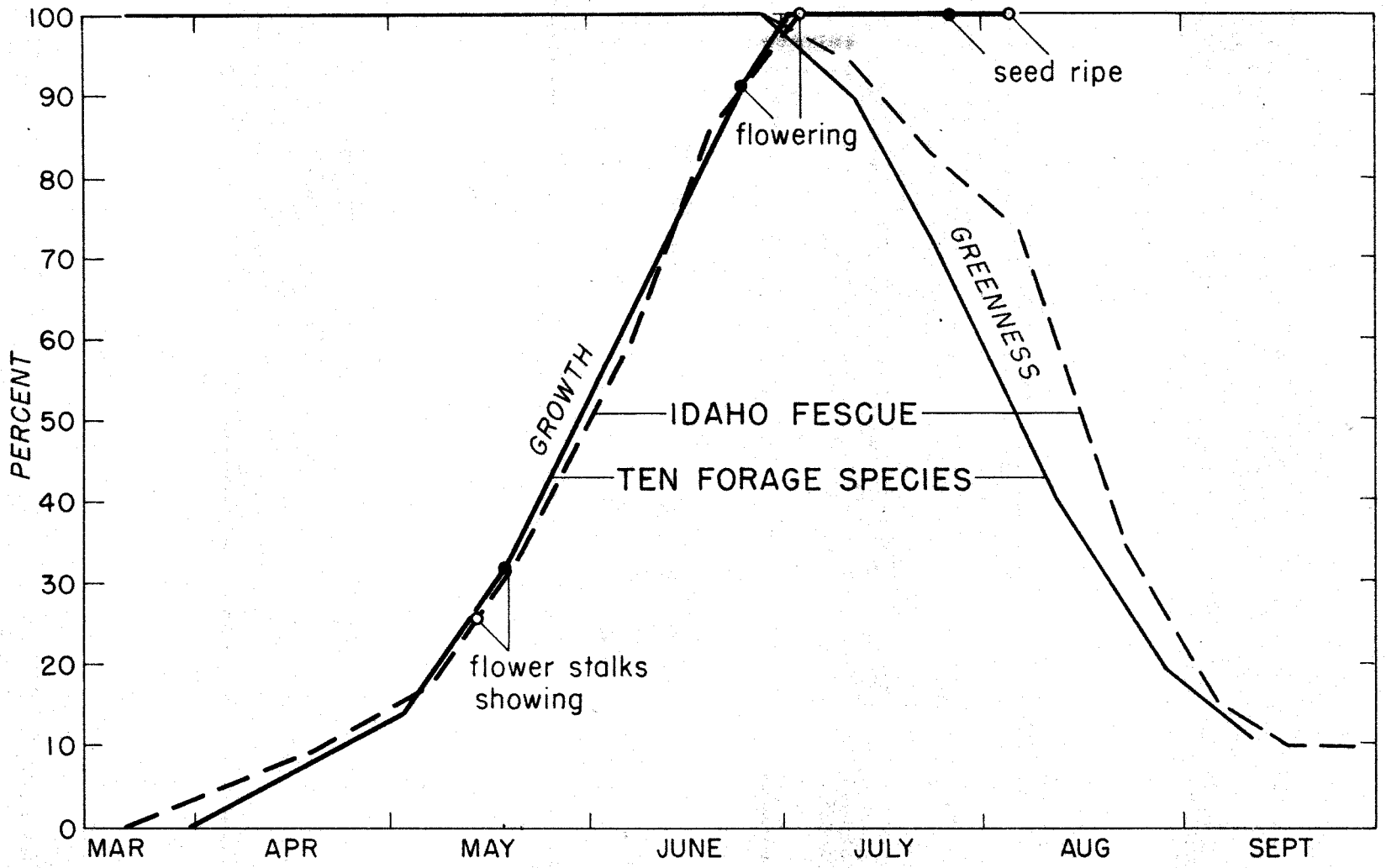

Figure 10.—Relation between the growth and development of Idaho fescue and 10 abundant forage species growing on the same area.

