

## PHOTOPERIODIC STUDIES ON RICE

### VI. Further Studies on the Turning Point of the Short Day Effect and the Long Day Effect on Certain Short Day Rice Varieties

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(Received August 22, 1966)

#### Introduction

In a previous paper (Yü and Yao, 1962), the authors pointed out that three Taiwan rice varieties and two Japanese rice varieties are short day ones, and that their turning point for the short day effect and the long day effect was between 12 and 13 hours of day length. However, Morinaga and Kuriyama (1954) reported that the turning points for several varieties were between 10 and 11.5 hours. Such a difference in the turning point led the authors to re-investigate this problem in 1960-1961, using increased numbers of varieties and the results of these studies are reported in this paper.

#### Materials and Methods

The experiments were conducted in the laboratory and 93 rice varieties were used. The source and catalogue numbers are shown below.

Source of varieties	Catalogue number	varieties used		
Chinese { Mainland	82-121	26	From the Taiwan Provincial Institute of Agriculture	
	Taiwan { Ponlai	26	1	"
		Local	59-79	10
American	122-132	7	"	
Japanese	33-53	9	"	
Others	133-136	3	"	
Markers for genetic studies	141-209	37	From Jodon's and Nagao's Laboratories	

The names of the varieties are listed in the appendix. Except for the varieties for genetic studies the majority of the varieties belong to the daylength sensitive group; and perhaps only five of them belong to the day

length insensitive group. In the present experiments, thirtyseven varieties used for genetic studies were used only once and these were studied in the second crop season in 1961 while others were used two or three times between the second crop season of 1960 to the second crop season of 1961.

The dates of sowing and treatment in each experiment are as given below:

Year	Crop season	Date of sowing	Starting date of treatment
1960	II	August 22	August 28
1961	I	April 1	April 15
	II	August 22	August 24

Sowing was carried out by directly placing 5 sprouting seeds in each Wagner's pot. The routine fertilization and care were described in previous papers (Yü and Yao, 1958). In the second crop season of 1960, the plants in each section were exposed to a daylength of 12.0, 12.5, 13.0, 13.5, and 14.0 hours respectively. In the first crop season of 1961, two sections of plants were added, and exposed to a daylength of 9 and 24 hours respectively. In the second crop season of 1961, one more section was added, and exposed to a daylength of 10 hours. In each experiment, the plants were moved outside from 8 a.m. through 5 p.m. giving a 9 hour period under direct sunlight, and for the rest of the day they were kept in dark rooms. Further daylength treatment for each section of plants was completed by exposing them to 200 watt incandescent bulbs respectively.

It is difficult to know from external form when a plant changes from the vegetative to a reproductive growth phase, therefore, in this experiment, the date of heading of each section was recorded. The interval of the time from the beginning of treatment to the beginning of the heading of each variety was used as a means to determine the turning point of the short day effect and the long day effect.

Hartley's method was used to test the significance of the difference of the growth duration under the different day lengths.

### Results

The detailed results in our experiment are contained in the appendix, and the condensed form of the results is presented in Table 1.

The results of the experiments in the two crop seasons on 93 rice varieties are summarized in Table 2.

From table 2, the turning point in the first crop season was less than 12 hours of daylength in 62.3% of the rice varieties, 12-13 hours of daylength in 29.5% of the rice varieties, and 13-14 hours daylength in 8.1% of the rice varieties. The turning point in the remaining rice varieties is not definite or

**Table 1.** *The days required from the beginning of treatment to the beginning of heading under different daylength for different rice varieties.*

Variety	Year and crop season	Daylength in hours								F-value	D <sub>0.05</sub>	
		9.0	10.0	11.0	12.0	12.5	15.0	13.5	14.0			24.0
Fukoku	1961-I	51.5	—	—	51.8↓	53.3	70.0	78.8	98.8	119.0	364.86**	1.37
	1960-II	—	—	—	47.8↓	54.0	69.3	86.0	102.0	—	325.89**	0.87
Eikō	1961-I	38.0	—	—	30.9↓	35.0	35.8	36.8	40.7	55.0	40.62**	1.53
	1960-II	—	—	—	35.8	35.6	33.6	33.4↓	36.3	—	41.87**	0.77
Ti-chiao meng-tang	1961-I	45.0↓	—	—	55.0	63.4	113.8	115.8	192.6	—	294.57**	5.40
	1960-II	—	—	—	40.5↓	78.3	+++	++	+	—	23.48**	24.81
Hsienlo	1961-I	40.6↓	—	—	51.6	65.3	109.8	136.8	187.0	—	448.23**	3.97
	1962-II	—	—	—	42.7↓	84.8	++	+	+	—	365.77**	7.35
Ning-chiao Hsiaoto	1961-I	45.3	—	—	38.3	38.8	38.0↓	46.6	44.8	55.4	85.65**	0.92
	1962-II	—	—	—	43.7	43.0	41.5	44.7↓	51.3	—	4.73**	3.34
Che-chang-chunghsien No. 1	1961-I	43.2	—	—	44.2	44.6↓	54.2	59.4	81.6	92.9	53.08**	3.85
	1962-II	—	—	—	40.3	42.2↓	75.4	75.5	+++	—	4.73**	3.34
Boenar	1961-I	47.3↓	—	—	51.4	51.6	64.4	83.0	98.5	—	485.19**	1.46
	1960-II	—	—	—	49.5	50.0↓	69.5	105.5	136.5	—	47.43**	8.85
Calora	1961-I	49.0	—	—	50.6	51.2↓	62.8	74.4	82.5	222.5	1,480.11**	1.85
	1961-II	—	—	—	49.0	53.0	53.5↓	80.0	100.0	—	12.12**	10.37

—: no experimentation

+: Floral buds differentiated but no heading, the number of

+ represents the degree of differentiation.

still completely unknown.

