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Comparison of the Growth Duration of Rice Varieties Grown in Korea and Other Countries

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韓國과 他地域間의 水稻生育期間 比較

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ABSTRACT

Highly positive correlations were obtained between the growth duration of the 1978 IRCTN entries in Chuncheon, Korea and all the experimental sites in 7 other countries. Among the entries the photoperiod responsive varieties had very long growth duration in Chuncheon although relatively early in flowering in the other low latitude sites. Selection under Korean conditions would eliminate the short growth duration varieties caused by photoperiod sensitivity in tropics or subtropics. Except for photoperiod sensitive rices, selection of varieties or lines for optimum growth duration before further evaluation in other low temperature areas would be most effective in Chuncheon, Korea.

INTRODUCTION

In many of the low-temperature rice areas, earliness or very short growth duration of rice plant but accompanied with sufficient dry-matter production is essential since the growing season is short. Together with earliness, the ability to predict growth duration is needed for better utilization of the arable land, crop planning, management and introduction of varieties from one country to another. Following the former report[1] this study involves the correlation of the growth duration of the International Rice Cold Tolerance Nursery (IRCTN) entries at Chuncheon, Korea and 9 other places where the 1978 IRCTN entries were planted The possibility of selecting rice varieties or breeding lines having proper growth duration as well as cold tolerance at Chuncheon, Korea before they are distributed to other countries will be discussed in this study.

MATERIALS AND METHODS

The 237 rice varieties and lines come from countries were planted at 10 locations of 7 countries-Korea, India, Nepal, Bangladesh, Pakistan, Burma and colombia ranging from 3°N to 37°52'N latitude as the 1978 IRCTN entries. In Korea, the entries were subjected to the water temperature gradient of 17°C at the inlet to 25°C at the outlet from 30 days after transplanting up to maturity. The monthly variations in day length and temperature at each experimental site are given in Table 1

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Table 1. Experimental sites and monthly maximum day length including civil twilight during growth period at each site

Country	Site	Latitude	Elevation	Day length (hr:min.) – month from seeding					
				1st	2nd	3rd	4th	5th	6th
Korea	Chuncheon	37°52′N	74 m	15:37	16:03	15:50	13:30	13:55	12:42
Nepal	Kathmandu	29°39′N	1338						
	(May seeded)			14:37	14:47	14:46	14:19	13:30	12:42
	(June seeded)			14:47	14:46	14:19	13:30	12:42	11:57
	(July seeded)			14:46	14:19	13:30	12:42	11:57	–
India	Almora	28°59′N	1300	14:55	14:52	14:23	13:32	12:41	11:54
	Almora	28°59′N	1650	14:55	14:52	14:23	13:32	12:41	11:54
	Naisutal	29°28′N	900	14:57	14:55	14:24	13:33	12:41	11:52
	Khudweni	33°60′N	1062	15:06	15:20	15:18	14:41	13:421	12:41
Bangladesh	Joydebpur	24°18′N	–	14:05	13:23	12:41	12:05	11:16	–
Pakistan	Khawaza Khela	35° N	975	15:17	15:31	15:29	14:50	13:47	12:42
Burma	Heho	20°48′N	1147	14:11	14:09	13:50	13:16	12:41	12:13
Colombia	Palmira	3°31′N	1000	13:02	13:06	13:06	13:00	12:53	12:47

Table 2. Monthly average maximum and minimum temperature during growth period at each experimental site

Country	Site	Seeding date	Temperarure (°C) – month from seeding					
			1st	2nd	3rd	4th	5th	6th
Korea	Chuncheon	April 21	a26.0	27.5	31.1	29.4	24.8	20.7
			b10.2	26.9	22.3	21.8	14.6	7.9
Nepal	Kathmandu	May 5	a26.3	26.6	25.7	25.8	25.9	23.7
			b16.7	19.1	19.6	18.7	17.8	13.6
	Kathmandu	June 5	a26.6	25.7	25.8	25.9	23.5	19.9
			b19.1	19.6	18.7	17.8	13.6	8.4
	Kathmandu	July 5	a25.7	25.8	25.9	23.5	19.9	–
			b19.6	18.7	17.8	13.6	8.4	–
India	Almora (1300m)	June 1	a30.4	29.4	28.5	27.9	28.3	22.1
			b20.4	20.7	20.5	18.4	11.4	5.0
	Almora (1650m)	June 13	a28.0	25.0	25.0	25.0	24.0	22.0
			b18.0	18.0	18.0	17.0	12.0	11.0
	Naisutal	June 13		no	data			
	Khudwani	May 5	a27.5	32.5	29.6	30.5	28.4	24.6
			b11.7	17.1	19.3	18.5	12.6	5.1
Bangladesh	Joydebpur	Aug. 5	a31.6	31.7	32.3	31.1	27.0	–
			b26.3	24.9	23.4	18.1	12.0	–
Pakistan	Khawaza Khela	May 23		no	data			
Burma	Heho	June 8	a27.5	26.7	28.6	28.8	30.4	28.3
			b18.7	19.0	18.8	18.4	15.8	10.3
Colombia	Palmira	May 19		no	data			

