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DUAL EFFECT OF NIGHTBREAK LIGHT

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ABSTRACT

Experiments with *Salvia occidentalis*, a short-day plant, showed that red nightbreak light which normally is effective in causing a long-day effect, can under certain conditions antagonize the long-day effect of a supplemental light period, thus causing a short-day effect. This short-day effect of nightbreak light disappears when the length of the nightbreak period is increased or when it is followed by an irradiation with far red (= near infra red).

INTRODUCTION

In a previous paper (MEIJER, 1959) it has been demonstrated with several photoperiodically sensitive plants that at least two different photoperiodic reactions are involved in a long-day effect, viz. a main-light-period reaction and a nightbreak reaction. The nightbreak reaction, especially sensitive to red light, depends on a main-light-period reaction which is specially induced by far red or blue radiation. Further the effectiveness of far red and blue radiation in the main-light-period reaction is antagonized by red light. Such an antagonism between different spectral regions also exists in the case of the night-break reaction, the effect of red radiation being nullified by a following irradiation with far red or blue.

In this paper experiments are described which show that red nightbreak light not always causes a long-day effect and can even reverse the long-day effect of a long-day treatment under certain conditions.

METHODS AND MATERIAL

In these experiments *Salvia occidentalis*, an obligate short-day plant, was used; the arrangement for irradiation has been described before (MEIJER, 1957). The main light period was given with blue light as it was found that this light quality is more effective than white light in causing a long-day effect. For the sake of convenience the duration of the main light period and of the supplemental light period is given in number of hours, the duration of a night interruption in number of minutes followed by an apostrophe. The temperature was kept constant at 22° C. The duration of the treatment was 28 days after which the plants were transferred to long-day conditions in a glasshouse.

EXPERIMENTAL RESULTS

With *Salvia* it was found (MEIJER, 1959) that the ineffectiveness of supplemental red light of low intensity, in changing a short day into a long day, was not due to an inactivity of the supplemental light period, but to an antagonizing effect of the first part of the red-light period which followed immediately after the main light period.

The following experiment was carried out to investigate whether the same inhibition occurred with a nightbreak treatment. Groups of 4 plants each were exposed daily to a main light period of 8 hours of blue light. One group was kept in darkness during the remaining 16 hours (8 B). Other groups were irradiated:

a) supplementarily for another 4 hours with red (8 B 4 R) or blue light (8 B 4 B);
b) with 15 minutes of red nightbreak light (8 B–15′ R) during the dark period, 7½ hours before the main light period started again;
c) with a combination of the supplemental 4 hours of red or blue light and the 15 minutes of nightbreak light (8 B 4 R–15′ R and 8 B 4 B–15′ R).

A similar series of treatments was carried out but with a main light period of 10 hours of blue light per day instead of the 8 hours period of the foregoing series (10 B, 10 B 4 R, etc.).

The intensity of the blue light was 680 μW/cm² and of the red light 830 μW/cm². The results are given in Table I.

TABLE I

The photoperiodic effect of supplemental light and nightbreak light following after a main light period of 8 hours and 10 hours of blue light. Intensity of blue light 680 μW/cm² and of red light 830 μW/cm². Duration of the treatment 28 days. + = generative (short-day effect); — = vegetative (long-day effect). Observations after 54 days

Main light period in hours per day	Supplemental light period in hours per day	Nightbreak in minutes per day	Conditions of the growing points
8 B	—	—	+ + + +
8 B	—	15′ R	— — — —
8 B	4 R	—	+ + + +
8 B	4 R	15′ R	+ + + +
8 B	4 B	—	+ + + +
8 B	4 B	15′ R	— — — —
10 B	—	—	+ + + +
10 B	—	15′ R	— — — —
10 B	4 R	—	— — — —
10 B	4 R	15′ R	+ + + +
10 B	4 B	—	— — — —
10 B	4 B	15′ R	— — — —

In preliminary experiments it was found that an exposure to 12 hours of red or blue light per day caused a short-day effect. An irradiation of 14 hours of blue light caused a long-day effect; 14 hours of red light were not completely effective in this respect.

