FLORAL INDUCTION THROUGH THE ROOTS OF SILENE ARMERIA L.

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SUMMARY

Induction to the formation of flower buds in *Silene armeria* takes place by exposing the roots to temperatures around 35 °C for some weeks. This result is explained by supposing that a specific DNA in the roots is derepressed by the high temperature, resulting in the formation of the floral hormone, which is translocated to the growing-tip, where it functions.

1. INTRODUCTION

When sown and grown in short day of 8 hours light and 16 hours darkness at a temperature around 20°C – indicated as: $SD_{20°}$ –, *S. armeria* maintains a stage of vegetative rosette indefinitely. Induction of flower bud formation is possible by the action of several external factors, two of which are:

1st. A long day of 16 hours light and 8 hours darkness at around 20°C, indicated as: $LD_{20°}$. After a limited number of $LD_{20°}$-cycles, flower initiation starts and continues in $SD_{20°}$, so that the LD-action is typically inductive (LIVERMAN 1952).

2nd. A relatively high temperature with an optimum near 32° in SD. WELLENSIEK (1966a) demonstrated that this high temperature acts only during the dark phase of a SD and concluded that its action consists of the destroying of an inhibition towards flower bud formation which exists in vegetative plants.

Evidence that $LD_{20°}$ and 32°SD influence the same process is threefold:

1st. After suboptimal induction – which is not followed by flowering in $SD_{20°}$ – a complete desinduction takes place in $SD_{20°}$. This holds true both for $LD_{20°}$ and for 32 °SD (WELLENSIEK 1966c).

2nd. A strong interaction exists between $LD_{20°}$ and 32°SD: both factors can replace and supplement each other (WELLENSIEK 1967).

3d. Selection for rapid or slow induction is possible. Such a selection for 32 °SD involves also a selection for $LD_{20°}$ (unpublished).

After optimal induction the realisation of the flower bud formation takes place through the action of a floral hormone (WELLENSIEK 1966b).

The present problem involves the question whether relatively high temperatures exert a floral inducing action when they are given to the roots only. After having answered this question in the affirmative, its implications will be discussed.

2. METHODS

Four tanks were constructed, filled with water of a constant temperature. In the water of each tank 9 plastic containers were put. These containers were

filled with soil and could each be planted with three vegetative plants. The tanks were put in a room with a temperature of 20 °C and SD-illumination, hence non-inductive circumstances.

The experiments were started with a water temperature of 35 °C. This was fully ineffective. The reason turned out to be a temperature gradient of about 12 °C from the water in the tanks to the soil and to the air. This temperature gradient could be avoided completely by covering the soil with black plastic and a layer of perlite of about 1 cm.

The rosette leaves were bound up, so that the lower ones did not touch the perlite. This was done as an extra precaution against a possibly too high temperature of the lower leaves, which might have an inducing action. Temperature measurements with thermocouples demonstrated the effectiveness of this procedure.

3. EXPERIMENTAL RESULTS

After the failure of the first experiment with a water temperature of 35 °C, an experiment with a water temperature of 45 °C was done, still with uncovered soil, so that the actual root temperature was 33 °C. After treatments during 1, 2, 3, 4 or 5 weeks the plants were aftertreated in both $LD_{20°}$ and $SD_{20°}$.

In $LD_{20°}$ of course 100 % flowering occurred. The differences in numbers of days for visible flower bud formation between the controls – exposed to 20°SD as treatment – and the high temperature treated plants amounted to 2.2, 6.0, 9.7, 12.7 and 21.3 days for 1, 2, 3, 4 and 5 weeks of treatment respectively. From 2 weeks on these values point clearly to an inductive action of the high temperature, to which the roots were exposed.

In $SD_{20°}$ the controls did not flower, as expected. Of the treated plants 17 %, 71 %, 60 %, 88 % and 63 % after 1, 2, 3, 4 or 5 weeks of treatment respectively flowered. This means that these flowering plants were optimally induced during the treatment, already after 1 week, but much better after 2 or more weeks.

The following experiments were performed with the improved technique of covering the soil and binding up the rosette leaves. First of all, different temperatures were compared and the best was found to be 35 °C, 37 °C already being harmful. The inductive factor was then indicated 20°/35°SD, read: temperature of leaves 20°, temperature of roots 35°, SD-illumination. *Fig. 1* illustrates the effect of this treatment.

Next, orientating experiments were taken on the interaction between $LD_{20°}$ and 20°/35°SD. Treatments with 0, 3, 5 or 7 $LD_{20°}$-cycles were followed by treatments with 20°/35°SD during 0, 1, 2 or 3 weeks, while in another series the reversed orders were applied. A certain combination of treatments never gave significantly better results than the best of the combined treatments alone. This means that no interactions were found.

The plants of the last two experiments were used for studying desinduction. As far as they did not come to flower bud formation in $SD_{20°}$, they were moved back to $LD_{20°}$, where they flowered simultaneously, hence were completely desinduced in $SD_{20°}$.

6

Fig. 1. Effect of 20°/35°SD. Duration of treatment (left) 0 weeks as control, (right) 3 weeks. Pretreatment and aftertreatment SD$_{20°}$. Photo was taken 3 weeks from the beginning of the aftertreatment.

4. DISCUSSION

The experimental results have convincingly demonstrated that when only the roots of *S. armeria* are exposed to temperatures around 35°C, the plants become induced to flower bud formation. The inducing effect of such temperatures, when whole plants are exposed to them, was found by CHOUARD *c.s.* (1965) in *Scrophularia alata* and *Stenactis annua*. Hence *S. armeria* is not the only case known, but other cases of an inducing effect of high temperatures when acting on the roots only are unknown to the present author.

The fact that no interactions were found between LD$_{20°}$ and 20°/35°SD is as could be expected, since LD$_{20°}$ is perceived by the leaves, 20°/35°SD is perceived by the roots. The regions of action of both factors are therefore apart from each other, so that no interaction is conceivable.

Regarding desinduction in SD$_{20°}$, 20°/35°SD behaves similarly as LD$_{20°}$ and 32°SD. Also considering the result of WELLENSIEK & ELINGS (1967) that the inhibition towards flower bud formation is not translocated out of leaves in SD$_{20°}$, the most plausible concept of desinduction is not a positive action of leaves in SD$_{20°}$, but simply the absence of an inductive factor.

WELLENSIEK (1966d) has put up a hypothesis on the total mechanism of flower bud formation in *S. armeria*, reading that a specific DNA is involved. This DNA is repressed in vegetative plants (inhibition) and derepression

takes place by any inducing factor. After optimal derepression the DNA starts functioning by forming a specific RNA which either is the floral hormone or gives rise to its synthesis. If this hypothesis would hold true, there is no reason why this mechanism would not work in the roots, for however it may be, root cells have the same chromosomes with the same DNA as the rest of the plant. This would mean that the floral hormone can be synthesized in the root cells and is translocated to the growing-tip, where it functions. The problem arises through what conducting tissue the hormone is translocated. Xylem seems to be more probable than phloem, but this would oppose the usual phloem transport as established by DE STIGTER (1966).

An intrigueing remaining problem is whether high temperature would act in the roots, when these are exposed to light, since high temperature on whole plants acts only in darkness. Also, it would be worth while studying the effect of temperatures around 5 °C on the roots, since such temperatures have a vernalizing effect on whole plants (WELLENSIEK 1964–1966).

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