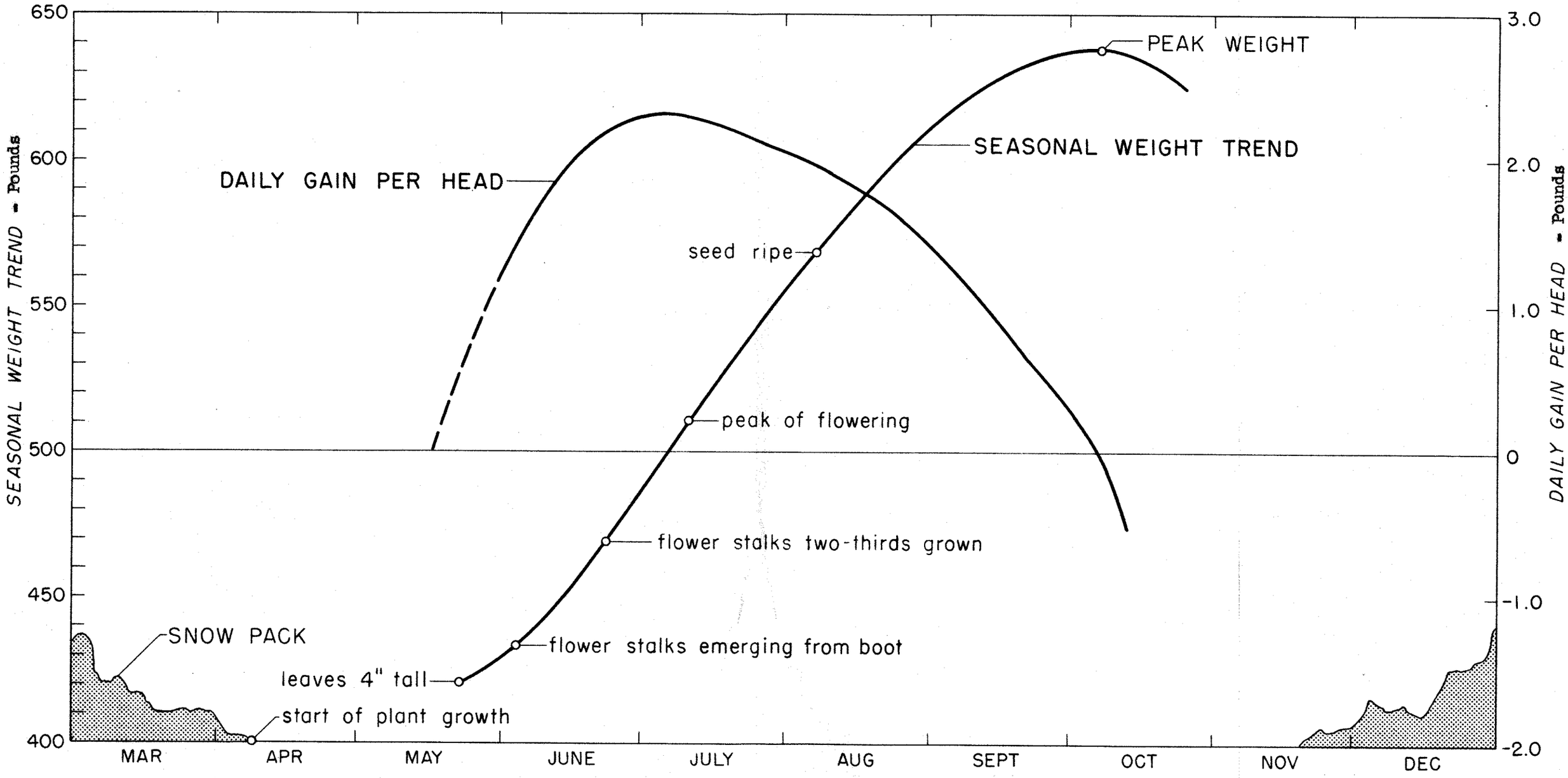

Figure 16.--Cattle weights in relation to growth of Idaho fescue. Average 1944-48, timber type, Burgess Spring Experimental Range.