In the second crop season the turning point was less than 12 hours of daylength in 14.6% of the rice varieties, 12-13 hours of daylength in 62.2% of the rice varieties, 13-14 hours of daylength in 13.4% of the rice varieties, and over 14 hours of daylength in 9.8% of the rice varieties. The turning point in the remaining rice varieties is not definite or still completely unknown.

Among the 53 rice varieties in which the necessary data has been fully obtained for the experiments carried out in two crop seasons, 18 varieties showed a constant turning point, that is, 6 varieties were found to have a turning point less than 12 hours of daylength in two crop seasons, 10 varieties having a turning point of 12-13 hours of daylength in two crop seasons, and 2 varieties having a turning point of 13-14 hours of daylength in two crop seasons. But 35 varieties were found to have a longer daylength in their turning point in the second crop season than in the first crop season.

### Discussion

1. On the basis of the above findings, it may be assumed that the difference between the turning point of the short day effect and the long day effect

**Table 2.** *The variation of the turning point of the short day effect and the long day effect among rice varieties in relation to the crop seasons.*

Variety number and Number of varieties	Photoperiod of first crop season		9.0-12.0		12.0-13.0		13.0-14.0		14.0-24.0	Yet certainly known	Unknown	Total percentage
	Photoperiod of second crop season		12.0-12.5	12.5-13.0	13.0-13.5	13.5-14.0						
9.0-10.0											202, 204, 209.	12 (14.6%)
9.0-11.0			74, 76.								201, 203.	
11.0-12.0			78, 111, 125, 134.								207	
9.0-12.0											136	51 (62.2%)
12.0-12.5			51, 52, 67, 71, 72, 75, 77, 79, 104, 112, 115, 120, 121, 133.		33, 59, 38, 114, 151.							
12.5-13.0			94, 97, 116, 117, 118, 119, 131, 158.		113, 150, 177, 183, 49						26, 101 (9.0-12.5)	
12.0-13.0											122, 127, 129, 186, 187, 189, 196, 190, 194, 191, 200.	
13.0-13.5			184		35		126, 141, 84, 85				195	11 (13.4%)
13.5-14.0											205, 206, 208.	
13.0-14.0											188	8 (19.8%)
14.0-24.0			132, 169.		37, 155, 170.		85					
Yet certainly known			82(12.0-13.5) 93(12.0-24.0) 96, 98, 107(12.0-24.0)		47(12.0-24.0)						95(9.0-12.5)	7 (7.52%)
Unknown			154, 171.		162		91					
Total percentage			38 (62.3%)		18 (29.5%)		5 (8.2%)				4 (4.3%)	93 (100%)
											28 (30.1%)	

of the short day rice varieties depends upon the rice varieties. Regarding this, Morinaga and Kuriyama (1954) have already made reference. Ormorod *et al.* (1960) after exposing 5 American rice varieties and 5 Japanese varieties to a day length of 9, 12, 15, and 18 hours respectively, found that the turning point of 5 American varieties and 3 Japanese varieties was 12-15 hours of daylength and that only the one Japanese variety—"Eikō" had a turning point of 15-18 hours. In our present study, it has been observed that this same variety has two turning points: in the first crop season it had a turning point of 12.0-12.5 hours daylength and in the second season it had 13.5-14.0 hours of day length. Although our results do not quite agree with that of Ormorod *et al.*, yet there is no doubt but that the "Eikō" variety is a rare variety which has shown a turning point with a daylength longer than 13.5 hours. Furthermore it has been found that the turning point of "Eikō" of Ormorod *et al.* is quite similar that "Bansei Eikō" of the authors (see appendix). Perhaps these two varieties may really be the same one.

The results of the present study indicate, furthermore, that the turning point of the short day effect and the long day effect of a considerable number of varieties obtained in the first crop season is not the same as in the second season. Rice requires a longer dark period in the first crop season than in the second. In other words, there are a considerable number of varieties of which the short day effect is more sensitive in the second crop season than in the first. Up to date there have been several investigators who have indicated that high temperature increases the short day effect. Yao (1962) found that under high temperature the photoperiodic induction of rice was comparatively faster. It is clear that under high temperature the short day effect of short day rice varieties is comparatively sensitive. Table 3 shows the average temperatures during the induction period in the two different crop seasons.

