ACTA SOCIETATIS
BOTANICORUM POLONIAE
Vol. XXXV — nr 2
1966

Observations on the development of plants XII.

The flowering conditions by *Verbascum thapsiforme*

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In field conditions *Verbascum thapsiforme* flowers from July to September. Observations were carried out over three years on plants sown at various dates. Ripe seeds were collected from the lower (August 23), middle (September 11) and upper (October 3) part of the infloerscence of one plant. No differences, dependent on the time and site of seeds formation on the parental plant, were observed in the plant development.

Experiment 1. Seeding on April 1, 1959. The plants were divided into three groups at the end of summer:

1. Plants hibernated in field conditions, coming into flower uniformly and profusely between June 23 and 30, 1960.

2. 30 plants were treated with gibberellic acid at the end of August (200 mg of gibberellin on the apex). At the end of September 6 plants produced stems forming buds. The other individuals hibernated as rosettes, coming into flower by a month earlier than the controls.

3. 20 plants were transferred on October 1 to a hothouse (temperature oscillating within the limits of 12—20°C). 75 percent flowered from April to June.

Experiment 2. Sowing in autumn 1959 in field conditions (3 replications) on 6 dates (Table 1).

Experiment 3 see (Table 2).

Experiment 4. Seeding on November 29, 1959. The plants grew in a hothouse from sprouting to August 15 under continuous light (L_{24}) and short 8 hours day (S_8), then under natural dayliht (N) (combination A). A part of the plants were kept in a vegetation house for vernalization from February 15 to March 1 (B), or from March 15 to May 1 (C) and then replaced in the hothouse. All three variants were treated with gibberellin either in August or January.

Each combination comprised 5 plants. The number of flowering plants is summarized in Table 3 and in parentheses the month is given which they came into flower.

Experiment 5. Plants growing under L_{24} and S_8 were treated with gibberellin (amount as above) at the phase of two leaves. None of the plants flowered nor did they form stems.

Experiment 6. Since in Exp. 4 some plants growing under short daylight and then rising daylight ($S \rightarrow L$) came into flower further observations were carried

Table 1

Experiment 2

Number of plants in series = 60

Seeding	% hibernated	No. of plants in spring	May 31	June 6	June 8	June 12	June 15	June 18	June 21	June 24	June 27	June 30	July 3	July 8	July 14	July 18	Number of days from begining to full bloom
Aug. 17	40	24							1	5	10	15	21	24			17
Sept. 2	60	36						1	6	17	19	22	29	33	36		26
Sept. 17	61	37				1	3	14	19	27	29	32	35	36	37		32
Oct. 3	76	46	2	8	10	16	30	36	45	46							
Oct. 17	81	49	3	11	15	19	26	39	45	47	49						
Oct. 31	42	25									1	6	10	18	24	25	21

For least two seeding dates stem shorter with smaller number of flowers.

Table 2

Experiment 3

Date of seeding	Number of plants	Conditions of plant development	Remarks
Aug. 17 1959	15	12 months in hothouse, on November 19—1961 transferred to the vegetation house, where they remained through winter, spring and summer 1961	till October 1961 exclusively rosettes
Sept. 25 1959	30	4.5 months in hothouse; a part of the plants vernalized in vegetation house from February 15 to March 15, all plants transferred to field conditions in summer	ibid

Table 3

Experiment 4

Combination		Gibberellin		
		0	August 1960	January 1961
L_{24}-N	A	1 (June)	4 (September)	5 (April)
	B	0	4 (September)	5 (April)
	C	1 (June)	5 (September)	5 (April)
S_8-N	A	1 (August)	0	5 (March)
	B	3 (August)	1 (September)	5 (April)
	C	2 (July)	1 (October)	5 (March)

Table 4

Experiment 6

Combination		Number of flowering plants
1	Constantly under continuous daylight (L_{24}) in hothouse	2
2	Constantly under short daylight (S_8) in hothouse	0
3	8 months under S_8 in hothouse +12 months (from March to March) out doors	10
4	15 months under S_8 in hothouse +5 months (October to March) in vegetation house	2
5	8 months under L_{24} in hothouse +12 months (from March to March) outdoors	6
6	15 months under L_{24} in hothouse +5 months (October to March) in vegetation house	4

out. The plants were sown in July. Observations were performed in the course of 20 months (n = 10 plants) (Table 4). Comparison of combinations 3 and 5 indicates that short day applied before 12 months under natural conditions (S → → L → S) vern. (→ L) was more favourable to generative development than L_{24}.

