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The Relationship of Photoperiod to Growth and Flowering of Melilotus Species

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The Relationship of Photoperiod to Growth and Flowering of Melilotus Species[1]

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Sweetclover is used extensively in Iowa as a soil-improving crop and forage legume. The two species utilized are *Melilotus officinalis,* the yellow-flowered type, and *M. alba,* the white-flowered type. Although both annual and biennial forms of *M. alba* are available, the biennial form is grown more extensively. Only biennial forms of *M. officinalis* are grown.

Since Garner and Allard (1920) first demonstrated that relative length of day was an important factor in the sexual reproduction of plants, numerous studies have been conducted on the effect of photoperiod on plant growth. Extensive literature reviews have been published by Murneek and Whyte (1948), Leopold (1951), and others. Few investigators, however, have reported studies concerning the effect of light and other environmental factors on the growth and flowering of sweetclover. Pieters (1925) noted that annual species exhibited longer internodes than biennial species under normal day lengths. This phenomenon was especially noticeable with seedlings grown out of doors in the late summer. Roberts and Struckmeyer (1938) obtained *Melilotus dentata* plants with a greater height when grown under long day conditions. Smith (1942) observed an increase in plant height of *M. alba* and *M. officinalis* when these species were subjected to long day periods. He also noted an increase in dry weight for plants grown in long days, although a greater proportion of the total weight was found in the roots of plants grown under short day conditions.

The primary purpose of the present investigation was to study the effect of various day lengths on the growth rate and flowering of the commonly grown species of *Melilotus.*

Materials and Methods

This study was carried out in the greenhouse during the winter of 1951-52. Three sweetclover varieties, Madrid (*M. officinalis,* biennial), Evergreen (*M. alba,* biennial), and Hubam (*M. alba,* var. *annua,* annual), were grown from certified seed which had been harvested the previous year. Seed was planted in 4 inch pots in a soil mixture containing two parts silt loam, and one part

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peat, and one part sand. Each pot was fertilized so that the soil mixture contained on a per acre basis, 33 pounds of N_2, 60 pounds of P_2O_5, and 60 pounds of K_2O. The stand was thinned so that each pot contained two seedlings.

On January 2 the pots were placed in a greenhouse where day temperatures of 78°F. and night temperatures of 68°F. were maintained. For 37 days a 9 hour photoperiod was provided by supplementing the natural day length with incandescent light. On February 8, when the seedlings were 4-6 inches tall and had 2 or 3 trifoliate leaves, four pots of each variety were transferred to each of eight photoperiod chambers. The chambers, which were 3 feet wide, 3 feet deep, and 4 feet tall, were made of hardboard and were open on one side during the daytime to admit sunlight. From 5 P.M. to 8 A.M. daily the open side was covered with a black cloth. The 9 hour day length provided by this arrangement was extended in seven of the photoperiod chambers by means of 200-watt clear incandescent bulbs. In the eighth chamber 2 daylight and 1 white 20-watt fluorescent bulbs were used. The following photoperiods were maintained by automatic equipment: with incandescent light, 12 hours, 14 hours, 16 hours, 17 hours, 18 hours, 19 hours, and 20 hours; with fluorescent light, 18 hours. Plant height was measured

