9669

Locus and Physiology of Photoperiodic Perception in Plants.

W. F. LOEHWING.

From the Department of Botany, State University of Iowa.

Photoperiodic responses of intact plants whose bases and tops have been exposed to contrasted length of daylight, indicate that the stimulus is not normally transmitted from the exposed area.[1] Flowering is usually restricted to the zone receiving the reproductive photoperiod. More recently, however, by the use of reciprocal grafts of photoperiodically sensitized plants, it has become possible to demonstrate stimulus transfer from one part to another across the graft union.[2] Opaque boxes and cloth bags have also been employed in studies on the interrelationships of contrasted photoperiods on adjacent parts.[1, 3]

The graft technique is not wholly satisfactory in studies of this sort, however, because it is difficult, entails delay and post-operative care, causes considerable mortality and involves the extraneous stimulus of severe traumatism. The results of whip, cleft and bud grafts vary greatly.[4, 5] The use of small bags or boxes impairs gas exchange and creates temperature differences between the exposed and shaded regions, thereby introducing possibility of error since the developmental temperatures of apical meristems also influence the reproductive behavior of many plants. Bagging is tedious and apt to involve injury whenever a large number of multistemmed plants is employed.

In order to minimize these difficulties and at the same time employ contrasted photoperiodic exposure on contiguous parts, plants were grown to a convenient height under vegetative light conditions on opposite sides of a thin, opaque panel having a long, 2-inch horizontal slit. Tops of plants were trained through the slit to various desired lengths from both sides of the panel, and one side was then given long day and the other short day illumination. Long photoperiods were provided by use of automatically controlled electric lights hung from pulleys. Short day exposure was obtained by use of adjustable, black curtains suspended from a light-weight frame

1 Garner, W., and Allard, H., *J. Agric. Res.*, 1925, **31**, 555.

2 Kuijper, J., and Wiersum, L. K., *Proc. Acad. Sci. Amsterdam*, 1936, **39**, 1114.

3 Rasumov, V. J., *Planta*, 1935, **23**, 384.

4 Cajlachjan, M. C., and Yarkovaja, L. M., *Comp. Rend. Acad. Sci. URSS*, 1937, **15**, 215.

5 Moskov, B. S., *Comp. Rend. Acad. Sci. URSS*, 1937, **15**, 211.

on the panel. In this way, the tops of the plants on one side received long day and their bases short day photoperiods, while reverse illumination of parts prevailed for plants on the opposite side of the panel. This arrangement made it possible to interchange the photoperiodic stimulus on the 2 sides without moving the plants.

Seeds of Ito San soybean, a variety flowering in short day, were sown in fertilized soil in 2 gallon jars, 4 plants per jar and 30 jars on each side. A 14-hour day was employed on both sides until plants were 14 inches tall and then a 9-hour day was initiated on one side by use of automatically controlled electric lights. Tops are uniformly designated as "a" in each group, and bases of the same plant receiving the opposite light treatment as "b" (Table I). Plants were divided into 4 groups of 30 on each side of the panel as follows: first and second with the entire upper half of fully foliated shoots protruding through the panel (Groups 1 and 2, Table I). The third and fourth groups were similar except that the protruding upper half of shoots was defoliated except near the tip (3 and 4, Table I). The short day bases of this group were kept continuously exflorated (4b, Table I). The fifth and sixth groups were like the first except that their bases were kept defoliated (5b, 6b) and the short day tops exflorated (5a). In the seventh and eighth groups only 2 inches of the apices projected through the slit (7 and 8).

TABLE I.
Effects of Contrasting Photoperiods on Tops and Bases of Single Plants of Ito San Soybean, a Variety Normally Flowering in Short Day.

Group	Part of Plant	Day Length, in Hours	Other Treatment	Plants in Flower, %	Age at Flowering, days
1a	Top	9	None	100	38
1b	Base	14	,,	0	—
2a	Top	14	,,	0	—
2b	Base	9	,,	100	38
3a	Top	9	Defoliated	0	—
3b	Base	14	None	0	—
4a	Top	14	Defoliated	80	45
4b	Base	9	Exflorated	0	—
5a	Top	9	Exflorated	0	—
5b	Base	14	Defoliated	87	42
6a	Top	14	None	0	—
6b	Base	9	Defoliated	0	—
7a	Apex	9	None	0	—
7b	Base	14	,,	0	—
8a	Apex	14	,,	0	—
8b	Base	9	,,	100	38

