Studies on Rice Cultivation in Northern Iran I. Eeffects of Date of Planting on Rice

S. K. Chang, C. H. Hong and W. H. Lin

1. Introduction

As rice yield is gratly influenced by the climate condition prevailing during the crop season, to grow it in the best time for getting maximum solar radiation, especially during tillering and ripening stages, is primarily important for obtaining maximum yield (Moomaw, et al 1967; Chang, et al 1966).

Mazandaran, located between 36°-38° N.L. adjacent to the Caspian Sea in the northern Iran, has approximately 120,000 ha of paddy field. Soils are mostly of alluvial clay, rich in organic matter and fertile (Dewan, et al 1964). Annual mean temperature ranges from 15°-18℃ in February and 26°-28℃ in August. The monthly temperatures suitable for rice cultivation are from early May through mid-October. Annual precipitation ranges from 700 mm to 1,000 mm and one third of which is received in rice crop season. Majority of the paddy field is irrigated with the river water originated from Mt. Eluruz. The climate in the most period of rice crop season, from mid-May to mid-July, is fine, dry, and mild. Neverthless, rice yield under this favorable environment recorded as low as 2-3 tons/ha. The main factors of lowering yield are found to be using low-yielding and cold sensitive cultivars of indica Meher and Frooz and practicing late planting (Chang, et al., 1971). The previous experiment conducted by ARES indicated that 500 kg/ha of grain yield was reduced with delaying planting time at an intervals of 15 days when rice was transplanted after May 20 (Mojtahedi, 1969).

The purpose of this experiment is to verify the effects of date of sowing, especially by early sowing with cold protected nursery, on the growth and yield of two leading rice varieties.

2. Materials and methods

A split-plot experiment, consisting of 4 dates of sowing, namely March 25, April 4, 14 and 24 as main plots and 2 rice cultivars of local Indica Meher and Taiwan introduced Japonica Taichung 65 as subplots, was conducted at the farm of Amol Rice Experiment Station (ARES). The size of each subplot was 2 m × 2.75 m with 4 replications.

Seeds were disinfected with Ceresan then soaked and presprouted. Sowing was made on raised wet-bed according to the scheduled date at a density of 150 gm/m^2. Seedbeds were covered with tunnel shaped PVC film except at the time when the temperatures were higher than 20℃ at daytime. Transplanting was made 24 days after sowing, at about 5-leaf stage, with 5 seedlings per hill and at a spacing of 25 cm × 25 cm. The rate and method of N-P-K fertilizationin the seedbed and main field were as follows: weeding was made by rotary weeder followed by hand at 12 days

Nutrient elements	Seedbed				Main field			
	Total rate kg/ha	Basal* dosage	Top-dressing**		Total rate kg/ha	Basal* dosage	Top-dressing**	
			12DAS	18DAS			12DAT	PPI
N	120	40%	30%	30%	120	40%	40%	20%
P_2O_5	60	100	0	0	60	100	0	0
K_2O	45	100	0	0	45	100	0	0

* Incorporated into topsoil by mechanized puddling.

** DAS, DAT and PPI stand for days after sowing, days after transplanting and panicle primordial initiation, respectively.

and 25 days after transplanting. Mole cricket was controlled by spraying Aldrin on levee sides. Bla-S was applied to prevent infestaion of neck and panicle blast disease at 10 days after complete heading. Throughout the growth stages, the scheme of irrigation with timely drainage, i.e., to drain just before top-dressing and weeding, maximum tillering, booting and ripening for 4-7 days based on the condition of field moisture.

Meterological et al, growth habit and agronomic characters of rice plant due to treatment effects were observed and collected. Grain yield and its components were measured and calculated.

3. Results and discussion

(1) Crop weather

The daily mean air temperature (Fig. 1) during the 1970 crop season, ranged from 14.8-26.2 ℃, was 3-5℃ higher in nursery stage, 1-3℃ higher in active vegetative and reproductive stages, with the exception of 0.5-2℃ lower in late vegetative to panicle initiation stages and after dough ripening stage, as compared to that of 1966-1970 average. It is realized that the weather in 1970 crop season was mostly warmer than the average of the past 5 years, with the exception of a rapid declined after late August. The comparative curves of 1969, 1970 and 1966-1970 also suggested that the temperature in such a continent temperate zone varied greater with years, particularly in cold months, than that in oceanic areas such as Taiwan (21). Therefore, much account of protection against cold damage in nursery stage should be paid.

The rainfall (Fig. 2) received during the nursery through reproductive periods in 1970 was conspicuously less than the 1966-1970 average. However. During the heading to dough ripening stages the frequency and amount of rainfall were quite high The cumulative rainfall received during the crop season (April through early September) was 217 mm in 1970 and 298 mm in 1966-1970 average which was approximately 1/4 and 1/3 the annual rainfall being 900 mm, respectively.

The changes in air temperature and amount of rainfall during the 1970 crop season were negatively correlated (Fig. 1 and 2).