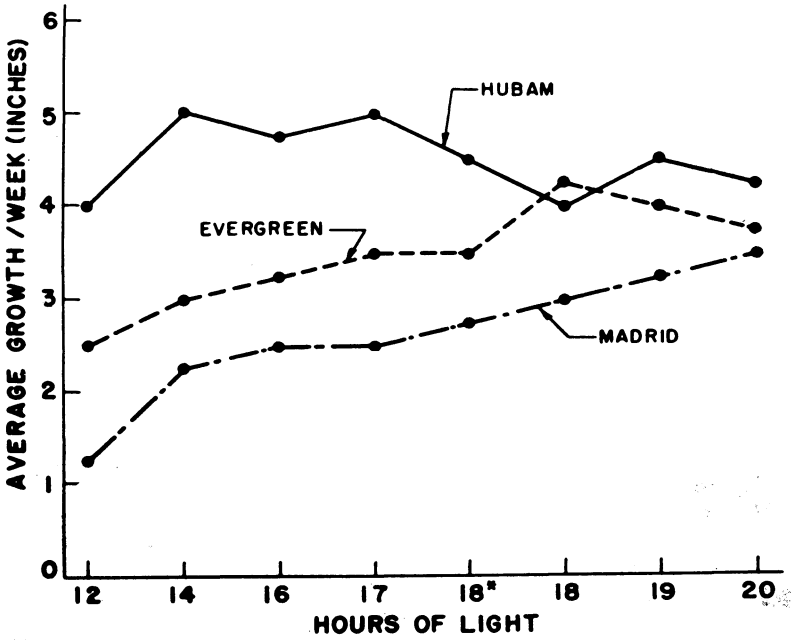

Figure 1. Average growth per week of Hubam, Madrid, and Evergreen sweet clover under varying photoperiods.

at weekly intervals for eight weeks and the date of first flowering of each plant in the experiment was recorded.

Results

The elongation of internodes on the biennial plants grown under a 12 hour photoperiod was relatively slow. Madrid was especially slow when grown under this photoperiod and averaged just slightly more than one inch of plant height increase per week. On the other hand, the annual variety, Hubam, grew rapidly and increased in height at least four inches per week under all photoperiods.

As the length of the photoperiod increased there was a marked increase in the growth rate of the biennial varieties. Figure 1 indicates that the growth rate of both Evergreen and Madrid under a 20 hour photoperiod approached that of Hubam.

The internodes of Hubam were relatively long at all photoperiods while those of the biennials were much shorter. Madrid produced short bushy plants when grown under the 12 and 14 hour photo-

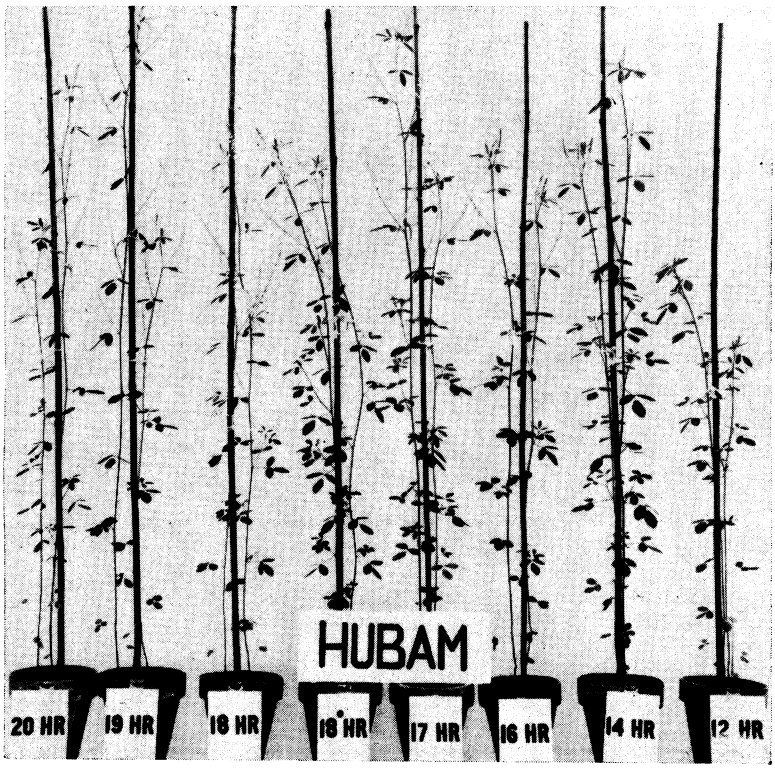

Figure 2. Hubam sweet clover grown under varying photoperiods. *Grown under fluorescent light.