a Average maximum temperature, b Average minimum temperature

and 2. The day lengths were interpolated from Smithsonian Meteorological Tables[6] according to the latitude of the site. Temperature summations were calculated by multiplying the average monthly temperature by the number of days from seeding to flowering. The correlation coefficients and selection effects were calculated from the growth duration datadays from seeding to flowering of 11 cultural cases in other countries and outlet point in the water temperature gradient field in Chun-

cheon, Korea.

RESULTS AND DISCUSSIONS

1. Relationship of growth duration in Chuncheon, Korea and other sites

Kathmandu, Nepal : Out of 1.28 million ha rice growing areas of Nepal, 15 to 20% has a climate comparable with temperature region. High altitude regions are affected by low air and water temperature(5). In Kathumandu valley, the temperature range is 8.4-26.6°C and day lengths are shorter than Chuncheon (Table 1 and 2). Figures 1, 2 and 3 show the correlation between the growth duration of IRCTN entries seeded in May, June and July in Kathmandu and Chuncheon.

Generally long growth duration entries in Kathmandu had also long growth duration in Chuncheon. However, some entries had short growth duration in Kathmandu but relatively long growth duration in Chuncheon. Again, these results are similar to the observation made in the Philippines in former report(1), which is a photoperiod response. The earlier sowing (May) gave a better correlation than the late (July) sowing, r=0.735** vs r=0.524**. The temperature summation in Kathmandu from May to August (2,641°C) is nearer to Chuncheon (2,979°C) than the temperature summation from June to September or July to

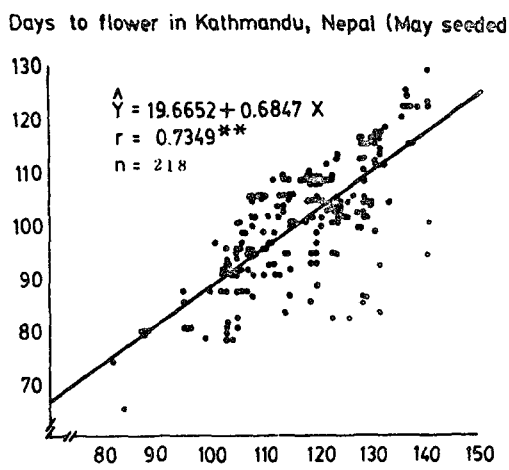

Fig. 1. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Kathmandu, Nepal.

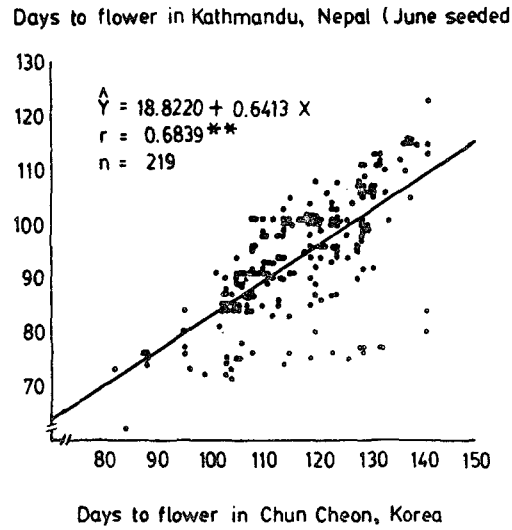

Fig. 2. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Kathmandu, Nepal.