2. From table 3, it is clear that the temperature during the induction period was higher in the second crop season than in the first. In 35 out of 41 rice varieties the dark period was shorter in the second season than in the first. These results clearly indicate that temperature plays an important role in accelerating the short day effect. Some varieties such as: 132, 155, 158, 169, 170, 177, 183, have been proved to be short day ones (Yü and Yao, unpublished). Their turning points of short day effect and long day effect were found shorter than 13 hour day length in the first crop season, but part of these varieties were found to have a turning point longer than 14 hour daylength in the second season. It appears that high temperature in the second season has also made a weak effect on their photoperiodic induction. Such varieties actually head in or later than November. It is assumed that such differences are due to the difference of their fundamental growth period, hence their periods of "ripening to flowering" are comparatively long.

**Table 3.** *The average temperature in the induction period of the rice varieties in the second crop season, 1960 and first crop season, 1961.*

Average daily temperature in the induction period	Photoperiod of the first crop season (hr)	9-12	12-13	13-14
	Photoperiod of the second crop season (hr)			
9-12	I	23.70±0.64(6)		
	II	25.17±1.37(6)		
12-13	I	23.72±0.73(22)	I 24.34±1.05(10)	
	II	26.29±1.13(21)	II 26.43±1.08(8)	
13-14	I	24.40±0.00(1)	I 23.67±0.68(3)	I 24.20±1.27(2)
	II	—	II 26.07±1.76(3)	II 26.40±0.77(2)
14-24	I	24.90±1.41(2)	I 26.07±2.46(3)	I 23.3 ±0.07(2)
	II	—	II 27.30±0.00(1)	II 27.15±0.07(2)

1. I and II represent the first and second crop seasons respectively. The numerical number in parentheses indicates the number of rice varieties used. The average temperature in the induction period is estimated by recording and averaging the temperature for the prevailing rice varieties as restricted in parentheses.
2. The temperature was recorded only under daylength treatment in the induction period which was taken as 40 consecutive days before the start of the heading.
3. The average temperature in the first crop season was based on 51 rice varieties, but in the second season it was based only on 43 varieties. This is because the heading period of several varieties of rice comes later in the year than November and the floral buds differentiate after the temperature has greatly dropped. The temperature recorded on these varieties is omitted because the weather has become cold and this would greatly effect the average temperature.
4. Table 3 shows that some varieties have a turning point longer than 14 hours of daylength. It is found that such a turning point has not yet been clear. According to our earlier report (Yü and Yao, 1962), it is known that the growth period is greatly prolonged under an exposure to 24 hours of daylength and that such varieties are actually daylength sensitive.

As mentioned, there are several varieties in which the turning points were found to be constant in both the first and second crop season. Therefore, on the basis of the effect of temperature on the photoperiodic induction, daylength sensitive varieties may be divided into two groups: thermosensitive group and non-thermosensitive group.

3. In trying to know the relation between the turning point of short day-long day effect and in the grouping as divided by the index of daylength sensitivity (Yü and Yao, unpublished) the results are shown in table 4.

Table 4 shows that in the first crop season, the turning points of a majority of the rice varieties are less than 12 hours of daylength, and

**Table 4.** *The relation between the turning point of short day-long day effect and groups of varieties as divided by the index of daylength sensitivity.*

Groups as divided by the index of daylength sensitivity	Crop season		First crop season					Second crop season				
	The number of varieties					The turning point is between:						
	I	IIa	IIb	IIc	Total	I	IIa	IIb	IIc	Total		
X <sub>1</sub> -12 (hr)	2	14	22	—	38	—	2	4	—	5		
12-13	1	7	10	—	18	2	9	24	2	37		
13-14	2	3	—	—	5	2	3	2	—	7		
14-X <sub>2</sub>	—	—	—	—	—	—	7	—	—	7		
Total	5	24	32	0	61	4	21	30	2	57		

X<sub>1</sub> is less than 12 hours of photoperiod, X<sub>2</sub> is more than 14 hours of photoperiod.

that the second crop season the turning points of most varieties are between 12 and 13 hours of daylength or longer. Furthermore, in the II b group of the second season, 28 out of 30 varieties have their turning points less than 13 hours of daylength, and in the II a group of the same season only 11 out of 21 varieties have their turning points less than 13 hours of daylength and 10 others have their turning points between 13 and 14 hours of daylength or longer.

#### Summary

1. 93 rice varieties were used in the present study in an attempt to determine their turning points of the short day effect and the long day effect under different photoperiodic conditions from the second crop season of 1960 through the second crop season of 1961. Complete data of first crop season and second crop season were obtained for 61 varieties; data for the first crop season only were obtained for 5 varieties; and data for only the second crop season were obtained for 27 varieties.

2. On the basis of the present findings, the turning point of the short day effect and the long day effect varied with the varieties, and even with the same varieties used in the experiment, it might vary with the season.

3. The uniformity or variation of the turning point of the variety might be due to the difference of the prevailing temperature during the photoperiodic-induction-period.

4. There seemed to be no clear correlation between the turning point of the short day-long day effect and the groups of varieties as divided by the index of their daylength sensitivity. However, some varieties with turning points of over 14 hours of daylength belonged to IIa group as classified by the authors (Yü and Yao, unpublished).