Ten days after start of short-day lighting, flowers began to appear on this side (1a, 2b, 8b, Table I). Four days later, flowers appeared in the fifth group, *i. e.,* on long-day, defoliated bases (5b) of plants whose short-day tops had been kept deflorated, followed in another 3 days by flowers on the long day, defoliated tops of the exflorated short-day bases in the fourth group (4a). Thus, it is necessary to defoliate a portion of the dually lighted shoots of soybean to demonstrate the possibility and actual occurrence of transfer of the flowering stimulus. That flowers formed on the defoliated shoots in long day (4a) are the result of the short-day stimulus on the opposite side of the panel is shown by the sequence of flower development. Flowers form first nearest the point of reproductive stimulus, namely nearest the panel and the foliage receiving short day. The flowering stimulus is conveyed downward more readily than upward if the delay in flowering of the defoliated shoots be taken as a criterion. The exfoliated bases (5b) flowered 3 days sooner than the corresponding exfoliated tops (4a).

Defoliated short-day tops (3a) and bases (6b) do not flower, a response which indicates that in soybean the leaves are the perceptive zones of the light stimulus. Though it might seem that failure of reproduction of the defoliated tops (3a) and bases (6b) was due to lack of food, this explanation is precluded both by the healthy appearance of the plants and the fact that flowers did form on the defoliated long-day tops (4a) and bases of exflorated series (5b). Short-day illumination of apex alone (7a) was inadequate for flower formation.

From the foregoing it is evident that the slit panel technique offers a simple and rapid method of subjecting different parts of the same plant to contrasted photoperiods. It permits ready use of larger populations than have been previously reported in studies of this sort, and this with a minimum of injury and care.

The responses to differential lighting are clear cut. The data, considered in conjunction with those of the workers cited and the established fact that photoperiodic responses can be induced in light intensities far below the threshold of photosynthesis, indicate that the flowering stimulus is a foliar influence entirely distinct from carbohydrate synthesis. In fact, the formative floral organization of the plastic nutrients synthesized in leaves apparently depends upon one or more specific inductors whose production in the soybean results from short-day illumination. The stimulus is obviously due to a hormonic or quasi-catalytic substance of foliar origin, normally inducing reproduction in closely adjacent areas in such a way that its translocatability is ordinarily not conspicuous in intact plants. Yet by properly combining the effects of exfloration and defoliation with photoperiodic illumination, it is possible to demonstrate not only stimulus transfer, but flower inception in normally vegetative regions.

The vegetative stimulus of long-day also appears to exert an inhibitive influence upon stimulus transfer because, in intact plants flowering is restricted to regions receiving short-day treatment, whereas in the defoliated plants (4a and 5b), on the other hand, there is clear cut evidence of transfer. In fact, both the flowering stimulus of short-day and its inhibition in long-day exhibited a direct quantitative relationship to the amount of foliage. The largest number of flowers on defoliated parts appeared on those plants with the greatest number of leaves under short-day illumination. Contrariwise, impedance of transfer varied directly with the number and size achieved by leaves before their removal from defoliated parts.

The postulation of a specific florigenic inductor derives further support from the recent conclusive determination that carbohydrate-nitrogen relations in the soybean are not, as hitherto frequently assumed, the direct causative factors of flowering.[6] Formation of flower primordia precedes the shift in nutrient balance characteristically associated with the transition from the vegetative to the reproductive phase. It seems safe to predict the early isolation and identification of this florigenic agent, a discovery which may provide an explanation for the paradox of its formation in some species under long-day and in others under short-day conditions.

9670

A Stable Metaphosphate Preparation for Use as a Protein Precipitant.*

DAVID R. BRIGGS. (Introduced by R. A. Gortner.)

From the Department of Biochemistry, University of Minnesota.

That metaphosphoric acid causes essentially quantitative precipitation of proteins, in pH ranges acid to the isoelectric point of

[6] Murneek, A. E., *Mo. Agric. Exp. Sta. Res. Bul.*, 1937, **268**, 84.

* Contribution from O. S. A. Sprague Memorial Institute, University of Chicago, and Division of Agr. Biochemistry, University of Minnesota. Paper No. 1550, Journal Series, Minnesota Agricultural Experiment Station.