

# 水稻極早生品種の花芽分化におよぼす日長,光の強さおよび 培地の影響

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## Effects of Photoperiod, Light Intensity and Components of Culture Medium on Flower Initiation in Highly Thermo-Sensitive Paddy Rice Plants\*

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Flower initiation in highly thermo-sensitive rice varieties have been investigated in our laboratory. By using a sterile culture method, the present experiment was performed to study the effects of photoperiod, light intensity and components of culture medium on flower initiation in two highly thermo-sensitive rice varieties.

### MATERIALS AND METHODS

Two highly thermo-sensitive varieties of paddy rice plants, *O. sativa L.*, *japonica type*, Norin No. 11 and Norin No. 15, were used as materials for this experiment.

The basic culture medium was a modified White's solution. Unless otherwise mentioned, it contained 360 mg MgSO<sub>4</sub>, 200 mg Na<sub>2</sub>SO<sub>4</sub>, 200 mg Ca(NO<sub>3</sub>)<sub>2</sub>, 80 mg KNO<sub>3</sub>, 65 mg KCl, 16.5 mg NaH<sub>2</sub>PO<sub>4</sub>, 4.5 mg MnSO<sub>4</sub>, 1.5 mg Zn<sub>2</sub>SO<sub>4</sub>, 1.5 mg H<sub>3</sub>BO<sub>3</sub>, 0.75mg KI, 10 mg Fe-citrate, 20 g sucrose, 6 g agar and 1000 ml distilled water. The medium was placed in test tubes, 16×250 mm, 20×350 mm and 24×350 mm, and autoclaved at 1.0 kg/cm<sup>2</sup> overpressure for 20 minutes.

To obtain uniform growth, well matured seeds of medium size were selected. After husking, seeds were sterilized by immersing in 80% alcohol for 3 minutes, in 10% solution of chlorinated lime for 20 minutes and finally in 3% hydrogen peroxide for 20 minutes. The seeds were then sown aseptically in cotton-stoppered tubes, so that each tube contained one seed. The upper portion of the tube was covered with paper to prevent the medium

from drying. After incubation at 25°C for 48 hours in darkness, the tubes containing of germinated seeds were transferred to sunlight rooms or artificial light rooms (3000 and 5000 lux) of a phytotron in our University. Light intensity in the artificial light rooms was measured with Cadmium iodide lux-meter.

The plants were examined for flower initiation 90~100 days after the start of the experiment. The effect of the treatment was evaluated by the number of leaves formed before the initiation of flower primordia on main culm. In some cases, the observation of flower primordia was carried out with a binocular microscope. Each experimental lot consisted of about 15 tubes. As the experiments with the two varieties showed nearly the same results, the data with Norin No. 15 will be mainly presented in this experiment. The materials have been obtained through the kindness of the Hokkaido Agricultural Experiment Station.

### RESULTS AND DISCUSSION

#### 1. Effects of photoperiod and sucrose concentration in culture medium on flower initiation

Since the investigation of Roberts and Struckmeyer, it is widely known that photoperiodic response of short day plants varies with temperature and environmental factors<sup>1,2,3,4</sup>.

In this experiment, sucrose concentrations in culture media (40 ml) were 0, 1, 3 and 5%. After incubation at 25°C for 48 hours in darkness, the plants were cultured under sunlight for 8 hours and subjected to 50 lux (long day) or darkness (short day) for 16 hours. Cultural temperatures were 15, 20, 25 and 30°C

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( $\pm 2^{\circ}\text{C}$  in each). The results are shown in fig. 1.

As shown in fig. 1, flowering response of this rice plant was the same in long day and short day at 20 and 25°C on the media containing 1, 3 and 5% sucrose. On the other hand, flowering response was inhibited under short day than under long day on the media containing 0, 1 and 3% sucrose at 15°C. However, flowering response was inhibited under long day than under short day on the media containing 3 and 5% sucrose at 30°C. At 30°C, the plants on the sucrose-free media could not initiate at all in both of light conditions.

From the above results, it seems to be said this rice variety is a neutral plant at from 20 to 25°C on the cultural media containing 1, 3 and 5% sucrose, though the photoperiodic response of this variety is affected by cultural temperature and sucrose concentration in culture medium.

