INHIBITING INFLUENCE OF THE LEAVES ON THE PHOTOPERIODIC RESPONSE OF NOBEL SPINACH

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(WITH TWO FIGURES)

Introduction

CAJLACHJAN (**2**), MOSKOV (**9**), LUBIMENKO (**8**), HAMNER and BONNER (**3**), HAMNER and LONG (**4**) and BORTHWICK and PARKER (**1**) have shown that the flower forming stimulus in short day plants is initiated in the leaves. One leaf of a normal plant kept in a favorable short photoperiod was reported to be sufficient to induce flowering in the short day plants, Biloxi soybean (**1**) and Xanthium (**3**), even though the remaining leaves on the plant were kept in an unfavorable photoperiod. Under certain circumstances, however, involving two-branched plants or grafted plants where one branch or plant is induced to flower while the other is kept in an unfavorable photoperiod, the leaves on the latter branch or plant have been shown to inhibit flowering of that branch or plant. The effect is not carried over to other plant portions (**1, 3, 5**).

Work of this type on long day plants has not been very extensive. KNOTT (**6**) reported that the flower stalk formation in Virginia Savoy and Old Dominion varieties of spinach was not affected by the photoperiod given the bud but only by that received by the leaves. LANG and MELCHERS (**7**) reported that leafy biennial *Hyoscyamus niger* plants which were pre-treated with a low temperature of 5° C., flowered only in a long photoperiod and failed to flower in a short photoperiod or in darkness. If, however, all the leaves were removed from plants which had received a low temperature treatment, they flowered under long photoperiods, short photoperiods, or in darkness. This indicates that the failure of this species to flower in a short photoperiod or in darkness may be caused by an inhibiting effect exercised by the leaves.

Methods and results

PRELIMINARY EXPERIMENTATION

A preliminary experiment with Nobel spinach was run to determine the reactions of this variety to photoperiodic treatment of the bud and the leaves. The plants were grown in flats of a sand-peat mixture and were supplied with a complete nutrient solution. Vegetative plants which had been kept in a 10-hour photoperiod from germination were used for these and subsequent studies. A night temperature of 60° F. was maintained with a minimum day temperature of 70° F. Part of the plants were left intact and part were defoliated so that only the last matured leaf remained. The defoliation

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technic was used when later experimentation showed that leaves in an unfavorable photoperiod exercised an inhibiting influence on flower bud initiation. It was thought desirable to reduce the number of such leaves to a minimum.

The intact plants were given two treatments, 24 plants per treatment, using essentially the same technic as that described by KNOTT (**6**). In the first treatment, the plants were covered with opaque rubberized black cloth so as to maintain a 10-hour photoperiod. The covering was perforated with holes 16 mm. in diameter with iron washers centered over the holes to help hold the cloth in place. The holes were so placed as to expose the bud and a few adjacent young leaves. The plants were then placed under a 24-hour photoperiod (continuous irradiation) made up of solar radiant energy supplemented with 20 footcandles of incandescent lamp radiant energy. This was used for all subsequent long photoperiod treatments. The buds and a few adjacent young leaves, therefore, received 24-hour photoperiods while the remainder of the plant received 10-hour photoperiods.

The second treatment was begun 38 days later, using vegetative plants of the same age as in the first treatment. The plants were placed under the long photoperiod with the entire plant exposed. Final data were taken 52 days after the first treatment was begun.

The one-leafed plants received three treatments, 16 plants per treatment: (1), the entire plant was given a 24-hour photoperiod; (2), the bud was given a 10-hour photoperiod and the leaf a 24-hour photoperiod; and (3), the bud was given a 24-hour photoperiod and the leaf a 10-hour photoperiod. Individual squares of opaque rubberized black cloth were so arranged that the indicated portions of the plants received the indicated photoperiod. Dissection under a low power binocular microscope was made at the end of the experimental period where macroscopic buds were not visible.

No intact plants formed flower buds except those in which the leaves received a long photoperiod, confirming KNOTT'S results with Virginia Savoy and Old Dominion varieties of spinach. Where the plants were defoliated to one leaf and the bud was given a long photoperiod while the leaf received a short photoperiod, the plants also failed to form flower buds. If only the leaf received the long photoperiod and the bud was given a short photoperiod, the results were the same as when both the leaf and bud were given a long photoperiod, *i.e.*, all the plants flowered.

INHIBITING INFLUENCE OF THE LEAVES

In an endeavor to determine if the presence of leaves in an unfavorable photoperiod inhibits flower bud initiation, the flowering of intact plants with only a portion of the plant in a favorable photoperiod and of partially defoliated plants was studied.

Intact plants with approximately nine leaves were given three treatments. A number of leaves developed during the experimental period,

increasing the initial number. The treatments were: (1), one leaf exposed to a 24-hour photoperiod while the remainder of the plant was given a short photoperiod by covering with opaque rubberized cloth at the end of 10 hours of solar irradiation; (2), three leaves exposed to a long photoperiod with the remainder in a short photoperiod; (3), the entire plant exposed to a long photoperiod. The method of curtaining the plants is shown in figure 1.

The plants were grown in subirrigation gravel culture with a complete nutrient solution. The minimum night temperature was approximately 60° F. with a minimum day temperature of 70° F. Twenty-four plants were used for each treatment. The long photoperiod was applied for 26 days after which time the plants were harvested. The plants were 58 days old at the beginning of the experiment. Microscopic dissection was made to observe floral primordia at the close of the experiment.