DISCUSSION

1. The transformation to the generative phase, both as regards flowering as well as uniformity, rapidity and profusion of florescence, indicates a high degree of dependence on lower temperatures. Without vernalization only a small number of plants and only after a long time came into flower (in Exp. 4 and 6).

2. Exp. 2 demonstrated that the perception of the vernalization stimultant occurs also at the period of germination, thus an inactive juvenile phase does not occur in *V. thapsiforme*. The plants from very late sowing dates vernalized during the pre-germination phase at water imbibition or after sprouting differed only by a lower flower stalk and smaller number of flowers from the plants, which grew vegetatively for a shorter or longer period before winter. The plants from various sowing dates (Exp. 1 and 2) differed in the time and uniformity of flowering. The plants sown in April (Exp. 1) and in August (Exp. 2) flowered most uniformly, while those sown last were came second as regards uniformity. The earliest flowering was observed in plants sown in October, whereas the latest in those sown last (October 31).

The results of Exp. 3, in which the plants, sown on August 17. grew throughout the year in a hothouse, and after hibernation in field conditions did not come into flower as well as the results of Exp. 6, in which only a part of the plants, grown for 15 months in the hothouse and vernalized, came into flower, seem to point to the existence of an upper limit of the plant's age as regards susceptibility to vernalization.

In Exp. 1, the plants sown in April and transferred to the hothouse on October 1 — flowered. Thus the relatively short period of exposure to lower temperature, under conditions of weaning daylight preceeded by a longer period of growth during the entire vegetative period proved to be sufficient for completing the vernalization.

On the other hand the vernalization, with active temperatures as regards vernalization in February or March (Exp. 3 and 4) proved ineffective or of little effect when the plants grew earlier under constant short and after vernalization under long day.

3. It seems also, that the day-to-night ratio as well as the direction of changes of the light conditions exert a certain influence on the generative processes particularly in interaction with vernalization.

4. In experiments 1, 4 and 5 the plants were treated with gibberellic acid. Gibberellin administered to very young plants at the phase of 2 leaves (Exp. 5) gave no effect. On the other hand, at the same phase, the plants reacted to vernalization.

This observation coincides with the opinion often found in the literature, that gibberellin does not "substitute" vernalization (Phinney, West 1961; Chouard 1960; Rasumov 1960).

Verbascum thapsiforme growing under continuous daylight (Exp. 4, combination $L_{24} \rightarrow N$) when treated with gibberellin rapidly came into flower though after this treatment it grew under weaning daylight and light intensity. Similarly, a part of the plants in Exp. 1 flowered in autumn or in spring earlier than the controls. Also the plants, which were treated with gibberelin at the end of January, when growing under short day and then transferred to rising daylight, came into flower.

On the other hand the plants constantly growing under short-day conditions and weaning light-intensity (after gibberellin) did not flower. Long-day plants, requiring no vernalization, growing under short day generally come into flower under the influence of gibberellin, whereas species requiring vernalization behave in different ways (Purvis 1961; Chouard 1960; Naylor 1961).

From our point of view the data reported by Krekule (1962) are more interesting. This author recorded a retarding influence of gibberellin on the vernalization effect in wheat, when vernalization was performed under short day. Also interesting observations were reported by Barbata and Ochesanu (1963) on wheat; these authors observed that the effect of gibberellin is correlated with day-length, spectral composition and light intensity.

The present results of experiments on *Verbascum thapsiforme* seem to confirm these observations, poiniting to the significance of light conditions and the direction of their changes before and after gibberellin treatment.

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Obserwacje nad rozwojem roślin
Warunki zakwitania Verbascum thapsiforme

Streszczenie

1. Przejście w fazę generatywną wykazuje wysoką korelację z działaniem niższych temperatur
2. Percepcja bodźca jaryzacyjnego zachodzi również w fazie kiełkującego nasienia.
3. Wydaje się, że reakcja na jaryzację zanika powyżej pewnej granicy wieku rośliny.

4. Układy świetlne przed jaryzacją, jak i stan fizjologiczny rośliny wywierają wpływ na efektywność bodźców jaryzacyjnych.

5. Giberelina zastosowana w zbyt młodocianej fazie rośliny, nie daje efektów. Ponieważ w tej samej fazie roślina reaguje na jaryzację — fakty te potwierdzają pogląd, iż giberelina nie „zastępuje" jaryzacji.

6. Efekt gibereliny jest różny w zależności od czasu jej zastosowania i warunków świetlnych (vide Tab. 3).