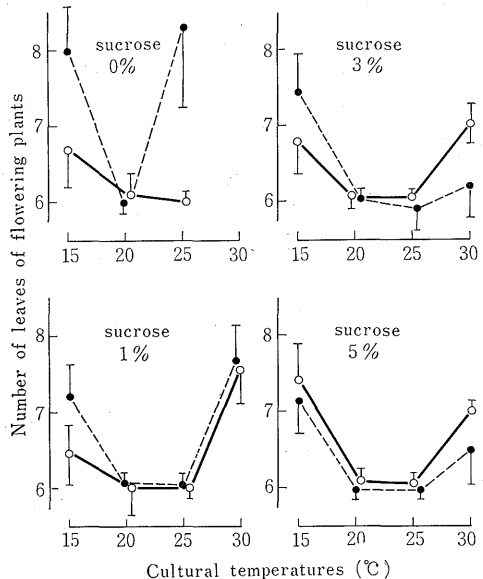


Fig. 1. Effects of photoperiod and sucrose concentration in culture medium on flowering in rice plants. (variety; Norin No. 15)

Note: ○ long day ● short day (8 hours light)

Vertical bars represented standard deviation of the mean

## 2. Effect of volume of culture medium in a tube on flower initiation

i). Under sunlight condition, effect of volume of culture medium in a tube, 24×350 mm, on flower initiation was examined. The volume was 40, 30, 20 or 10 ml. Sterilized seeds were sown on 17th of January and 14th of May in 1965. After incubation, the tubes were subjected to cultural temperatures of 25°C (8 hours) —20°C (16 hours) or 30°C (8 hours)—25°C (16 hours) under natural day length in sunlight rooms. As the results of these experiments, there were no differences in seeding times and cultural temperatures. Table 1 shows the result of experiment on 14th of May at 25°C —20°C.

With decreasing of the volume of culture medium from 40 to 10 ml, flower initiation of this rice plant was fairly promoted, i.e. the number of leaves formed before flower initiation were 6.0 in 40 ml, 5.8 in 30 ml, 5.1 in 20 ml and 5.0 in 10 ml, respectively. Plant height and dry matter in these plants, however, showed lower values with decreasing of the volume of culture medium.

ii). Under low light intensity (5000 lux) in continuous light condition at 25°C, volume of culture medium were 40 ml in 24×350 mm, 30 and 20 ml in 20×350 mm, and 10, 5 and 2.5 ml in 16×250 mm. The results are presented in table 2.

Flower initiation was promoted with decreasing of volume of culture medium as same result as under sunlight condition. Moreover, the plant initiated flowers even on the medium of 2.5 ml in

Table 1. Effect of volume of culture medium on flowering in rice plants under sunlight condition at 25 —20°C. (variety; Norin No. 15)

Volume of media (ml)	Number of plants	No. of flowering plants (%)	No. of leaves of flowering plants with standard deviation
40	19	100	6.0±0.00
30	33	100	5.8±0.41
20	30	100	5.1±0.37
10	27	100	5.0±0.39

volume, though the plant grew poorly. It seems that effect of the volume on flower initiation in this rice variety may be caused by drying of culture medium or deficiency of nutrients.

In order to obtain more detailed information to this subject, following experiments were designed. (a) The volume of culture medium was 40 ml in each lot in which the basic culture solution (modified White's minerals) were 40, 30, 20, 10, 5 and 2.5 ml. That is, concentrations of the basic solution were 100, 75, 50, 25, 12.5 and 6.25% (agar 0.6% and sucrose 2%), respectively. (b) Culture media (10 ml) containing 1% sucrose and peptone (0.1 - 0%) with

minerals of White's solution were used for examination of the effect of organic nitrogen flowering. The results are shown in tables 3 and 4.

As shown in table 3, flower initiation in this rice plant was promoted with decreasing of concentration of the basic culture solution in the medium. On the other hand, peptone added to the medium inhibited flower initiation (table 4). These results suggest that promotion of flowering with decreasing of culture medium is not by drying of the medium but lack of nutrients. Flower initiation in this rice variety may be also related to the amount of nitrogen.

### 3. Effects of components of culture medium and light intensity on flower initiation

From tables 1 and 2, it was considered that flower initiation of these rice varieties was inhibited under low light intensity, i.e. number of leaves of flowering plants on 40 ml of culture medium was 6.0 under sunlight condition and 6.6 under 5000 lux. In order to examine the effect of light intensity, rice plants of Norin No. 11 and Norin No. 15 were cultured under various light intensities (900~5000 lux) in continuous light condition at 25°C. In this case, following culture media of 10 ml in volume were used. A, 0.6% plain agar; SA, 1% sucrose + 0.6% agar; MA, minerals + 0.6% agar; MSA,

Table 2. Effect of volume of culture medium on flowering in rice plants under continuous light of 5000 lux at 25°C. (variety; Norin No. 15)

Volume of media (ml)	Number of plants	No. of flowering plants (%)	No. of leaves of flowering plants with standard deviation*
40	19	100	6.6±0.48
30	15	100	6.3±0.34
20	15	100	5.7±0.57
10	11	100	5.4±0.51
5	22	86	5.3±0.81 (5.0±0.00)
2.5	16	87	5.0±0.00 (5.0±0.00)

\* The number of leaves of plants without flower primordia is enclosed in parenthesis.