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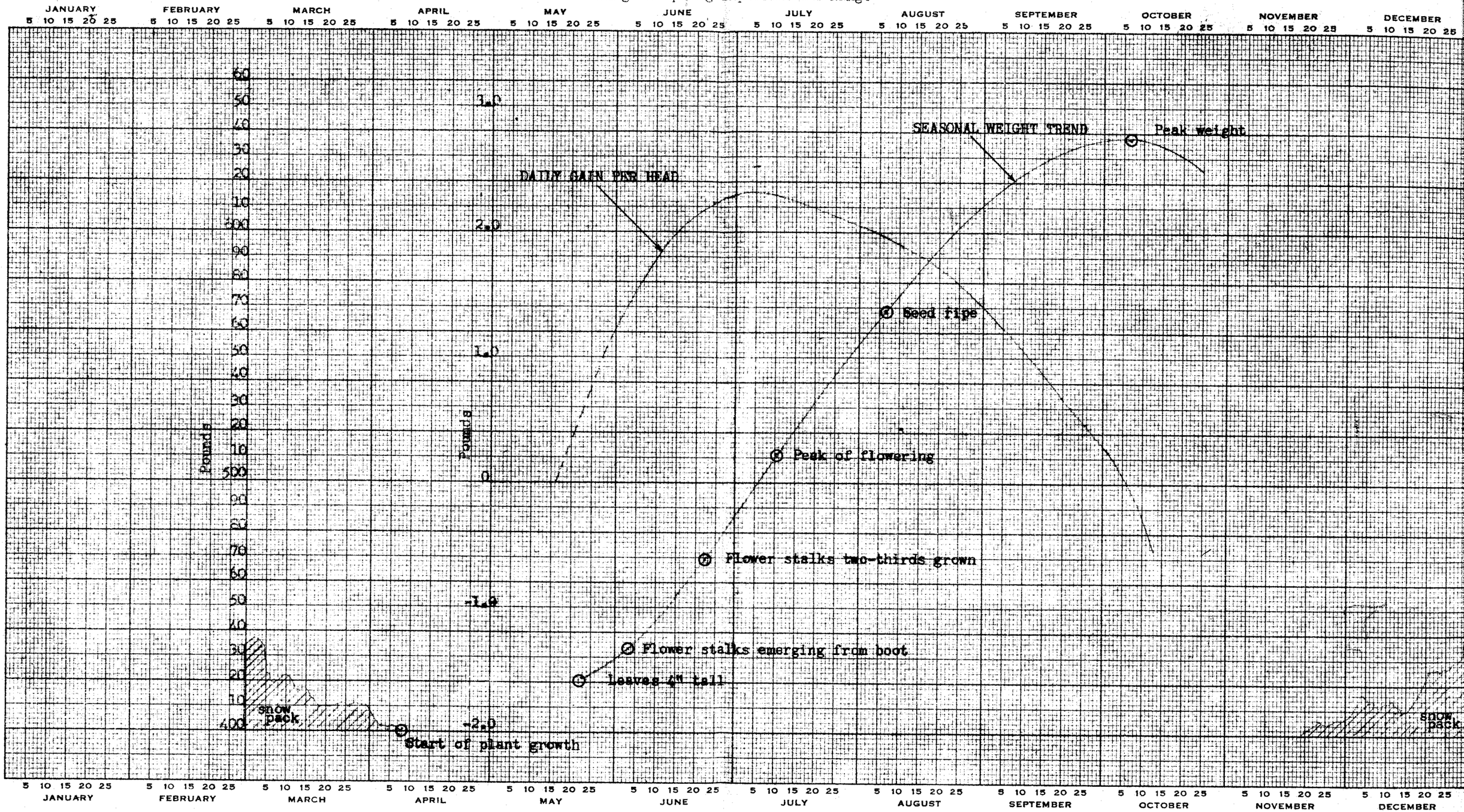
Cattle weights in relation to growth of Idaho fescue.