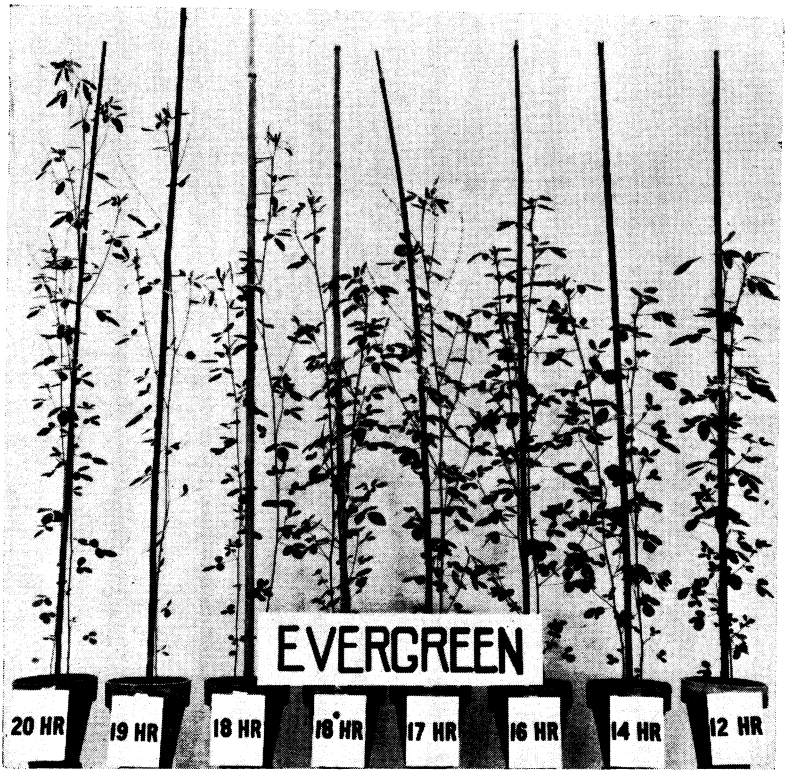

Figure 3. Evergreen sweet clover grown under varying photoperiods. *Grown under fluorescent light.

periods but tall erect plants were formed as the length of day was increased. Evergreen grew more rapidly under a 12 hour day length than Madrid, but still was benefitted considerably by a longer photoperiod. Evergreen had a more open growth than Madrid and presented considerably greater leaf surface than Hubam under similar conditions. Types of growth characteristic of each variety under varying photoperiods are shown in figures 2, 3, and 4.

Plants of all three varieties, when grown under fluorescent lights in an 18 hour photoperiod, exhibited no significant difference in growth rate from those grown with the same photoperiod under incandescent light. Hubam gave a slightly more rapid rate of growth under fluorescent lights, although the difference was not significant.

The effect of day length on flowering was very marked, especially on the biennial varieties. Hubam produced flowers under all day lengths from 12 to 20 hours. However, as shown in table 1, the

12 hour photoperiod caused a delay of about two weeks in flower formation. There was little variation in date of flowering for Hubam grown under photoperiods ranging from 14 to 20 hours.

Table 1

Effect of light on flower production of *Melilotus* species. Each figure is the number of days necessary to produce flowers from seed during varying photoperiods.

	Photoperiod (hours)							
Variety	12	14	16	17	18*	18	19	20
Hubam	91	79	79	74	82	76	77	78
Madrid	....	....	....	....	103	97	90	85
Evergreen	....	....	....	93	96	88	88	82

*Grown under fluorescent light.

The biennial, Evergreen, needed at least a 17 hour photoperiod to bring it to the flowering stage. The other biennial, Madrid, required an 18 hour photoperiod. Although the plants were grown for 146 days under various photoperiods these two varieties did not produce flowers when grown under shorter photoperiods. In both Evergreen and Madrid it was noted that flowering occurred earlier as the photoperiod was increased to 20 hours. The biennials, as

