THE INFLUENCE OF GREEN LIGHT ON GEOTROPISM OF AVENA COLEOPTILES

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SUMMARY

Monochromatic green light (563 nm) of very low intensity (2.10^{-5} W m^{-2}) given to isolated *Avena* coleoptiles shortly before the beginning of geotropic stimulation enhances the ensuing curvature.

1. INTRODUCTION

In experiments on physiological processes in plants light may be a disturbing factor, especially in experiments concerning the influence of light. When working in darkness is not possible light is often used with the smallest possible physiological activity. Often monochromatic green light is used as such.

WILKINS (1965), who used green working light during his work on the influence of red light on the geotropism of *Avena* coleoptiles, claims that it did not influence the geotropic reaction.

HUISINGA (1964), however, has demonstrated that small quantities of green light affect the geotropic response of dark grown *Avena* seedlings. In the present experiments on the geotropism of *Avena* coleoptiles minimal quantities of pure green light were used as working light. However, these minimal quantities of green light clearly enhanced the geotropic curvature of *Avena* coleoptiles.

2. MATERIAL AND METHODS

The *Avena* seedlings (var. Victory C.I. 2020) were raised as described by BLAAUW & BLAAUW-JANSEN (1964). After an initial irradiation with red light for 21 hours after soaking of the seeds the seedlings were put in darkness. When the seedlings were about 94 hours old the coleoptiles were excised and after removal of their primary leaves placed on pins in holders with twelve pins. These manipulations were performed in pure green light of 563 nm of very low intensity (about 2.10^{-5} W m^{-2} at the level of the plants). The source has been described by BLAAUW-JANSEN & BLAAUW (1966). The coleoptiles received 2.10^{-2} J m^{-2} of green light at most.

After a subsequent period of three to five hours in darkness part of the coleoptiles were irradiated for 15 minutes with the green light used during the isolation of the coleoptiles. The quantity of light was about 2.10^{-2} J m^{-2} ($= 10^{-11}$ einstein cm^{-2}), and equal for all irradiated coleoptiles. Immediately after the irradiation or 30 minutes after the end of the irradiation the coleoptiles were placed in a horizontal position and shadowgraphed with 30 minutes intervals (this differ-

ence in time between the irradiation and the beginning of the geotropic stimulation did not cause clear differences in the geotropic curvature of the coleoptiles).

The shadowgraphs were made on Kodak Royal X pan sheet film with light of 560 nm from an incandescent lamp with a 560 nm "Depal" double band filter. About 10^{-5} J m^{-2} of this light was sufficient to produce satisfactory blackening.

Temperature during cultivation and experiment was 23 °C, relative humidity about 95%.

3. RESULTS

As the daily variations in the curvatures were rather great the influence of green light on the geotropic curvature of the coleoptiles was investigated by comparing a sample of coleoptiles irradiated shortly before the beginning of the geotropic stimulation with a sample of coleoptiles grown and isolated at the same time but kept in darkness between the isolation of the coleoptiles and the beginning of the geotropic stimulation. Only the influence of green light that was given shortly before the beginning of the geotropic stimulation was studied.

All samples received green light during isolation of the coleoptiles several hours earlier. Curvatures with 95% confidence intervals after 1½ hours and after 3 hours (sometimes 2½ hours) of continuous stimulation are given in

Table 1. Influence of green light on the geotropic curvature of *Avena* coleoptiles.

	Curvature time 1½ hours			Curvature time 3 hours		
	Curvature in degrees		Sign of	Curvature in degrees		Sign of
	Irradiated	Non irradiated	difference	Irradiated	Non irradiated	difference
I	9 ± 1 (10)	6 ± 2 (12)	+	17 ± 3 (10)	13 ± 4 (12)	+
	9 ± 2 (10)	10 ± 2 (12)	−	21 ± 5 (10)	20 ± 3 (12)	+
	14 ± 4 (11)	12 ± 2 (11)	+	28 ± 7 (11)	22 ± 3 (11)	+
II	11 ± 1 (11)	9 ± 2 (11)	+	19 ± 2 (11)	15 ± 4 (11)	+
	9 ± 1 (10)	8 ± 3 (11)	+	18 ± 3 (10)[1]	15 ± 5 (11)[1]	+
	13 ± 1 (10)	10 ± 2 (10)	+	24 ± 2 (10)	20 ± 3 (10)	+
	11 ± 2 (10)	9 ± 4 (9)	+	16 ± 1 (9)[1]	12 ± 5 (9)[1]	+
	10 ± 2 (12)	9 ± 2 (12)	+	17 ± 3 (11)	18 ± 3 (12)	−
	12 ± 3 (9)	10 ± 2 (9)	+	25 ± 5 (9)	20 ± 4 (9)	+
	7 ± 3 (11)	8 ± 1 (11)	−	18 ± 4 (11)	17 ± 2 (11)	+

[1] In this sample curvature time was 2½ hours.

Curvatures are given with 95% confidence intervals; between brackets the number of coleoptiles. Series I contains the samples irradiated for 15 minutes immediately before the beginning of geotropic stimulation, series II the samples irradiated from 45–30 minutes before the beginning of geotropic stimulation.

table 1. The 95% confidence intervals have been calculated by multiplying the standard deviation of the mean by $t_{0.05}$ for the appropriate number of degrees of freedom.

In the great majority of the pairs of samples the curvatures of the irradiated coleoptiles were larger than the curvatures of the controls with both curvature times, though some of the differences are small. In the few pairs of which the curvatures of the controls were greater than the curvatures of the irradiated coleoptiles the difference was always small. The sign rank test shows this to happen by chance with a probability of less than 5%. Therefore the effect may be regarded as significant.

4. DISCUSSION

From the above data it is evident that green light enhances the geotropic curvature of *Avena* coleoptiles. Also the data of WILKINS (1965), who used about 10^5 times the quantity of green light used in these experiments, show an enhancement of the geotropic curvature of *Avena* coleoptiles through his working light. His conclusion that green light has no influence was based on a statistical test which does not show small differences. Moreover, the effect is clearer with longer curvature times – HUISINGA (1964) used 7 hours, Wilkins 2 hours, the present experiments took 3 hours –, but with a curvature time of $1\frac{1}{2}$ hours the enhancement still shows.

Though green light influences the geotropic curvature of *Avena* coleoptiles it is unlikely that the results of the experiments of WILKINS & GOLDSMITH (1964), WILKINS (1965), and LION (1968) on the influence of red light on the geotropic curvature of *Zea* and *Avena* coleoptiles would have been different if no green light had been used, because green light probably influences physiological phenomena in the same way as red light does, though it does so less effectively. This is made plausible by the action spectra of several phenomena that are influenced by light, with red light as the most active part of the spectrum. These action spectra reach into the green wavelength range (WEINTRAUB & MCALISTER 1942; GOODWIN & OWENS 1948; PARKER *c.s.* 1949; BUTLER *c.s.* 1964; HUISINGA 1964; BLAAUW *c.s.* 1968). As long as the green light does not saturate the phenomenon that is to be studied, the use of green light will make the results less clear, but they will be qualitatively similar to the results obtained, if no green light had been used.

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