

# Effects of Vernalization and Preceding Dark Treatment on Floral Induction of Naked Barley

*College of Agriculture, Kangweon National University*

Song, Yoong Nam, and E Hun Kim

## 裸麥品種의 開花誘起에 關한 暗黒前處理와 春化處理의 效果

강원대학교 농과대학

송용남 · 김이훈

### ABSTRACT

The effects of vernalization and darkness on flower initiation were reviewed by using naked barley varieties. The dark effects were pronounced on flower induction even at 25°C. There were no differences in flowering responses among varieties. The effects of vernalization and darkness combined with 25°C were 100% and 60% respectively which showed a significant difference. When the alternation of darkness with light was taken as first and last the flowering rate was 92 per cent. When it was intercalated by light treatments the flowering rate was 91 per cent. Thus the effects of vernalization and darkness seems to differ.

### INTRODUCTION

It has been known that winter naked barley like other winter cereals requires low temperature and long day for the flower initiation. Some workers reported that the effect of vernalization on floral induction can be replaced by short day condition.

Hiroyoshi (1) demonstrated that the short day vernalization effect was most pronounced at 18°C, and the heading was promoted more or less by the short day treatment even at 30°C for floral induction

of naked barley.

Recently it has been reported that flower initiation could be induced by dark treatment even at high temperature (3).

The primary objectives of this study were to determine the relation of mechanism between the dark and vernalization effect on floral induction. The low temperature effect was nullified at 18°C. Therefore, in naked barley, the low temperature and the short day effect seems to have different mechanism in flower induction.

### MATERIALS AND METHODS

As shown in Table 1 four varieties of naked barley were chosen for study. The composition of the basal culture medium is presented in Table 2. For uniformity of plant growth well matured seeds of medium size were selected.

For sterilization the selected seeds were 1) immersed in 80 per cent alcohol for 5 min., 2) washed in distilled water, 3) soaked in 10 per cent calcium hypochlorite solution for 25 min., 4) washed in distilled water, 5) soaked in 3 per cent hydrogen peroxide for 20 min., and finally washed until the smell of chlorine disappeared from the waste water. The test tubes, 16 x 250 mm, containing about 10 ml of the culture medium were autoclaved at 1.2 kg/cm<sup>2</sup>

for 20 minutes. Two grains of naked barley were sown in each tube. For dark cultures, the tubes were wrapped with light-proof paper, kept at 29°C for 48 hours. After germination all the materials were transferred from the thermal chamber to various treatments.

**Experiment 1.** The effect of vernalization and dark treatment. Two temperature levels (5°C, 25°C in darkness, 25°C in light) were given as shown in table 3. The treatment duration was 30 days for Kinai No. 5 and Akashinriki but 45 days for Hashirihadaka and Kobinkadagi.

**Experiment 2.** The duration effect of dark treatment on floral induction of Hashirihadaka. Three levels of duration (15, 30, 40 days) were treated at 5°C and 25°C. Combination of 8 hour light and 16 hour dark was given for the short day treatment at 25°C.

**Experiment 3.** Effect of seedling age prior to dark treatment and vernalization in Hashirihadaka. Five different seedling ages shown in Table 5 were used. The seedlings were grown at 25°C under continuous light prior to dark treatment in which two temperature levels (5°C, 25°C) were chosen.

**Table 1.** Responses to short day in varieties used

Kinai No. 5	:	Spring type. Response to short day is slight.
Akashinriki	:	Spring type. Response to short day is great.
Hashirihadaka	:	Winter type. Response to short day is slight.
Kobinkadagi	:	Winter type. Response to short day is great.

**Table 2.** Component of basic culture medium used.

Substances	Quantity
MgSO <sub>4</sub>	360 mg
Ca(NO <sub>3</sub> ) <sub>2</sub>	200 mg
Na <sub>2</sub> SO <sub>4</sub>	200 mg
KNO <sub>3</sub>	80 mg
NaH <sub>2</sub> PO <sub>4</sub>	65 mg
ZnSO <sub>4</sub>	1.5 mg
KI	1.5 mg
Fe-citrate	4 mg
Sucrose	10 g
Agar	7 g
Deionized water	1000 ml

**Experiment 4.** The alternation effect of dark treatment with vernalization on flower induction. As shown in Table 6 the continuous light treatment at 5°C was alternated with the dark treatment. The other combinations were given in Table 6.

## RESULTS AND DISCUSSION

**Experiment 1.** The effects of vernalization and dark treatment on flower initiation. The dark effects were markedly pronounced on flowering and leaf number even at 25°C as compared with the light effect (Table 3). The fact that the flowering response to dark treatment at 25°C was somewhat low in Kobinkadagi may be due to the specific characteristics of the variety. The plants which received high temperature (25°C) under the light condition flowered 10 or 14 per cent for the spring type (Kinai No. 5, Akashinriki), while no flower was found in the winter type (Hashirihadaka, Kobinkadagi). Although not as high as in the case of low temperature treatment, the rate of flowering when high temperature was given was considerably high as 85, 80, 71, and 54 per cent.