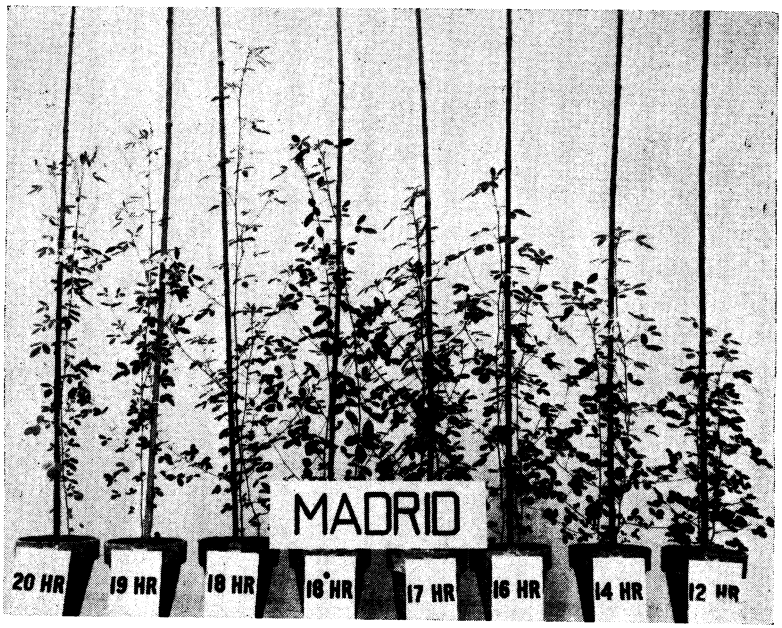

Figure 4. Madrid sweet clover grown under varying photoperiods. *Grown under fluorescent light.

well as the annual variety, when grown under fluorescent lights, flowered a few days later than those grown under incandescent lights.

Discussion

These data show that length of day is an important factor in determining the rate of growth and time of flowering of both annual and biennial sweetclover. This is in agreement with Smith (1942) who reported that flower production of biennial sweetclover is influenced by day length. Murneek and Whyte (1948), Leopold (1951), and others have shown that nutrient level, temperature, moisture, and intensity and quality of light are also important factors in determining the rate of growth and time of flowering of many species.

This study indicates that annual sweetclover should be well adapted to growth under a wide range of day lengths. It grows rapidly in both long and short day conditions although the rate of growth would probably be slower if grown in a cooler temperature. Although the internodes of Hubam grown under both long and short day conditions were about equal, there was some delay in flower production under short day (12 hour) conditions.

Biennial sweetclover generally does not bloom the first season of growth. Apparently the plants need to attain a certain minimum size before they can make use of the long days of late June to produce a sufficient quantity of a precursor substance needed to induce flowering. All of the biennials in this study were at least 22-24 inches tall before buds and flowers were formed. This study shows that biennials grow almost as rapidly as the annual sweetclover under continuous long days and that flowering was only slightly delayed from that of the annual type under these conditions. Under rapid growing conditions, in long days, sufficient precursor apparently accumulated in the biennial to produce flowers in the first year. This suggests that biennial varieties are able to flower in the field during the second year because the new growth, which arises from the crown buds on the roots, is able to make use of the root reserves. Thus growth is much more rapid early in the season during the second year than it is during the first year, and sufficient precursor accumulates in the plant under the long days of early summer to stimulate flower production.

Plants grown under fluorescent light were slightly later in flower production than those grown under incandescent light. Since these two types of light were used only to lengthen the effective photoperiod, it seems likely that this difference in date of flowering is

caused by differences other than source of light. The temperature in the chambers lighted with incandescent light was about 10°F. higher than in the fluorescent lighted chambers one hour after the lights had come on and the open side of the photoperiod chamber was closed. Since high temperatures generally promote more rapid growth than low temperatures, this factor may be responsible for the earlier flower production.

The knowledge that biennial sweetclover, grown from seed, can be made to flower in approximately the same time as the annual in the greenhouse may be useful information to the plant breeder. Flowers of different species can be made available for crossing by proper manipulation of light, even when they are planted on the same day.

Summary

An annual sweetclover variety, Hubam, and two biennial sweetclover varieties, Madrid and Evergreen, were grown from seed under varying photoperiods. Hubam grew most rapidly and produced flowers during all photoperiods of from 12 to 20 hours. The biennials were retarded in growth during the shorter photoperiods, but grew almost as rapidly as the annual under long day conditions. Evergreen needed at least 17 hours of light to produce flowers and Madrid 18 hours. Proper manipulation of the photoperiod can make the sweetclover plant available for breeding purposes at any time desired.

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