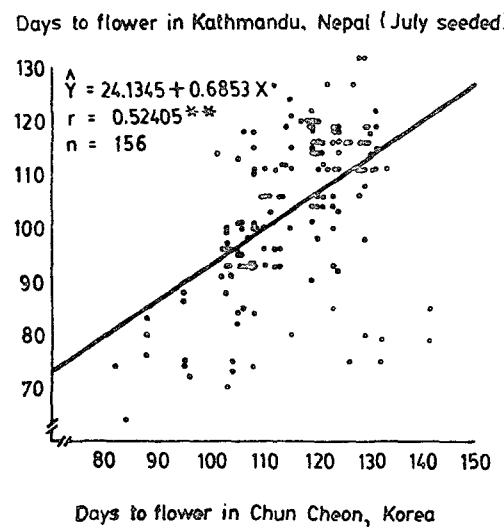

Fig. 3. Growth duration of IRCTN entries grown in Chun Cheon, Korea and Kathmandu, Nepal.

October. However, in the case of May seeding, of the 81 entries that flowered in less than 95 days in Kathmandu, 55 entries had growth duration less than 110 days in Chuncheon (Table 3). In the July seeding, of the 67 entries that flowered less than 110 days in Kathmandu, 48 entries had growth duration less than 110 days in Chuncheon. Except for the photoperiodsensitive varieties, selection for the early maturity in Kathmandu would eliminate most of the long growth duration entries in Chuncheon, Korea.

Almora, Naisutal, and Khudwani, India : The hill zones of north India have 1.8 million ha of rice land. Injury due to low temperature is one of the major constraints to rice production in the hill areas. The problem of rice improvement in India's cold regions is complicated by the short cropping period and temperature fluctuation[2]. The temperature ranges were 5-30.5°C at an altitude of 1,300m and 1,650m, and day lengths are shorter than Chuncheon during growth period. Figures 4 and 5 show the correlation between the growth duration in Almora at 1,300m and 1,650m and Chuncheon.

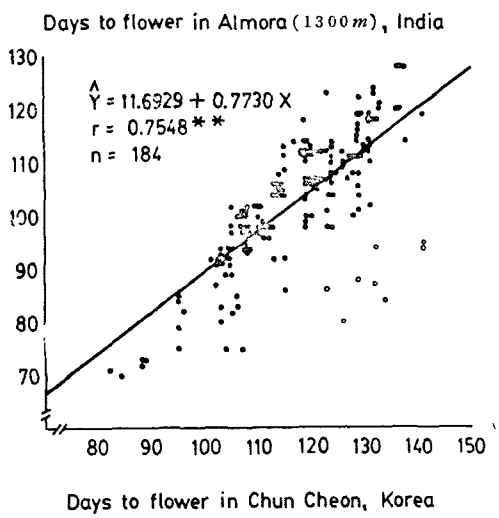

Fig. 4. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Almora, India.

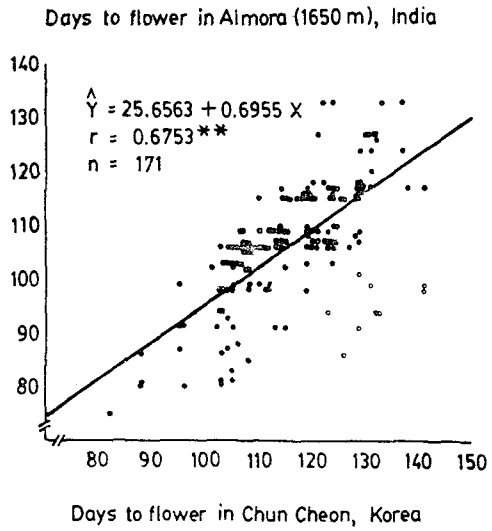

Fig. 5. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Almora,. India.

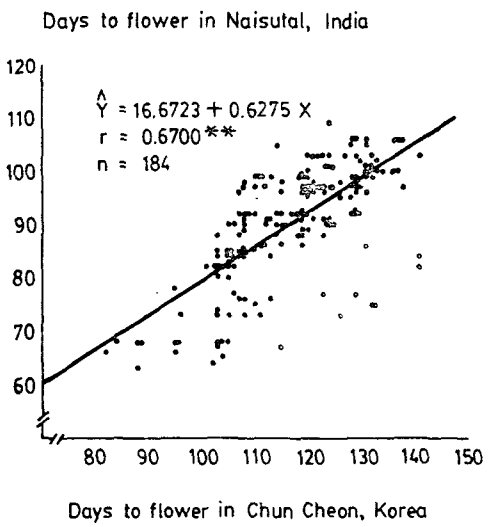

Fig. 6. Growth durationon of 1978 IRCTN entries grown in Chun Cheon, Korea and Naisutal, India.

