

PHOTOPERIODIC STUDIES ON RICE

II. Test of the Interruption of Light-Period and Dark-Period during the Growth Stage of a Short-Day Rice Variety

by

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Introduction

In a previous report (Yü and Yao, 1962) the authors have found that the turning point of the short-day effect and long-day effect on some short-day varieties of rice is between 12- and 13-hours. The flowering of plants of those short-day varieties, when subjected to a dark period of 12 hours or more, would be accelerated. However, an interruption of either the dark-period or the light-period might bring about a change in this photoperiodic effect. Thus, the present experiments were conducted in order to evaluate the effects of the interruption of the light-period or dark-period. It was carried out in 1955, Taipei, Taiwan, China.

Material and Methods

A native Taiwan rice variety, Shuang-chiang (霜降) was used. Two-week old seedlings were transplanted into Wagner's pots. Before starting treatments, the plants were grown in continuous light for 65 days. At night the natural day was extended by light from 200W incandescent bulbs. The distance between the lamps and the experimental pots was one meter. The light- and dark-periods were arranged in two patterns:

A. Eight hours of light and sixteen hours of dark (8L+16D).

B. Both light-period and dark-period twelve hours (12L+12D).

During the middle of the light-period, 15 minutes of darkness was used as an interruption. That is, 4L+¼D+4L in pattern A, and 6L+¼D+6L in pattern B. The 15 minutes of dark time was taken from the dark period to make a 24-hour day. Reversely, the dark period was interrupted by 15 minutes of light in the middle of the dark period. Treatments were started on December 2. Three plants of each treatment were dissected each week. The size and stage of development of the growing point were determined. During the experimental period, mean temperature was around $16.37 \pm 3.31^\circ\text{C}$.

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Results and Discussion

From the results given in Table 1, it appears that the flower buds of control plants (8L+16D) started to differentiate on the 21st day after the beginning of the treatment. Interruption of the 8-hour light period with 15 minutes darkness ($4L+\frac{1}{4}D+4L+15\frac{3}{4}D$) did not affect development, because plants treated this way started to differentiate an inflorescence on the same day. However, when the 16-hour dark period was interrupted ($8D+\frac{1}{4}L+8D+7\frac{3}{4}L$), differentiation did not start until the 35th day of treatment, and the elongation of the growing point was much retarded.

Table 1. The effect of an interruption of the light or the dark period on differentiation and rate of elongation of the growing point of the short-day rice variety "Shuang-chiang" grown in an 8-hour photoperiod.

Treatment	8L+16D		$4L+\frac{1}{4}D+4L+15\frac{3}{4}D$		$8D+\frac{1}{4}L+8D+7\frac{3}{4}L$	
	Length	Width	Length	Width	Length	Width
Dec. 2	0.081±0.002	0.072±0.002				
9	0.099±0.015	0.088±0.016	0.088±0.009	0.079±0.011	0.085±0.009	0.081±0.008
16	0.114±0.018	0.104±0.014	0.109±0.013	0.098±0.011	0.111±0.012	0.098±0.011
23	*0.244±0.090	0.204±0.064	*0.269±0.076	0.224±0.064	0.119±0.024	0.106±0.016
30	0.766±0.086	0.679±0.082	0.487±0.091	0.718±0.075	0.127±0.023	0.109±0.018
Jan. 6	2.460±0.788	0.780±0.089	2.789±0.975	0.837±0.162	*0.238±0.138	0.206±0.037
13	2.830±0.847	0.783±0.158	2.821±0.789	0.863±0.270	0.288±0.142	0.208±0.083

* The flower bud was differentiated. According to Akimoto and Togari (1939), the differentiation stage of the growing point is between the stage of differentiation of the bract primordia and the stage of bract primordia increase.

Similar results were obtained when photoperiod and dark-period were both 12 hours. The inflorescence of control plants (12L+12D) and of plants which received a dark interruption during the light period ($6L+\frac{1}{4}D+6L+11\frac{3}{4}D$) started differentiation after 21 days of treatments, and their rates of elongation were identical. A light break during the dark period ($6D+\frac{1}{4}L+6D+11\frac{3}{4}L$) delayed differentiation till the 42nd day after the beginning of the treatment.

Hamner and Bonner (1938) found in a short day plant, cocklebur, that the short day was no longer effective in inducing flowering when the dark period was interrupted by a very short light break. Similar results were obtained by Harder and Bode (1943) with *Kalanchoë* and by Parker, Hendrick, Borthwick and Scully (1946) with soybean and cocklebur. Cua and Okuda (1950) obtained

Table 2. The effect of an interruption of the light or the dark period on differentiation and rate of elongation of the growing point of the short-day rice variety "Shuang-chiang" grown in a 12-hour photoperiod.