## Appendix

The days required from the beginning of treatment to the beginning of heading

Catalogue number	Variety	Crop season and year	9:00	10:00
26.	Taitung No. 24 (臺東24號) *	I. 1961	71.6	—
		II. 1960	—	—
33.	Fukoku (富國)	I. 1961	51.5	—
		II. 1960	—	—
		II. 1961	59.3	—
35.	Ekō (榮光)	I. 1961	38.0	—
		II. 1960	—	—
37.	Bansei-Ekō (晚生榮光)	I. 1961	40.8	—
		II. 1960	—	—
38.	Rikuu No. 20 (陸羽20號)	I. 1961	36.2	—
		II. 1960	—	—
		II. 1961	49.8	—
47.	Norin No. 21 (農林21號)	I. 1961	55.0	—
		II. 1960	—	—
		II. 1961	72.8	—
49.	Aikoku No. 1 (愛國1號)	I. 1061	47.3	—
		II. 1961	55.5	—
51.	Shinriki (神力)	I. 1961	45.0	—
		II. 1960	—	—
		II. 1961	83.0	—
52.	Iwata-Asai (磐田朝日)	I. 1961	47.5	—
		II. 1960	—	—
		II. 1961	55.5	—
53.	Daikoku (大黒)	I. 1961	40.8	—
		II. 1960	—	—
59.	Pan-tien-tzu (半天仔)	I. 1961	59.8	—
		II. 1960	—	—
		II. 1961	78.3	76.0
67.	Tj-chiao-meng-tang (低脚敏黨)	I. 1961	45.0	—
		II. 1960	—	—
		II. 1961	41.0	—
71.	Ko-tzu (格仔)	I. 1961	40.2	—
		II. 1960	—	—
		II. 1961	52.8	50.4
72.	Liu-chan (柳占)	I. 1961	33.0	—
		II. 1960	—	—
		II. 1961	48.3	50.2
74.	Chin-kuo-chan (菁菓占)	I. 1961	48.0	—
		II. 1960	—	—
		II. 1961	58.6	—
75.	Hsien-lo (暹羅)	I. 1961	40.6	—
		II. 1960	—	—
		II. 1961	34.0	37.0
76.	Ya-mu (鴨母)	I. 1961	43.6	—
		II. 1960	—	—
		II. 1961	60.6	—



of 93 rice varieties under the different day lengths and different seasons.

11:00	12:00	12:30	13:00	13:30	14:00	24:00	F Value	D <sub>0.05</sub>
—	—	75.8	77.4	90.5	123.7	+	59.31**	1.82
—	105.0	88.5	108.3	114.3	++	—	5.25*	10.73
—	51.8	53.3	70.0	78.8	98.8	119.0	364.86**	1.37
—	47.8	54.0	69.3	86.0	112.0	—	325.89**	0.87
—	59.8	—	72.3	—	—	+	48.26**	3.83
—	30.0	35.0	35.8	36.8	40.7	55.0	40.62**	1.53
—	35.8	35.6	33.6	33.4	36.3	—	11.87**	0.79
—	35.8	36.4	39.8	40.3	42.8	59.6	148.59**	0.92
—	38.8	39.0	35.8	38.7	39.2	—	0.92	—
—	38.8	38.6	54.3	66.0	85.5	89.5	8.98**	9.13
—	35.4	39.2	48.0	76.7	87.3	—	138.31**	3.59
49.3	48.0	—	58.8	—	—	+	32.23**	2.38
—	55.3	49.8	58.8	61.7	76.4	98.3	180.70**	1.62
—	54.0	55.8	54.8	59.0	65.0	—	51.88**	1.10
—	67.8	—	70.3	—	—	+	2.59	—
—	45.0	45.5	59.8	72.3	78.5	89.3	36.78**	3.49
52.4	48.3	—	64.8	—	—	+	13.36**	4.79
—	49.0	51.0	70.3	83.0	93.0	214.6	2,122.63**	1.48
—	45.0	62.2	83.6	95.0	117.0	—	15.60**	13.25
52.2	50.8	—	72.0	—	—	+	86.83**	4.33
—	50.0	51.2	73.4	85.8	95.0	104.0	263.27**	1.71
54.8	41.6	47.5	59.0	103.0	119.3	—	353.70**	3.11
—	43.4	—	64.6	—	—	+	15.96**	5.89
—	38.0	37.4	38.0	41.0	41.0	46.4	5.91**	1.76
—	40.8	41.3	40.8	40.0	40.3	—	1.21	—
—	60.0	62.8	65.4	70.0	69.6	71.3	51.16**	0.93
—	65.0	74.4	75.0	82.7	87.0	—	41.51**	2.45
75.0	71.2	—	81.2	—	—	+	15.82**	2.33
—	55.0	63.4	113.8	115.8	192.6	—	294.57**	5.40
—	40.5	78.3	+++	++	+	—	23.48**	24.81
41.5	44.0	—	114.3	—	—	+	1,197.75**	2.60
—	52.2	54.6	80.8	96.8	116.8	113.8	59.36**	5.60
—	40.4	49.8	86.8	125.6	+++	—	348.86**	5.01
41.3	45.0	—	81.0	—	—	+	47.69**	4.75
—	46.4	47.8	49.0	51.2	53.8	62.8	22.65**	2.48
—	48.8	58.8	58.6	60.3	55.3	—	18.08**	2.20
52.0	50.5	—	58.0	—	—	73.2	9.00**	5.06
—	65.6	81.8	117.0	123.5	154.7	195.5	70.32**	7.01
—	62.8	88.2	++	+	+	—	147.29**	7.63
70.8	83.3	—	+	—	—	+	33.94**	8.60
—	51.6	65.3	109.8	136.8	187.0	—	448.23**	3.97
—	42.7	84.8	++	+	+	—	365.77**	7.35
37.0	39.2	—	104.7	—	—	+	284.22**	3.01
—	66.0	81.0	121.5	149.3	175.0	205.5	961.49**	2.18
—	68.2	104.8	++	+	+	—	403.36**	6.39
69.0	76.8	—	+	—	—	+	21.26**	7.15