There were no differences in flowering responses among varieties when treated at 5 and 25°C in the dark. The flower primordia was observable about 60 days after sowing. In darkness, the flower primordia of winter type was seen at 7.9, 7.2th nodes. In the light, however, the flower primordia of winter type which received 25°C treatment was shown at 13.5 and 10.7th nodes.

**Experiment 2.** Duration effects of preceding dark treatment on flower induction. The degree of response to duration is given in Table 4. In case of 5°C treatment, no significant differences were not obtained in flowering rate between 30 and 45 days but significant difference occurred between them when treated at 25°C. Mean value for leaf number at the time when flower primordia could be seen is also presented in Table 4.

**Experiment 3.** Effects of seedling age prior to dark treatment and vernalization on floral induction. Regardless of varying seedling ages all the plants

which received 5°C chilling in the dark initiated in this variety. Under the conditions of high temperature and darkness, however, the flowering response decreased as the seedling age decreased.

**Experiment 4.** The alternation effect of preceding dark treatment with vernalization on floral induction. As expected, the plants which were treated by low temperature in continuous light produced 100 per cent flower. Under darkness at the same temperature (5°C), the flowering response was nearly the same although it was somewhat less than that of light condition. The combination in which low temperature, darkness coupled with 25°C and low temperature are alternated by 15 days respectively showed nearly the same response as that in which darkness coupled with 25°C, low temperature and darkness are alternated by 15 days. However, the flower induction only by the darkness combined with 25°C gave lower value than those of alternating treatment.

**Table 3.** Effects of vernalization and preceding dark treatment on floral induction of four barley varieties.

Varieties	Preceding treatment*	No. of Plants	Flowering (%)	No. of leaves**
Kinai No. 5	5°C in dark	23	96	7.9 (6.0)
	25°C in dark	20	85	8.6 (6.7)
	25°C in light	20	10	13.5 (6.5)
Akashinriki	5°C in dark	27	93	7.2 (6.0)
	25°C in dark	25	80	8.7 (5.2)
	25°C in light	22	14	10.7 (6.1)
Hashirihadaka	5°C in dark	41	95	9.2 (7.0)
	25°C in dark	34	71	10.5 (7.5)
	25°C in light	25	0	(7.4)
Kobinkadagi	5°C in dark	32	84	10.5 (8.2)
	25°C in dark	26	54	12.3 (8.5)
	25°C in light	26	0	(8.5)

\* : Duration of treatment was 30 days in Kinai No. 5 and Akashinriki but 45 days in Hashirihadaka and Kobinkadagi.

\*\* : The number of leaves of plants without primordia is shown in parentheses.

Inouye (4) reported that in total darkness the barley which received no vernalization initiated flower primordia even at 30°C. This study, which determined the effect of preceding dark treatment

**Table 4.** Duration effects of preceding dark treatment on floral induction of Hashirihadaka.

Preceding dark treatment	Duration (days)	No. of Plants	Flowering (%)	No. of leaves**
5°C	15	30	43	10.2 (7.5)
	30	40	98	9.2 (7.0)
	45	34	94	8.7 (7.0)
25°C	15	23	9	12.0 (7.8)
	30	30	57	11.5 (8.5)
	45	30	80	10.5 (7.5)
short day * at 25°C	15	28	0	(7.8)
	30	24	0	(7.4)
	45	25	0	(6.8)

\* : 8 hour light and 16 hour dark.

\*\* : The number enclosed in parentheses refers to the plants that did not produce flower primordia.

**Table 5.** Effects of seedling age prior to preceding dark treatment and vernalization on floral induction of Hashirihadaka.

Treatment	Days *	No. of plants	Flowering (%)	No. of leaves**
5°C in dark	0	17	100	7.5
	1	24	100	8.0
	2	20	100	8.5
	5	16	100	8.6
	10	14	100	9.6
25°C in dark	0	28	57	9.8 (7.6)
	1	15	47	10.3 (6.9)
	2	18	33	10.0 (6.4)
	5	14	36	10.4 (6.3)
	10	14	14	10.5 (6.7)

\* : Days of seedling growth at 25°C under continuous light prior to treatment.

\*\* : The number in parentheses indicates the plants which did not produce primordia.

on flower induction, gave a support to the premise that vernalization effect on flower initiation would be replaced by dark treatment even at high temperature. That is, vernalization seems not to be indispensable for flowering in the dark in these four naked barley varieties.