Treatment	12L+12D		6L+¼D+6L+11¼D		6D+¼L+6D+11¼L	
	Length	Width	Length	Width	Length	Width
Dec. 2	0.081±0.002	0.072±0.002				
9	0.094±0.009	0.085±0.011	0.104±0.009	0.092±0.008	0.098±0.006	0.090±0.009
16	0.106±0.084	0.094±0.009	0.117±0.015	0.107±0.012	0.101±0.009	0.092±0.007
23	*0.263±0.213	0.226±0.083	*0.168±0.098	0.141±0.081	0.113±0.035	0.105±0.027
30	0.643±0.213	0.549±0.179	0.370±0.167	0.235±0.166	0.119±0.027	0.107±0.026
Jan. 6	2.071±1.032	0.733±0.124	2.131±1.217	0.760±0.129	0.131±0.028	0.122±0.025
13	2.375±1.290	0.830±0.119	2.563±0.927	0.776±0.254	*0.155±0.042	0.149±0.018

* The flower bud was differentiated. The differentiation stage of the growing point is the same as with the plants shown in table 1.

a similar response to the interruption of dark period by 15 minutes of lightening with three Japanese rice varieties (Kameji No. 1, Kyoto-Asahi, and Aichi-Asahi), however, the effect was not as pronounced as in the plants mentioned above.

The results of this experiment indicate that the interruption of the light period has no effect on the acceleration of flowering of rice, while the interruption of the dark-period strongly inhibits the differentiation of the inflorescence of rice. Furthermore, the interruption of a 12-hour dark-period is more effective than that of a 16-hour dark-period. The closer the length of the dark-period is to the turning point, the more effective is the inhibition of reproductive development of this short-day variety of rice by a light break during the dark-period. This can be explained on the basis of an interaction of the light break with the previous main light period (Claes und Lang, 1947). The interposing of the light break leaves an uninterrupted dark-period of 8 hours in pattern A and 6 hours in pattern B. This means that a light break in the middle of a 12-hour dark-period must be more effective than a break in the middle of a 16-hour dark-period.

Summary

1. The effects of interruption of the light- and dark-period of a Taiwan native short-day variety of rice were tested.
2. The interruption of the light period did not affect the development of the

growing point, but the interruption of dark period strongly inhibited flower initiation.

3. The effect of the light interruption on a 12-hour dark period was stronger than that on a 16-hour period.

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Literature cited

- AKIMOTO S., and Y. TOGARU. Varietal differences in panicle development of rice with reference to early or late transplanting. *Proc. Crop Sci. Soc. Jap.* 11: 168-184, 1939.
- CLAES, H., u. A. LANG. Die Blütenbildung von *Hyoscyamus niger* in 48-stündigen Licht-Dunkel Zyklen und in Zyklen mit aufgeteilten Lichtphasen. *Z. Naturforsch.* 2b: 56-63, 1947.
- CUA, L. D., and M. OKUDA. A note on the effect of light interruption on rice plants receiving short photoperiods. Rep. Kihara Inst. Res. 'Seiken Ziho' 4: 54-56, 1950.
- HAMNER, K. C., and J. BONNER. Photoperiodism in relation to hormones as factors in floral initiation and development. *Bot. Gaz.* 100: 388-431, 1938.
- HARDER, R. u. O. BODE. Ueber die Wirkung von Zwischenbelichtung während der Dunkelperiode auf das Blüten, die Verlaubung und die Blattsukkulenz bei der Kurztagspflanze *Kalanchoë Blossfeldiana*. *Planta* 33: 469-504, 1943.
- PARKER, M. W., HENDRICK, S. B., BORTHWICK, H. A., and N. J. SCULLY. Action spectrum for the photoperiodic control of floral initiation of short-day plants. *Bot. Gaz.* 108: 1-26, 1946.
- YÜ, C. J. and Y. T. YAO. Photoperiodic studies on rice. I. The turning point between the short-day effect and the long-day effect in certain short day varieties of rice. *Bot. Bull. Acad. Sinica* 3: 73-82, 1962.

水稻光週性的研究

II. 在一短日性水稻品種的生長期中截斷其 光期與暗期的測驗

于景讓 姚潤德 王鴻秀

以短日性水稻品種霜降置於 24 小時照明下 65 日後，分作二組。一組為 8 小時光亮，16 小時黑暗；一組為光亮與黑暗各為 12 小時。

截斷明期是在明期正中時插入 15 分鐘黑暗，截斷暗期是在暗期正中時插入 15 分鐘光亮；而各留不截斷者為對照區。實驗結果，知截斷明期，對於花芽分化無抑制效果；而截斷暗期則花芽分化顯見延遲，且截斷 12 小時暗期之效果是較截斷 16 小時暗期之效果更為顯著。