Average 1944 to 1948 inclusive
Timber pasture
Burgess Spring Experimental Range



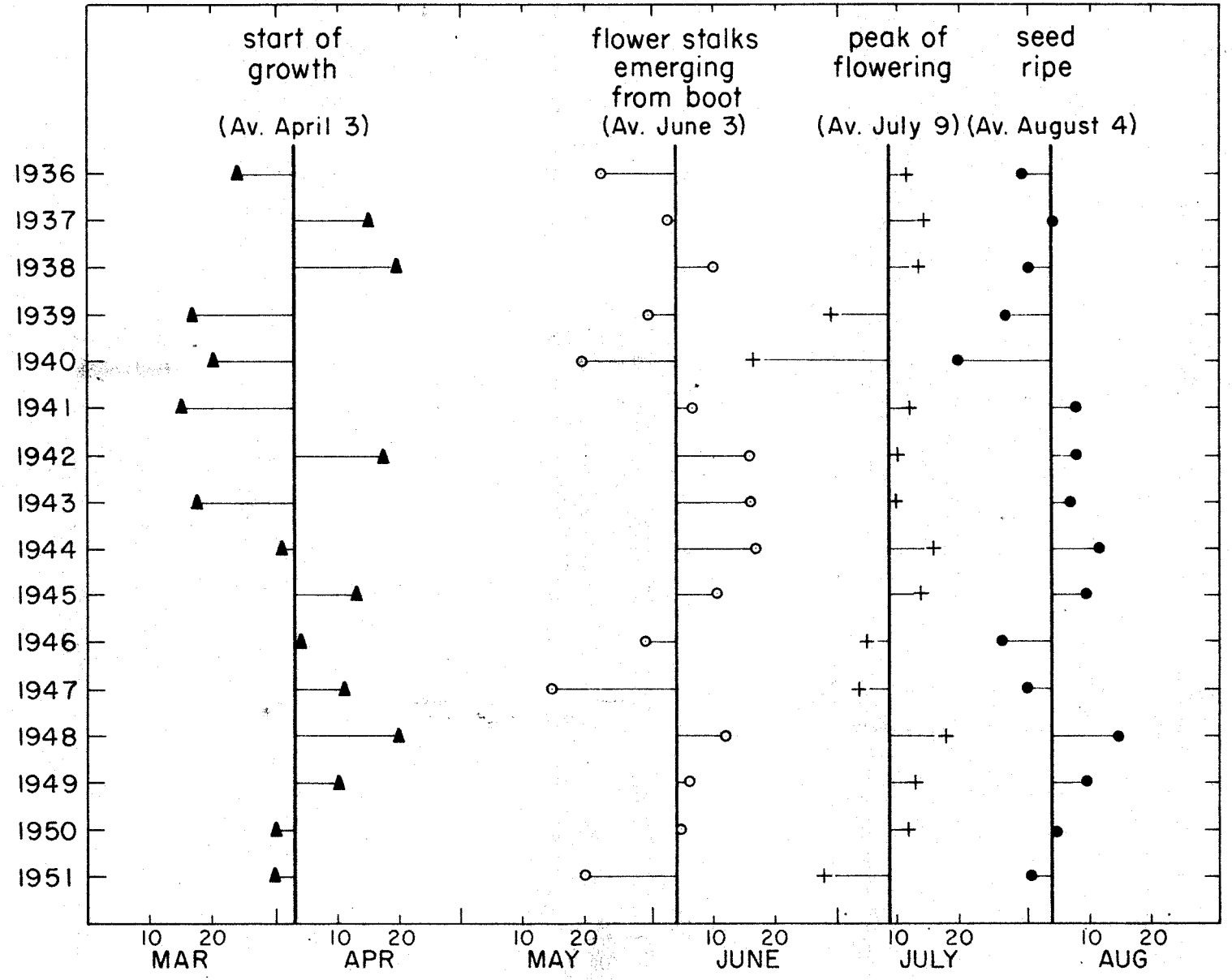


Figure 12.--Yearly variations in four main plant growth stages, Idaho fescue, 1936 to 1951.