The flowering responses to the duration of vernalization in dark condition vary with plants. Kimura (5) reported that *Raphanus sativus* L. developed flower buds by 120 day cold treatment

**Table 6.** Effects of alternation with preceding dark treatment and vernalization on floral induction in Hashirihadaka.

Days of treatment				No. of plants	Flowering (%)	No. of leaves
0	15	30	45			
[White bar]				17	100	7.5
[Dotted bar]				15	93	8.8(7.0)
[White bar with black bar]				22	91	9.7(7.5)
[Black bar with white bar]				26	92	9.7(7.0)
[White bar]				20	60	9.8(6.4)
[Hatched bar]				23	0	(6.2)

[White bar] : 5°C under continuous light,  
 [Dotted bar] : 5°C in darkness  
 [Black bar] : 25°C in darkness  
 [Hatched bar] : 25°C under continuous light

in total darkness. As shown in this study, effect of vernalizing duration in darkness has a significant influence upon flower induction. According to Song (6) developing spikes were not found in both of non-chilling and 15 day dark treatment while two or three out of 20 plants were seen to be at the early stages of spike primordia in both of 30 and 45 day chilled plants in dark condition.

Chujo (2) in his experiment with barley observed that when low temperature was given during the short day treatment its effect was not marked, and that the short day vernalization was effective with the rise in the temperature during the dark period up to 14°C or 18°C or the rise in the temperature during the photoperiod up to 18°C or 22°C.

Considering our experiment, it is evident that no differences in flowering response occur among the seedling ages when treated at 5°C in the dark. However, when treated at high temperature in the dark the response of flower induction to seedling age was less with the increase of seedling age. Our results showed that the responses of alternating darkness with light was much the same as the case of continuous light treatment at 5°C. On the other hand, the flower initiation was less in the continuous dark condition at 25°C than in the alternation.

#### LITERATURE CITED

1. Hiroyoshi Chujo 1961. Studies in short day

vernalization of barley.日本作物學會紀事 第30卷60.

2. Hiroyoshi Chujo 1975. Studies of vernalization in wheat and barley plants, especially on effects of factors or the vernalization of growing plants. Bull. Univ. Osaka Pref., Ser. B Vol. 27 : 253 ~ 255.  
 3. Jun Inouye 1965. Flower initiation in total darkness in a quantitative short day plant, *Fagopyrum Esculentum* Moench. Plant & Cell Physiol., 6 : 167 ~ 177.  
 4. Jun Inouye and Kenji Ito 1968. Flower initiation in total darkness in long-day plant, *Hordeum vulgare* L. var. *nudum* Hook. f. Plant & Cell Physiol., 9. 137 ~ 142.  
 5. Kazuyoshi Kimura 1961. Effect of temperature and nutrients on flower initiation of *Raphanus sativus* L. in total darkness. Bot. Mag. Tokyo. 74: 361 ~ 368.  
 6. Song, Yoong Nam 1975. A study on vernalization in total darkness in wheat. Res. Bull. Kangweon Univ. Vol. 9 : 31 ~ 34.

#### 摘 要

暗黒處理가 裸麥의 開花誘起에 대한 一連의 試驗 結果는 다음과 같다.

##### 1. 低温과 暗黒處理의 效果

低温效果에 對하여 反應이 뚜렷한 4 가지 裸麥品種에 對한 暗黒處理의 效果는 모두 低温效果와 同一하고 5°C下에서 80~90%의 開花誘起를 보였으며 秋播型이며 短日春化에 민감한 Kobinkadagi品種을 제외하고 나머지 3品種은 高温(25°C)에서도 低温效果에는 미치지 못하나 71~80%의 開花誘起를 보였다.

##### 2. 暗黒處理期間의 效果

Hashirihadaka品種의 暗黒處理期間에 따른 開花效果는 45日 처리가 제일 높았고, 5°C인 경우에는 30日과 45日사이에서 차이가 없었으나 25°C인 경우에는 3 가지 수준사이에 有意的인 차이가 있었다.

##### 3. 暗黒處理前의 苗齡에 의한 效果

2 가지 溫度水準에 있어서 開花效果는 5°C인 경우에는 苗齡에 관계없이 모두 開花하였으나 25°C인 처리구에서는 묘령이 증가할수록 開化率이 감소하였다.

#### 4. 低温暗黒 交互處理效果

低温과 暗黒의 全期間(45 日) 處理에 의한 開花率은 100%와 60%로써 有意的 차이를 나타내었고 初期와 後期の 15 일간씩의 交互處理效果는

91%, 中期 15 日間の 交互效果는 92%의 開花率을 보였으므로 低温과 暗黒의 作用機構는 相異한 것으로 思料된다.