Table 3. Effect of concentrations of basic minerals in culture medium (40 ml) on flowering in rice plants under continuous light of 5000 lux at 25°C. (variety; Norin No. 15)

Conc. of minerals in media (%)	Number of plants	No. of flowering plants (%)	No. of leaves of flowering plants with standard deviation
100	9	100	6.4±0.68
75	8	100	6.0±0.00
50	9	100	6.0±0.00
25	8	100	5.6±0.06
12.5	8	100	5.1±0.33
6.25	9	100	5.1±0.31

Table 4. Effect of peptone in culture medium (10 ml) on flowering in rice plants under continuous light of 5000 lux at 25°C. (variety; Norin No 15)

Cnnc. of peptone in media (%)	Number of plants	No. of flowering plants (%)	No. of leaves of flowering plants with standard deviation*
0.1	6	17	9.0±0.00 (8.0±0.00)
0.01	6	100	7.8±0.41
0.001	11	100	7.7±0.47
0.0001	8	100	6.4±0.51
0.00001	15	100	5.3±0.59
0	12	100	5.1±0.29

\* The number of leaves of plants without flower primordia is enclosed in parenthesis.

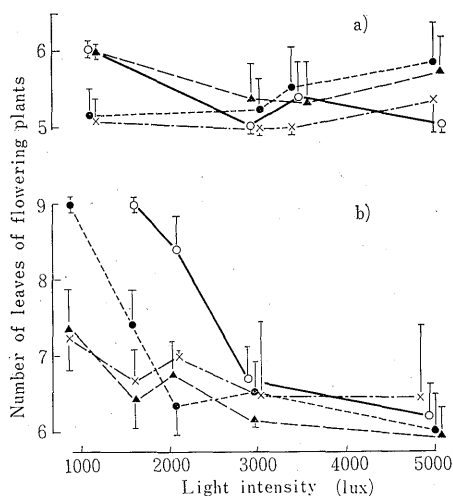


Fig. 2. Effects of components of culture medium and light intensity on flowering in rice plants at 25°C.

variety; a, Norin No. 11

b, Norin No. 15

Note: ○ MSA ● MA ▲ SA × A

Vertical bars represented standard deviation of the mean

minerals + 1% sucrose + 0.6% agar. The results are shown in fig. 2.

It is seen from fig. 2 that the flowering response of these rice plants decreased with decreasing of light intensity regardless of components of culture medium. In this experiment, the effect of light intensity on flower initiation was likely more obvious in the plants cultured on MA and MSA media than in the plants on A and SA media. Furthermore, for flower initiation under continuous light condition at 25°C, Norin No. 11 likely requires higher light intensity than Norin No. 15.

From the above facts, it seems that light intensity may play an important role in flowering in highly thermo-sensitive rice plants, and critical light intensity for flowering in these rice varieties may be about 900 lux or less under continuous light condition at 25°C.

#### SUMMARY

By using highly thermo-sensitive paddy rice plants, *O. sativa* L., Norin No. 11 and Norin No.

15, effects of photoperiod, light intensity and culture medium on flower initiation were studied. All the experiments were conducted by an aseptic culture method. The following results were obtained.

1. At the both cultural temperatures of 20 and 25°C, flower initiation occurred after having developed the same leaves in long and short day conditions on the media which contained 1, 3 and 5% sucrose. At 30°C, flower initiation was inhibited under long day on the media containing 3 and 5% sucrose. On the other hand, it was inhibited under short day on the media containing 0, 1 and 3% sucrose at 15°C.

2. Flowering response of these rice plants increased with decreasing of volume of culture medium and reached to a maximum in volume as little as 2.5 ml.

3. Flowering response of these rice plants decreased with decreasing of light intensity, regardless of components of culture medium. It seems that critical light intensity for flower initiation in these rice varieties may be 900 lux or less under continuous light.

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## 〔和 文 摘 要〕

## 水稻極早生品種の花芽分化におよぼす日長，光の強さおよび培地の影響

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感温性の非常に高い水稻農林 11 号および農林 15 号を用いて，花芽分化におよぼす日長と光の強さおよび培地の影響について実験した。実験はすべてガラス管瓶を用い無菌培養法で行なわれた。

1. 自然光下 20°C および 25°C では，培地の糖濃度の高低にかかわらず長日区（連続光），短日区（8 時間日長）ともに同じ節位で花芽が分化した。ところが，30°C では糖 3% および 5% で短日区が長日区より，一方，15°C では糖 0%，1%，3% で長日区が短日区より低節位で花芽が分化した。
2. 培地の組成のいかにかわらず，照度が低下するにつれて花芽分化は阻害された。この実験の範囲内では，感温性の高いイネの花芽分化にとっては 900 lux がほぼ限界照度と考えられる。