The correlation was better at lower altitude. Figure 6 shows the correlation between the growth duration in Naisutal and Chuncheon. Figure 7 shows the correlation between the growth duration in Khudwani and Chuncheon. Khudwani planting was se-

Table 3. Selection effect for earliness of rice varieties and lines

Location	Total entries	Early entry		Early entry in Chuncheon		Selection effect on
		Days to flowering(A)	No. of entries	Days to flowering (B)	No. of entries (A&B)	
Kathmandu, Nepal						
May seeding	218	95	81	110	55	68%
June seeding	219	90	81	110	52	64
July seeding	156	100	67	110	48	72
Almora (1300m), India	184	100	81	110	56	69
Almora (1650m), India	171	100	59	110	41	69
Naisutal, India	184	90	81	110	52	64
Khudwani, India	78	95	52	110	36	69
Joydebpur, Bangladesh	183	85	92	110	57	68
Khawaza Khela, Pakistan	181	100	63	110	40	63
Heho, Burma	189	110	71	110	46	65
Palmira, Colombia	219	90	80	110	57	71

Note : "A" means the limiting days to flowering for early varieties at each site.

Note: "A&B" means the number of entries flowered less than "A" days in each site and also flowered less than 110 days in Chuncheon.

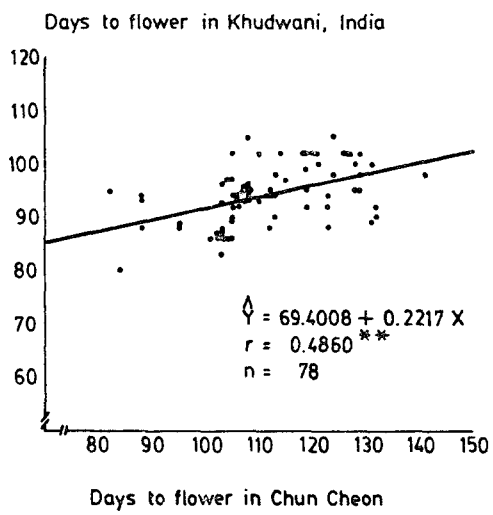

Fig. 7. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Khudwani, India.

cond to the lowest correlation among 11 planting sites. Many entries did not flower at this location. A comparison of the temperature patterns in Korea and Khudwani show that the minimum temperatures in Khudwani are much lower.

The data indicate that generally long growth duration entries in Almora, Naisutal and Khudwani had also long growth duration in Chuncheon. Out of the 81 entries flowering in less than 100 days in Almora (1,300m), 56 entries had growth duration less than 110 days in Chuncheon, and of 59 entries flowered less than 105 days in Almora (1,650m), 41 entries had growth duration less than 110 days in Chuncheon, and out of 52 entries flowered in less than 95 days in Khudwani, 36 entries had growth duration less than 110 days in Chuncheon (Table 3). Preliminary section for early maturity to fit the maturity requirement in Chuncheon can be done in Almora, Naisutal and Khudwani for photoperiod sensitive varieties.

Joydebpur, Bangladesh : The late transplanted rice in Bangladesh may suffer from low temperature during the reproductive stage[3,8]. However, the temperatures are high during the vegetative growth stage. The transplanted aman rice of Bangladesh are usually photoperiod sensitive[8]. The temperature range in Joydebpur was 12-32.3°C and day lengths are shorter than Chuncheon, during growth period (Table 1 and 2). Figure 8 shows the correlation between the growth duration in Joydebpur and Chuncheon. Generally long growth duration entries in Joydebpur had also long growth

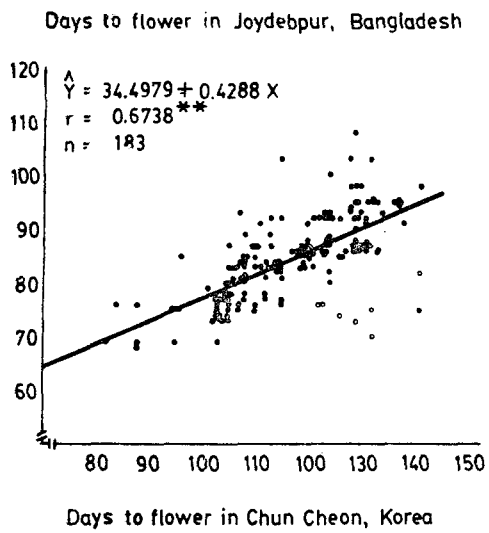

Fig. 8. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Joydebpur, Bangladesh.