(Continued)

Catalogue number	Variety	Crop season and year	9:00	10:00
77.	Chien-lo (潛羅)	I. 1961	44.0	—
		II. 1960	—	—
		II. 1961	41.8	—
78.	Shuang-chiang (霜降)	I. 1961	36.8	—
		II. 1960	—	—
		II. 1961	44.8	—
79.	Man-tzu (蔓仔)	I. 1961	44.0	—
		II. 1960	—	—
		II. 1961	42.8	—
82.	Yungan-fan-lung-tsao (永安分龍早)	I. 1961	44.4	—
		II. 1960	—	—
		II. 1961	47.0	—
84.	Ning-chiao-hsiao-tao (寧交小稻)	I. 1961	45.3	—
		II. 1960	—	—
85.	Sinchiang-tsaotao (新疆早稻)	I. 1961	39.3	—
		II. 1960	—	—
86.	Shenyang-hsien (瀋陽秈)	I. 1961	56.7	—
		II. 1960	—	—
91.	Chochou-tao (涿州稻)	I. 1961	—	—
93.	Mao-tzu-tou (帽子頭)	I. 1961	47.0	—
		II. 1960	—	—
		II. 1961	58.0	—
94.	Shengli-hsien (勝利秈)	I. 1961	52.3	—
		II. 1960	—	—
95.	Chung nung-yuli-tsao (中農玉粒早)	I. 1961	45.6	—
96.	Chung-kuei-mafang-hsien (中桂馬房秈)	I. 1961	50.2	—
		II. 1960	—	—
		II. 1961	71.5	—
97.	Li-ku-tsao (粒谷早)	I. 1961	46.6	—
		II. 1960	—	—
98.	Chung-chien No. 2 (中黔2號)	I. 1961	49.0	—
		II. 1960	—	—
		II. 1961	83.3	—
100.	Fu-chin-huang (富錦黃)	I. 1961	66.6	—
		II. 1960	—	—
101.	Shui-pai-tiao (水白條)	I. 1961	51.8	—
		II. 1960	—	—
104.	Tsao-ho No. 4 (早禾4號)	I. 1961	49.4	—
		II. 1960	—	—
		II. 1961	77.8	—
107.	Wan-li-hsien (萬利秈)	I. 1961	46.2	—
		II. 1960	—	—
		II. 1961	68.8	—
111.	Iliang-tapaiku (宜良大白谷)	I. 1961	46.2	—
		II. 1960	—	—
		II. 1961	59.0	—
112.	Chung-hsiang No. 33-1 (中湘33-1號)	I. 1961	54.8	—
		II. 1960	—	—
		II. 1961	59.6	—

