THE PHYSIOLOGY OF SPROUTING AND FLOWERING IN ONION BULBS: PHOTOPERIOD AND TEMPERATURE EFFECTS

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Abstract

Onion bulb growth and development are affected by photoperiod, light quality and light interception. In short-days no bulbs are formed; in long-days large bulbs are formed, but take some time to mature; in very long-days small bulbs are formed and mature quickly. The effect of photoperiod depends on light quality; bulb growth is stimulated by far-red light. In conditions favourable to bulbing, sucrose and oligosaccharides accumulate in the bulb. Bulb growth and carbohydrate accumulation depend on current environmental conditions and cease if conditions are no longer favourable. High light intensity and leaf area enhance bulb growth.

Photoperiod and temperature effects on sprouting and floral development, and the effect of duration of chilling at 8°C on inflorescence development, were investigated in three cultivars of onion. The cultivars used were early maturing ('Sakigake Yellow'), midseason ('Gladalan Brown') and late maturing ('Early Long Keeper'). These cultivars were subjected to treatments comprising all combinations of two photoperiods (8 h and 14 h) and two constant temperatures (15°C and 20°C), except that 'Sakigake Yellow' was subjected to constant 8°C in 8 h days instead of 15°C and 14 h days. 'Sakigake Yellow' sprouted readily under all conditions except 8°C; 'Gladalan Brown' sprouted much faster in short-days than in long-days; and 'Early Long Keeper' sprouted poorly in all conditions. In long-days, some 'Gladalan Brown' plants showed evidence of remobilisation of assimilates, leading to growth of new bulbs within the original one, without growth of leaf blades.

'Early Long Keeper' plants were slow to develop roots as well as to sprout. Leaf appearance rates after sprouting were affected by photoperiod in 'Sakigake Yellow', and in 'Gladalan Brown' they were affected by both photoperiod and temperature. Rates were lower in long-days, and photoperiod had more effect at 15°C than at 20°C. It appears that bulbs of 'Sakigake Yellow' and 'Gladalan Brown' were ecodormant when planted, requiring only sufficient water to begin growth; however, leaf appearance in 'Sakigake Yellow', and both sprouting and leaf appearance in 'Gladalan Brown', showed a photomorphogenetic response to photoperiod. 'Early Long Keeper' bulbs were very slow to root and to sprout, indicating that they required more than the availability of water to begin growth, and were therefore not simply ecodormant when planted. The effects of duration of chilling at 8°C and subsequent photoperiod and temperature on floral initiation and development in three onion cultivars were investigated. Four weeks of chilling at 8°C followed by four weeks of growth at 15°C was sufficient for floral initiation in 'Gladalan Brown' and 'Early Long Keeper', but the bolting-resistant cultivar 'Sakigake Yellow' required eight weeks of chilling at 8°C followed by four weeks of growth at 15°C. With all cultivars, subsequent emergence of inflorescences was more rapid in 14 h days than in 8 h days, but at 20°C there was abortion of some inflorescences in 14 h days. Development of the emerged inflorescence to anthesis was also rapid in 14 h days, and faster at 20°C than at 15°C. There was apparent competition between leaf growth and inflorescence development in 8 h days, with resultant abortion of some inflorescences. At 15°C in 8 h days many of the inflorescences had bulbils or malformed florets in the inflorescence. Mature onion bulbs may be brought into flower in 35 weeks by sprouting them for 8 weeks in 15°C and 8 h days, followed sequentially by 8 weeks chilling at 8°C, 10 weeks at 15°C and 8 h days (until most plants have emerged inflorescences), and 8-10 weeks at 20°C in 14 h days. Knowledge of the responses of specific cultivars would allow the time to flowering from planting to be reduced further. Malformations occurring during floral development in unfavourable conditions are described; these are compared with floral development in *Allium cepa* var. *proliferum*. A conceptual model for dry weight partitioning in onion bulbs is described.

Keywords: photomorphogenesis, *Allium cepa* L., dormancy, bulb sprouting, inflorescence initiation, floral initiation, inflorescence development, floral development, light interception, phytochrome, red/far-red ratio, plant growth models.

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