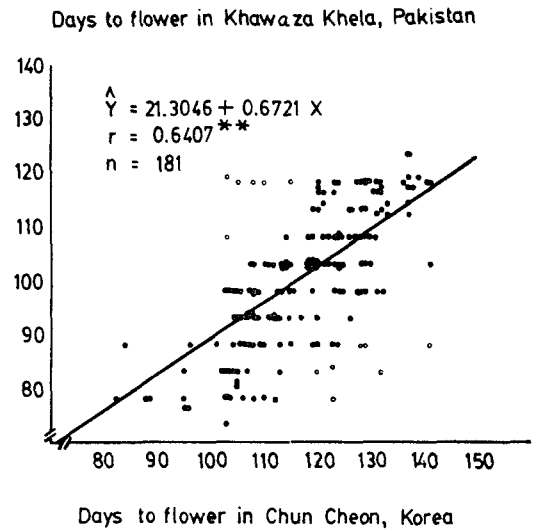

Fig. 9. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Khawaza Khela, Pakistan.

duration in Chuncheon. Out of the 92 entries that flowered less than 85 days in Joydebpur, 57 entries had growth duration less than 110 days in Chuncheon (Table 3).

Although the correlation in growth duration between the two sites is relatively high (r=0.674**), growth duration per se is not an important character in Bangladesh. The photoperiod response of the variety is more important and its response to low temperature at reproductive stage in terms of fertility of the spikelet is followed for the selection of the cold tolerance rice variety[3,8]. In Bangladesh as well as Banaue, Philippines in former report[1] day length can be used to obtain short growth duration.

Khawaza Khela, Pakistan : Khawaza Khela is located almost at the same latitude as Chuncheon. The day length in Khawaza Khela is around 20 minutes shorter than Chuncheon during the rice growing period. No temperature data was received from Khawaza Khela. Figure 9 shows the correlation between the growth duration in Khawaza Khela and Chuncheon. Out of the 63 entries that flowered less than 100 days in Khawaza Khela, 40 entries had growth duration less than 110 days in Chuncheon (Table 3). This indicates that preliminary selection for early maturity to fit the maturity requirement in Khawaza Khela can be done in Chuncheon.

Heho, Burma : The problem in the high altitude areas of Burma is mainly low minimum temperatures since the day temperatures are relatively high even at heading time[3,4]. The temperature range is 10.3-30.4°C and day lengths are shorter than Chuncheon during rice growth period. Figure 10 shows the correlation between the growth duration in Heho and Chuncheon. Heho had the lowest correlation among the 18 cases studied including 5 different points in water temperature gradient field in Chuncheon and Philippine cases in former report[1]. Generally long growth duration entries in Heho had also long growth duration in Chuncheon. Out of the 71 entries flowering in less than 110 days in Heho, 46 entries had growth duration less than 110 days in Chuncheon. Preliminary selection for early maturity to fit the maturity requirement in Heho can be done in Chuncheon. Except for photoperiod sensitive varieties, selection

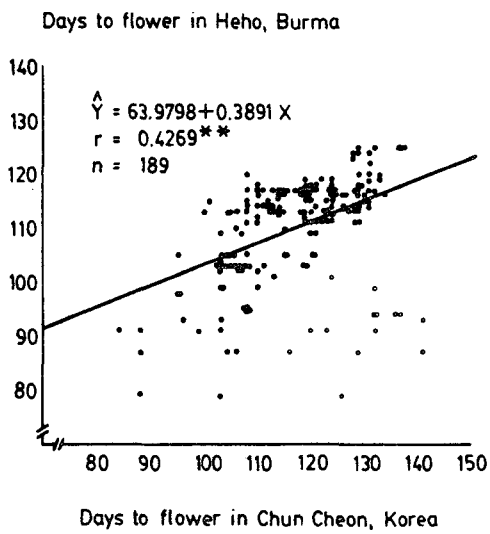

Fig. 10. Growth duration of 1978 IRCTN entries growth in Chun Cheon, Korea and Heho, Burma.