11:00	12:00	12:30	13:00	13:30	14:00	24:00	F Value	D <sub>0.05</sub>
—	55.4	63.8	102.0	127.0	168.5	—	513.04**	2.72
—	41.8	77.2	+++	+	+	—	394.07**	6.50
40.2	44.2	—	+++	—	—	+	3.04	—
—	49.6	57.2	110.0	122.3	182.0'	—	1,272.94**	2.28
—	43.0	76.4	136.3	++	++	—	215.53**	3.54
44.8	53.3	—	112.0	—	—	+	396.80**	3.60
—	56.6	63.0	101.5	126.5	162.3	168.3	105.48**	6.75
—	42.2	74.0	+++	+	+	—	1,366.50**	3.13
41.2	44.3	—	++	—	—	+	5.77**	2.67
—	51.0	51.5	51.7	59.0	60.2	81.6	544.82**	0.71
—	46.8	52.0	56.0	64.7	71.0	—	43.17**	2.76
54.0	56.8	—	60.8	—	—	+	3.06	—
—	38.3	38.8	38.0	46.6	44.8	55.4	85.65**	0.92
—	43.7	43.0	41.5	44.7	51.3	—	4.73**	3.34
—	36.2	36.2	37.0	37.2	39.0	54.8	30.48**	1.69
—	41.2	42.5	39.0	38.0	42.0	—	1.10	—
—	58.0	58.8	58.0	63.0	62.5	69.0	5.35**	2.28
—	50.6	52.2	53.6	53.0	57.7	—	6.21**	1.73
—	74.8	68.0	64.8	71.2	82.7	82.8	16.64**	2.96
—	52.3	53.2	55.2	59.4	61.5	66.5	164.66**	0.67
—	50.6	56.2	62.0	72.3	67.3	—	77.74**	1.83
58.4	59.8	—	64.0	—	—	95.0	34.72**	5.54
—	58.5	58.7	62.5	61.8	62.8	68.0	41.57**	0.93
—	62.4	61.8	68.4	80.3	72.3	—	126.60**	3.82
—	—	53.7	—	61.8	62.0	63.7	24.02**	2.62
—	55.8	—	60.8	—	60.3	68.4	122.34**	1.25
—	54.0	56.4	64.3	66.0	65.7	—	27.36**	1.92
75.3	73.5	—	71.8	—	+	—	0.91	—
—	51.8	53.2	61.0	62.2	66.3	73.0	131.93**	1.01
—	54.4	56.8	61.8	71.3	66.7	—	14.35	3.37
—	56.8	59.0	66.4	70.4	75.0	75.8	100.23**	1.29
—	60.6	66.2	70.8	76.3	75.7	—	61.08**	1.65
89.2	88.3	—	87.0	—	+	—	1.83	—
—	—	71.4	70.5	73.8	81.0	—	68.94**	1.24
—	75.0	75.0	75.4	77.7	77.0	—	4.32**	1.37
—	—	55.0	58.3	63.4	71.0	73.0	43.68**	2.08
—	60.8	61.2	64.3	72.7	71.7	—	65.77**	1.29
—	54.0	55.8	64.0	65.0	68.0	67.8	41.88**	1.60
—	54.0	62.4	62.4	70.3	70.7	—	17.85**	2.87
79.6	79.4	—	85.0	—	109.6	—	126.65**	2.43
—	52.6	52.6	59.8	62.4	64.8	70.4	82.49**	1.30
—	54.0	58.8	59.2	64.7	66.0	—	40.13**	1.53
70.0	71.5	—	71.8	—	+	—	1.24	—
—	59.8	59.3	71.8	81.0	91.8	91.3	582.11**	0.95
—	59.2	73.6	76.3	107.0	109.7	—	1,136.93**	2.15
59.7	66.8	—	89.3	—	+	—	28.30**	5.72
—	57.3	56.6	61.0	66.2	68.4	74.0	92.88**	0.93
—	59.0	67.2	66.8	74.3	71.7	—	18.99**	2.54
53.2	45.0	—	62.6	—	—	+	15.12**	5.41

(Continued)

Catalogue number	Variety	Crop season and year	9:00	10:00
113.	Che-chang-chung-hsien No. 1 (浙場中和1號)	I. 1961	43.2	—
		II. 1960	—	—
114.	Chung-ta No. 345 (中大345號)	I. 1961	54.8	—
		II. 1960	—	—
115.	Fang-wan-hsien No. 21-3 (芳晚和21-3號)	I. 1961	36.3	—
		II. 1960	—	—
		II. 1961	39.5	35.6
116.	Che-chang No. 9 (浙場9號)	I. 1961	38.0	—
		II. 1960	—	—
		II. 1961	37.4	38.8
117.	Fei-lai-feng (飛來鳳)	I. 1961	47.3	—
		II. 1960	—	—
118.	Paichueh-hsia-yu-chan (白穀小油粘)	I. 1961	37.0	—
		II. 1960	—	—
119.	Lungnan-shuang-chiang-pai (龍南霜降白)	I. 1961	40.3	—
		II. 1960	—	—
120.	Pucheng-wuchueh-pai (浦城烏穀白)	I. 1961	46.4	—
		II. 1960	—	—
		II. 1961	66.6	—
121.	Che-chang No. 3 (浙場3號)	I. 1961	45.8	—
		II. 1969	—	—
		II. 1961	62.2	—
122.	Improved Blue Bonnet	II. 1960	—	—
125.	Cody	I. 1961	45.3	—
		II. 1960	—	—
		II. 1961	42.2	—
126.	Calora	I. 1961	49.0	—
		II. 1960	—	—
127.	Texas Patna	II. 1960	—	—
129.	Rerocre	II. 1960	—	—
131.	Boenar	I. 1961	47.3	—
		II. 1960	—	—
132.	PTB 16	I. 1961	64.0	—
		II. 1960	—	—
133.	Indedsal Llinoy	I. 1961	51.4	—
		II. 1960	—	—
		II. 1961	60.4	—
134.	Potik Tjem Poka	I. 1961	56.8	—
		II. 1960	—	—
		II. 1961	61.3	—
136.	Macan Banet	II. 1960	—	—
141.	A-73	I. 1961	57.8	—
		II. 1960	—	—
150.	7041	I. 1961	44.0	—
		II. 1961	—	—
151.	7043	I. 1961	64.3	—
		II. 1961	—	—
		II. 1961	66.0	—

