

Day-length and Hæmatin Compounds in Plants

It has been shown that day-length regulates the chlorophyll content of many plants¹⁻³ and that this is a true photoperiodic phenomenon⁴. In leguminous plants, day-length controls both the chlorophyll content and the number and efficiency of the root nodules^{5,6}. It seems that, in this case, both the synthesis of hæmoglobin in the nodules and the synthesis of chlorophyll in the leaves are depressed by short day-length. Moreover, there are indications that in some plants (tobacco, for example), the ratio between the quantity of chlorophyll and the quantity of total hæmatin in the leaves remains constant over a wide range of concentrations (Davenport, H., personal communication).

I therefore thought it of interest to investigate whether day-length influences hæmatin-content as it does chlorophyll-content. I studied simultaneously the chlorophyll and total hæmatin during long-day (16 hr.) and short-day (8 hr.) in four species: soya bean (*Soja hispida*), lupin (*Lupinus albus*), wild strawberry (*Fragaria vesca*), and hemp (*Cannabis sativa*). Total hæmatin was measured by the method of Hill and Scarisbrick⁷. Chlorophyll was measured with the Beckman spectrophotometer in 80 per cent acetone using the formula of Mackinney⁸.

As shown in Fig 1, in mature leaves there was generally a constant molar ratio of about 60 molecules of chlorophyll to 1 molecule of hæmatin.

In the leguminous plants, soya bean and lupin, the ratio remains constant on changing from long to short days and vice versa. Short-day treatment reduces the hæmatin- and chlorophyll-content of the leaves simultaneously and to the same extent, while long-day treatment increases both. In the leaves, there is about 20-30 per cent less hæmatin during short-day than during long-day (Table 1). The decrease is not only evident in the leaves, but also in the roots. With the lupin, some nodules during short-day had a hæmatin-content 50 per cent lower than in the long-day control. These facts support the idea that, in the leguminous plants, the lack of nodule formation and efficiency in short-day is due to a general hæmatin deficiency, itself related to a marked depression of chlorophyll content in short-day. The occurrence of such a relation between hæmatin and chlorophyll is particularly striking when one considers the photoperiodic control of flowering.

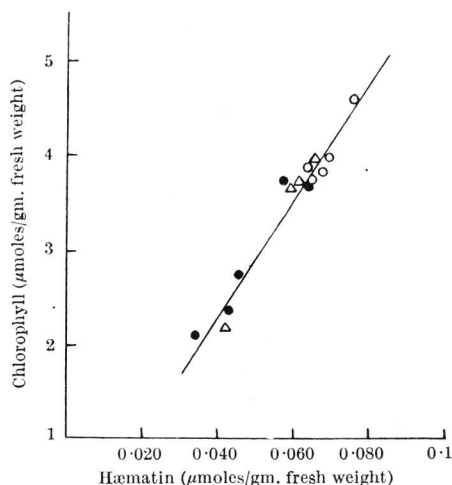


Fig. 1. Relation between haematin- and chlorophyll-content in mature leaves. (For lupin and soya bean, the different chlorophyll contents were obtained in different day-length conditions; for hemp, the figures are for long-day only.) ●, lupin; ○, hemp; Δ, soya bean

Table 1. EFFECT OF DAY-LENGTH ON HAEMATIN CONTENT IN LUPIN AND SOYA BEAN
Haematin in µmoles/gm. fresh weight

| Organs analysed | Day-length | Lupin | | | Soya bean | |
|------------------|------------|------------|-------|-------|------------|-------|
| | | Series No. | | | Series No. | |
| | | 1 | 2 | 3 | 1 | 2 |
| Adult leaves (a) | Long | 0.058 | 0.046 | 0.065 | 0.060 | 0.066 |
| | Short | 0.043 | 0.035 | 0.037 | 0.046 | 0.043 |
| Roots (b) | Long | 0.017 | 0.014 | 0.011 | 0.016 | — |
| | Short | 0.012 | 0.010 | 0.007 | 0.008 | — |
| Nodules | Long | 0.270 | 0.144 | — | — | — |
| | Short | 0.124 | 0.083 | — | — | — |

(a) The following leaves have been analysed: in lupin, leaf No. 12 (series 1 and 2) and leaf No. 14 (series 3); in soya bean, leaf No. 1 (series 1) and leaf No. 2 (series 2).

(b) In lupin, the principal roots have been analysed; in soya bean the total roots including the secondary roots.

In wild strawberry, which does not flower when grown in short-day, we find a much lower haematin-content in the mature leaves in short-day than in long-day (in agreement with the decrease in chlorophyll content). But the opposite occurs in hemp, a plant in which flowering is immediately induced by short-day. A typical experiment is shown in Fig. 2.

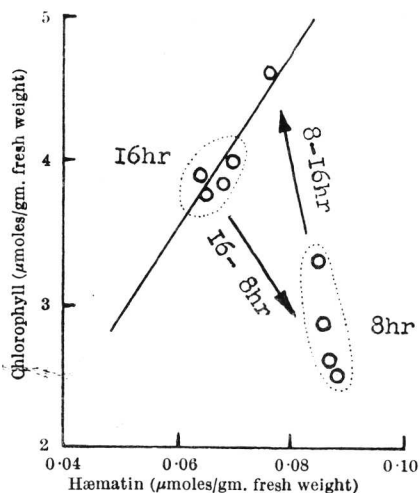


Fig. 2. Effect of transfer from long to short days and vice versa on chlorophyll/hæmatin ratio in hemp. (The arrows indicate directions of transfer; see text)

In long-day, hemp shows the normal molar ratio chlorophyll/hæmatin of about 60. If one transfers it at the stage of four expanded leaves from long- to short-day, the chlorophyll content immediately decreases². In this particular case, however, instead of decreasing, the hæmatin content increases (the molar ratio chlorophyll/hæmatin drops to 30-40). In short-day, there is about 30 per cent more hæmatin than in long-day. The transformation is very rapid. It needs only five short days to show a significant effect in the fourth leaf. It is entirely reversible. After five short days, the transfer back to long-day leads to an increase of chlorophyll content and a decrease of hæmatin. The molar ratio chlorophyll to hæmatin returns to its normal value of 60. At the same time, induction of flowering stops.

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C. SIRONVAL

Department of Biochemistry,
Cambridge, and
Laboratory of Plant Physiology,
Centre des Hormones Végétales,
Liège. Aug. 1.

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