As can be seen in Table I a supplemental light treatment with

4 hours of red or blue light was only effective in obtaining a long-day effect when given after a main light period of 10 hours (10 B 4 R and 10 B 4 B), but not after 8 hours of light per day (8 B 4 R and 8 B 4 B).

As expected, a long-day effect could also be obtained with nightbreak light after a main light period of 8 or 10 hours of blue light (8 B–15′ R and 10 B–15′ R).

However, when the main light period was composed of 8 hours of blue + 4 hours of red light (which by itself induced a short-day effect), no long-day effect could be obtained by a nightbreak of 15 minutes (8 B 4 R–15′ R = short day).

Still more remarkable was the fact that the nightbreak light caused a short-day effect after a main light period of 10 hours of blue + 4 hours of red light, which by itself resulted in a long-day effect (10 B 4 R = long day, 10 B 4 R–15′ R = short day).

When the main light period consisted of 14 hours of blue light, no such activity of the nightbreak light could be observed (14 B = long day, 14 B–15′ R = long day).

In another experiment, the results of which are given in Table II, it was found that by increasing the length of the nightbreak period after a main light period of 10 B 4 R a long-day effect was obtained again. In this experiment the light intensities of blue and red light were 750 μW/cm^2 and 810 μW/cm^2, respectively.

TABLE II

The influence of the length of the nightbreak period on the photoperiodic effect of a supplemental light treatment. Intensity of blue light: 750 μW/cm^2 and of red light: 810 μW/cm^2. Duration of the treatment 28 days. + = generative (short-day effect); — = vegetative (long-day effect). Observations after 55 days.

Main light period in hours per day	Supplemental light period in hours per day	Nightbreak in minutes per day	Conditions of the growing points
10 B	—	—	+ + + +
10 B	4 R	—	— — — —
10 B	4 R	5′ R	+ + + +
10 B	4 R	10′ R	+ + + +
10 B	4 R	15′ R	+ + + —
10 B	4 R	30′ R	+ + — —
10 B	4 R	60′ R	+ — — —

As can be seen in Table III, the short-day effect of red nightbreak light (10 B 4 R–10′ R) was also annulled when it was followed by an irradiation with far red (10 B 4 R–10′ R 10′ FR).

CONCLUSION

It is clearly shown in this paper that it depends on the preceding light period whether nightbreak light causes a long-day effect. It is quite remarkable, however, that a nightbreak given after a special treatment which just causes a long-day effect even reverses this long-day effect. This short-day effect of a nightbreak disappears when its length is increased or when it is followed by far-red radiation.

TABLE III

The influence of far red on the effect of red nightbreak light. Intensity of blue light 680 μW/cm^2; of red light 870 μW/cm^2 and of far red 300 μW/cm^2. Duration of the treatment 28 days. + = generative (short-day effect); — = vegetative (long-day effect). Observations after 51 days.

Main light period in hours per day	Supplemental light period in hours per day	Nightbreak in minutes per day	Conditions of the growing points
10 B	—	—	+ + + +
10 B	—	10′ R	— — — —
10 B	—	10′ R 10′ FR	+ + + —
10 B	4 R	—	— — — —
10 B	4 R	10′ R	+ + + +
10 B	4 R	10′ R 10′ FR	— — — —

So it appears that under certain conditions the short-day plant *Salvia occidentalis* behaves like a long-day plant, nightbreak causing flower initiation. A special light treatment caused only vegetative growth (10 B 4 R); a nightbreak of 10 minutes of red light added to this main light period induced flowering (10 B 4 R–10′ R).

A comparable phenomenon has been reported by DE LINT (1959) for *Hyoscyamus niger*, a long-day plant. Under certain conditions flowering was obtained; an interruption of the dark period, however, caused vegetative development, i.e. a short-day effect.

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