11:00	12:00	12:30	13:00	13:30	14:00	24:00	F Value	D <sub>0.05</sub>
—	44.2	44.6	54.2	59.4	81.6	92.9	53.08**	3.85
—	40.3	42.2	73.4	75.7	+++	—	169.87**	3.75
—	—	49.4	66.4	93.0	112.3	248.0	1,162.16**	1.87
—	40.6	44.5	64.5	++	++	—	102.57**	2.61
—	47.4	47.0	59.4	78.0	101.0	—	90.52**	4.13
—	38.0	42.4	59.0	98.7	115.0	—	496.67**	2.80
—	37.2	—	53.4	—	—	+	35.52**	3.72
—	46.3	47.8	53.3	72.2	84.7	—	84.23**	2.79
—	35.6	39.0	48.0	87.7	107.7	—	441.20**	2.74
—	37.4	—	57.0	—	—	108.4	1,518.53**	1.79
—	54.3	53.5	70.5	100.3	113.2	112.2	327.39**	2.16
—	50.3	66.2	96.0	++	++	—	21.95**	17.60
—	45.4	44.0	56.5	84.8	93.5	—	102.60**	3.61
—	39.2	41.6	57.8	88.0	104.8	—	213.37**	4.04
—	47.3	45.3	60.8	82.5	95.3	—	69.15**	4.06
—	37.5	38.6	48.0	96.0	109.7	—	206.83**	3.86
—	54.8	54.8	62.8	66.0	70.4	88.2	523.08**	0.83
—	54.6	60.5	66.6	79.8	77.7	—	56.38**	2.79
66.8	62.6	—	70.0	—	—	+	2.57	—
—	54.4	55.6	58.0	66.0	69.2	87.0	250.81**	1.03
—	57.4	60.4	69.0	73.7	77.3	—	48.32**	2.29
63.3	64.2	—	67.6	—	—	+	1.19	—
—	114.0	114.3	126.5	129.3	135.0	—	15.14**	3.63
—	48.5	49.0	55.5	61.8	69.0	70.3	156.51**	1.08
—	42.0	44.5	50.3	60.8	81.3	—	171.31**	2.09
43.3	48.2	—	58.8	—	—	+	61.84**	2.54
—	50.6	51.2	62.8	74.2	82.5	222.5	1,480.11**	1.83
—	49.0	53.0	53.3	80.0	100.0	—	12.12**	10.37
—	135.5	133.5	++	++	+	—	0.18	—
—	117.0	134.0	++	+	+	—	3.44	—
—	51.4	51.6	64.4	83.0	98.5	—	485.19**	1.46
—	49.5	50.0	69.5	105.5	136.5	—	47.43**	8.85
—	67.6	66.6	69.4	72.4	81.6	—	60.93**	1.31
—	77.0	79.0	84.3	85.0	85.5	—	2.98	—
—	54.4	54.2	55.6	59.8	63.4	66.5	119.01**	0.68
—	56.0	60.7	64.0	65.3	103.9	—	17.40**	2.36
58.4	58.0	—	60.6	—	—	96.6	286.27**	2.00
—	64.0	70.0	109.0	129.8	188.7	—	1,006.51**	2.31
—	64.5	100.8	+++	++	+	—	248.43**	7.96
59.8	62.8	—	+++	—	—	+	0.77	—
—	118.3	++	++	+	+	—	—	—
—	53.4	52.6	57.6	61.2	65.5	64.0	72.54**	1.90
—	57.0	61.5	64.0	70.0	90.5	—	6.59**	8.25
—	47.8	46.4	56.0	69.3	84.0	158.5	907.60**	4.24
—	39.3	40.3	46.6	60.0	94.7	—	10.69**	3.84
—	53.3	55.6	71.5	96.6	98.0	+	68.78**	3.50
—	47.0	84.6	82.6	138.0	—	—	9.87**	23.90
59.6	55.2	—	84.5	—	—	+	3.44	14.01

(Continued)

Catalogue number	Variety	Crop season and year	9:00	10:00
154.	7108	I. 1960	53.0	—
155.	7111	I. 1961 II. 1960	87.5	—
158.	7121	I. 1961 II. 1960	72.6	—
162.	7141	I. 1961	53.2	—
169.	7165	I. 1961 II. 1960	53.2	—
170.	7184	I. 1961 II. 1960	70.5	—
171.	7186	I. 1961	70.8	—
177.	7245	I. 1961 II. 1960	59.3	—
183.	7270	I. 1961 II. 1960	71.4	—
184.	9781	I. 1961 II. 1960	52.3	—
186.	156-1 (Caloro)	II. 1961	59.5	—
187.	1779 (Rexoro)	II. 1961	94.3	—
188.	5883 (Early Prolific)	II. 1961	91.5	89.8
189.	7787 (Zeith)	II. 1961	98.0	95.8
190.	8310 (Arkrose)	II. 1961	—	—
191.	8643 (R-D)	II. 1961	100.7	—
192.	8988 (Calrose)	II. 1961	61.3	—
193.	8990 (Bluebonnet 50)	II. 1961	88.6	—
194.	8989 (Lacrosse)	II. 1961	74.0	72.0
195.	8998 (Nato)	II. 1961	83.5	—
196.	9366 (7/8 Rex. × XBbt)	II. 1961	102.5	—
197.	9370 (BR × Rexoro <sup>8</sup> )	II. 1961	104.3	—
198.	9416 (Gulfrose)	II. 1961	84.2	—
199.	9417 (Century × Rexoro)	II. 1961	84.2	—
200.	9418 (4-11-1-8 × Rex-C252)	II. 1961	84.8	—
201.	9419 (Century 231 <sup>8</sup> × Bbt)	II. 1961	89.5	—
202.	9425 (Rexoro-Red × Unknown)	II. 1961	65.0	70.0
203.	9433 (Belle Patna)	II. 1961	54.5	54.0
204.	9439 (4-11-8-14 <sup>8</sup> × A6-23)	II. 1961	88.7	103.0
205.	9463 (Mo. 207)	II. 1961	86.3	85.7
206.	9475 (R-R × 250-Magnolia)	II. 1961	—	68.7
207.	9496 (Blue Rose Sel.)	II. 1961	50.0	—
208.	(R-D × R-Z)	II. 1961	82.8	85.5
209.	(Rec. 13 × long-grain dwarf)	II. 1961	83.4	92.3