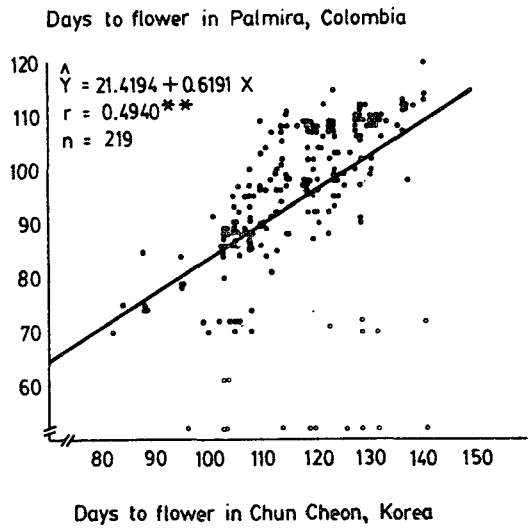

Fig. 11. Growth duration of 1978 IRCTN entries grown in Chun Cheon, Korea and Palmira, Colombia.

for early maturity in Heho would eliminate most of the long growth duration entries in Chuncheon, korea.

Palmira, Colombia : Palmira is located at the lowest latitude (3°31'N) among the experimental sites, therefore, day lengths are shortest during the growth period. Temperature data was not received from Palmira. Figure 11 shows the correlation between the growth duration in Palmira had also long growth duration in Chuncheon. Out of the 80 entries flowering in less than 90 days in Palmira, 57 entries had growth duration less than 110 days in Chuncheon. At Palmira, the effect of short day length is more pronounced. Many entries had very short growth duration at Palmira but relatively long growth duration in Chuncheon, hence the possible low correlation. Except for photoperiod sensitive varieties, selection for early maturity in Palmira would eliminate most of the long growth duration entries in Chuncheon.

2. Selection in Chuncheon

The data from several sites indicate that selection for short growth duration can be made in Chuncheon so that breeders and agronomists in different low temperature areas of the tropics and sub-tropics do not need planting many lines to obtain the optimum growth duration. All the correlations on growth duration obtained between Chuncheon, Korea and the 13 other sites including Philippines were significant at one percent level. Highest correlations were obtained in planting at Almora (1,300m) and Kathmandu (May seeding) while lowest correlation was obtained in Heho, Burma. Essentially, plants with growth durations around 110 days in Chuncheon or plants that flower more or less between the flowering of China 1039 and RPKN 2 would have the acceptable growth duration in other sites. Transplanted aman rice in Bangladesh would probably be an exception since China 1039 is too early for that season but might be optimum for the winter rice crop (boro). Except for rice areas needed photoperiod sensitive rice varieties, it is suggested that breeding lines be grown first at Chuncheon for selection on optimum growth duration as well as cold tolerance at seedling and panicle initiation stages before they are distributed to other sites. This would greatly minimize the

field work of breeders and increase the Chances of selecting better breeding lines.

摘　　要

本 研究는 1978年 國際連絡水稻耐冷性檢定試驗(IRCTN) 計劃에 따라 237品種을 10個地域에 供試하여 韓國의 春川 耐冷性檢定圃에서의 水稻生育期間과 他地域에서의 生育期間과를 比較分析하여 水稻品種의 出穗性에 對한 地域間의 關係를 알기 위하여 實施하였다.

1. 春川과 他地域間의 水稻生育期間은 모두 높은 正의 相關關係를 보였는데 日長反應이 銳敏한 品種들은 例外的인 反應을 보였다.

2. 他地域에서 生育期間이 짧았던 品種이 春川에서도 同一한 傾向을 보일 수 있는 確率은 63~72%였는데 이는 春川이 他地域보다 生育期間中의 日長이 길기 때문이었다.

3. 春川에서 生育期間이 짧은 品種을 選拔하여 緯度가 낮은 地域에 보내면 日長反應에 依하여 生育期間이 짧았던 品種들이 除外되는 結果를 가져오며 耐冷性을 同時에 檢定할 수 있기 때문에 育種效果를 增大시킬 수 있을 것이다.

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