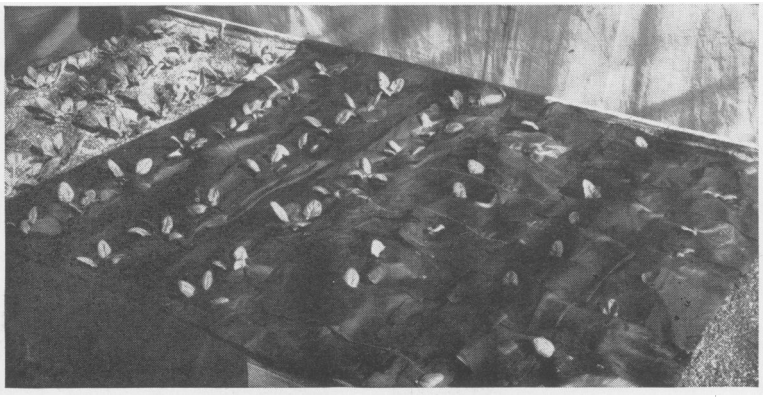

FIG. 1. Method used to curtain intact plants so that one and three leaves received a 24-hour photoperiod while the remainder of the plant received a 10-hour photoperiod.

No flower primordia could be found at the end of the treatment when only one leaf received a long photoperiod. When three leaves were given a long photoperiod, no macroscopic buds developed; but on microscopic examination, 70 per cent. of the plants were found to have developing floral primordia. If the entire plant received a long photoperiod, all the plants had macroscopic buds at 17 days; the first buds were visible in 12 days.

In the defoliation experiments, plants with about nine leaves were defoliated respectively to one and three leaves and left intact. The leaves left on the plant were the youngest mature leaves and were more or less symmetrically arranged about the bud when three remained. The older leaves and the young developing leaves were removed. Young developing leaves were removed daily from the partially defoliated plants after the beginning of the experimental treatments. The plants were placed in a 24-hour photoperiod immediately after defoliation. The same number of leaves received the long photoperiod as was the case with the intact plants. The cultural conditions, age and number of plants, selection of leaves for the

long photoperiod treatment, length of treatment, and method of observation for flower buds were the same as for the intact plants.

The plants defoliated to one and three leaves all had macroscopic flower buds 19 days after the beginning of the treatment, about two days later than did the intact plants. The plants with one leaf first showed floral buds 16 days after the beginning of the treatment and those with three leaves, 13 days. The rate of flower stalk development was greater, in direct proportion to the number of leaves on the plant. It should be pointed out that the leaf area eventually exposed to the long photoperiod was not in proportion to the number of leaves since those plants having only one or three leaves produced much larger leaves than did the intact plants. Figure 2 shows plants in which one and three leaves of partially defoliated and intact plants received 26 long photoperiods.

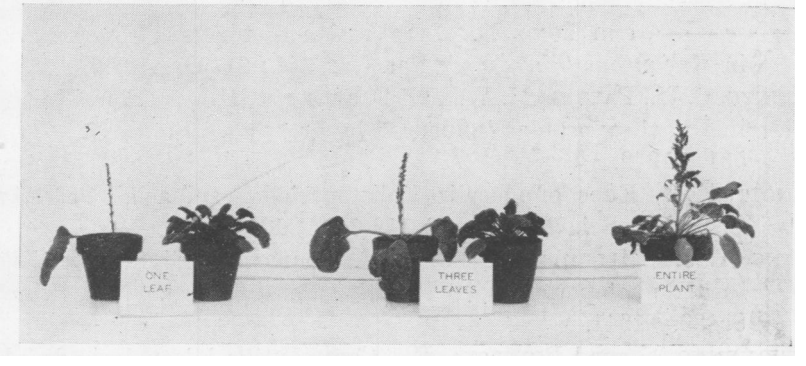

FIG. 2. Flower stalk formation resulted when Nobel spinach plants were defoliated to one and three leaves and given a long, 24-hour photoperiod treatment (left plants of each pair). When corresponding numbers of leaves of intact plants were given long photoperiod treatments (right plants of each pair), those with one leaf exposed to the long photoperiod failed to form floral primordia. Those with three leaves exposed formed floral primordia but no flower stalks during the experimental period.

Discussion

The results secured indicate that the bud of Nobel spinach is relatively insensitive to photoperiod and that the phasic development of the bud is controlled principally by reactions in the leaf. Unlike Biloxi soybean (**1**) and Xanthium (**3**), one leaf of a normal intact plant exposed to a favorable photoperiod was not sufficient to cause flower bud initiation if the remainder of the plant was given a short photoperiod. One leaf, however, was sufficient in the absence of leaves in an unfavorable photoperiod, indicating that leaves in an unfavorable photoperiod exert an inhibiting influence on flower bud initiation and development. Even if three leaves, which approximated one-third of the leaves of the plant at the beginning of the treatment, were exposed to a long photoperiod treatment, the remainder of the leaves kept in an unfavorable photoperiod exerted an inhibiting influence on the expression of the flower forming stimulus initiated in those leaves which were in a long photoperiod.

Conclusions

1. The initiation of flower buds in Nobel spinach is controlled by the leaf and the bud is relatively insensitive to photoperiod.

2. Leaves kept in an unfavorable short photoperiod exert an inhibiting influence on flower bud initiation and development in Nobel spinach.

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