Crop season and year

Date of sowing

First crop, 1961

April 1

Second crop, 1960

August 22

1961

August 22

11:00	12:00	12:30	13:00	13:30	14:00	24:00	F Value	D <sub>0.05</sub>
—	56.6	58.8	62.2	65.2	66.8	76.2	603.62**	0.44
—	86.8	83.8	86.5	87.2	101.0	115.8	27.21**	2.86
—	118.0	117.0	129.0	122.5	128.0	—	1.23	—
—	78.0	78.0	85.6	94.7	94.3	104.0	14.38**	3.97
—	106.0	102.6	113.7	124.7	134.7	—	234.86**	3.90
—	57.8	56.2	77.3	91.4	98.0	130.7	30.41**	6.25
—	57.8	66.0	66.6	72.7	73.5	81.0	59.26**	1.71
—	71.0	80.0	78.3	86.7	92.0	—	1.87	—
—	70.8	67.5	71.6	74.0	80.0	86.3	10.87**	2.34
—	88.0	81.0	83.0	—	88.0	—	0.62	—
—	76.8	79.0	81.0	83.2	96.3	100.3	32.31**	2.32
—	57.3	56.6	76.0	93.4	110.6	124.0	1,038.26**	0.95
—	66.8	70.2	84.6	+++	++	—	14.84	8.43
—	70.6	68.0	83.4	86.8	87.8	—	101.08	1.49
—	88.0	89.0	105.0	94.0	100.0	—	—	—
—	56.7	57.4	73.0	80.2	86.8	114.0	122.88**	2.33
—	65.0	75.0	75.0	105.0	105.0	—	—	—
59.5	56.3	—	60.0	—	109.0	+	150.27**	3.43
—	95.7	—	137.0	—	+	+	42.65**	13.66
89.5	82.6	—	94.3	—	98.5	+	2.60	—
92.8	85.6	—	97.5	—	108.4	+	55.10**	1.69
65.3	54.8	—	78.8	—	122.0	+	184.73**	5.85
—	103.8	—	137.3	—	+	+	25.45**	13.14
61.8	53.3	—	64.0	—	107.4	+	133.53**	3.81
—	92.0	—	115.0	—	+++	+	80.87**	5.35
65.4	58.5	—	77.0	—	120.7	+	52.93**	4.25
—	83.0	—	86.6	—	105.3	+	11.03**	6.98
98.7	91.4	—	112.0	—	+++	+	39.45**	3.23
105.3	107.7	—	+++	—	+	+	0.06	—
—	82.8	—	91.4	—	105.0	+	18.15**	4.74
86.0	86.0	—	104.0	—	115.8	+	39.24**	4.29
85.8	89.8	—	95.6	—	113.7	+	13.48**	5.64
92.3	97.8	—	106.3	—	112.0	+	11.21**	4.46
68.7	68.0	—	70.0	—	87.4	113.5	126.82**	1.93
55.0	60.0	—	71.8	—	101.8	+	70.42**	3.41
111.8	114.3	—	114.0	—	118.0	+	28.72**	2.54
—	82.0	—	91.8	—	90.2	+	3.73*	3.49
69.4	70.3	—	70.8	—	77.0	108.8	25.07**	4.73
—	63.0	—	72.5	—	+++	+	31.55**	6.55
87.7	88.3	—	89.3	—	102.0	+	4.31*	4.36
105.0	109.0	—	111.6	—	119.0	+	22.33**	3.83

Date of beginning of treatment

April 15

August 28

August 24

## 水稻光週性的研究

VI. 若干水稻品種之短日效果與長日效果的  
轉捩點的進一步的研究

于景讓 姚潤德

1. 作者等以 93 品種在 1960 年第二季至 1961 年第二季的期間分置不同的光週 (Photo-period) 下, 求取其短日效果與長日效果的轉捩點。有完整的兩季記錄者是有 61 品種, 祇有第一季記錄者是有 5 品種, 祇有第二季記錄者是有 27 品種。
2. 據實驗記錄, 知該項轉捩點是有着品種間的差別; 而同一品種, 在不同的栽培季節中, 其轉捩點之是否一致, 是隨品種而異。
3. 轉捩點之一致與不一致的原因, 作者等推測是由於該項品種在光週誘導 (Photo-periodic induction) 期間對於溫度的反應不同之故。
4. 短日效果長日效果的轉捩點與根據作者等所提指數而劃分的品種羣間, 似無明顯的關係。惟在第二季中轉捩點延遲至日長 14 小時以後者, 則皆屬於作者等所說的 IIa 羣。

## Literature Cited

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