(2) Effects on growth durations at different stages

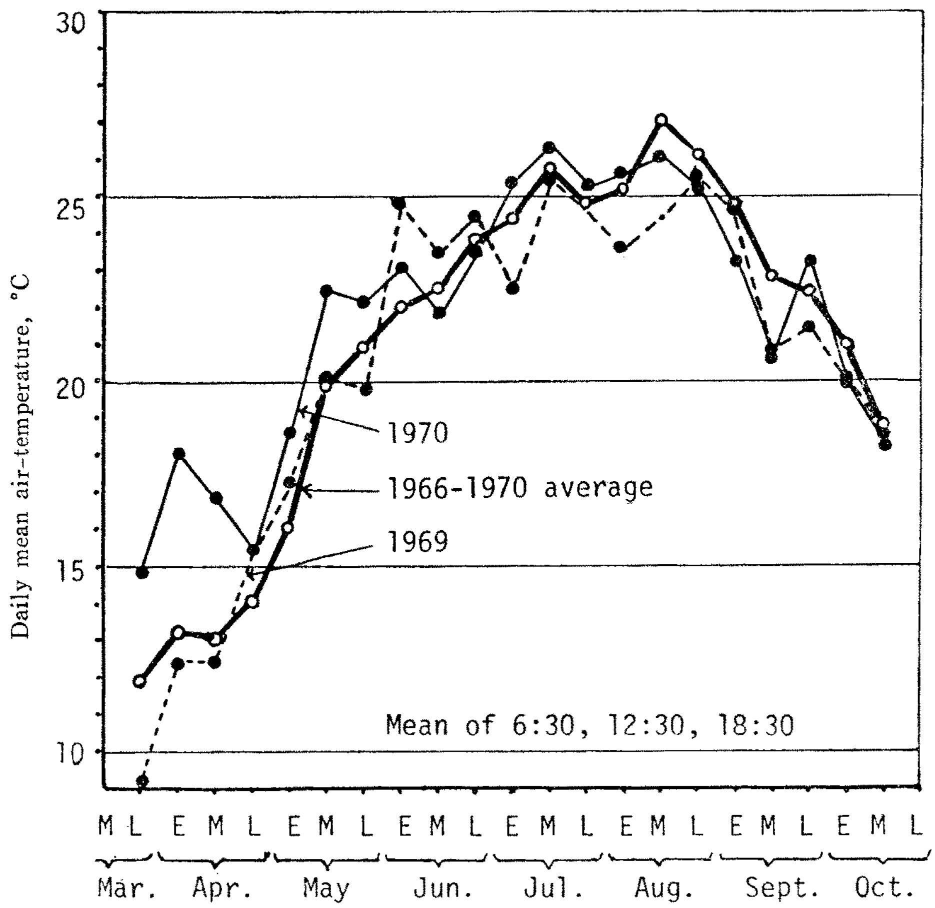

Fig 1: Comparative curves for daily mean air-temperatures of 1969-1970 and 1966-1970 average during rice season.

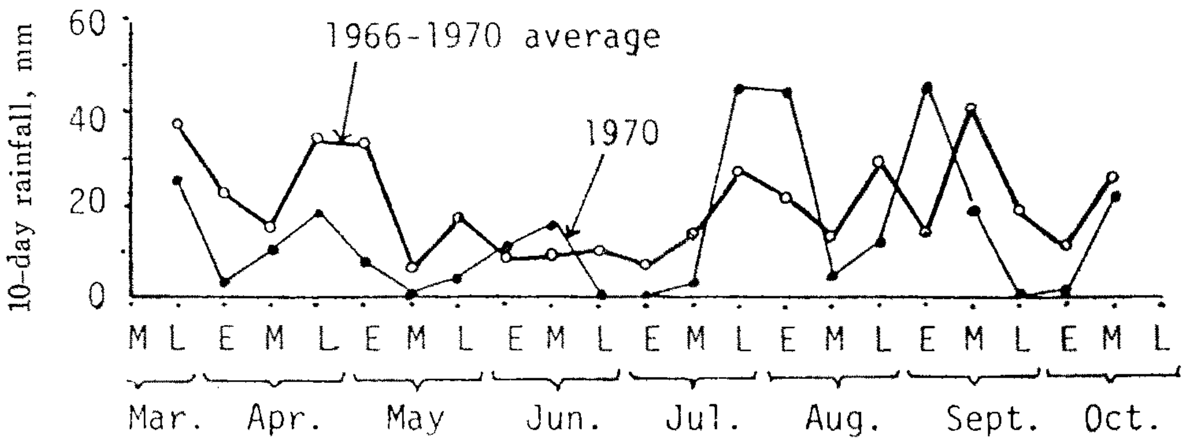

Fig 2: Comparative curves for 10-day rainfall of 1970 and 1966-170 average during rice season.

Table 1 shows that the earlier the sowing, the longer was the duration required for vegeative growth phase. Both varieties in the eariest sowing required for vegetative growth phase. Both varieties in the eariest sowing required the same duration of 64 days for reaching panicle initiation, but needed only 51 to 52 days in the latest sowing at one month later. In reproductive phase Taichung 65 showed 2 to 3 days shorter, being 28 days in T_1 an T_2 and 27 days in T_3 and T_4, than Meher which no difference in sowing times. Horwever, in ripening stage, due to a rapid drop of temperature after September, those later sowing matured in September, showing 2 (T_3) to 6 (T_4)

Table 1. Effects of sowing date on growth periods, cumulative and daily air temperature (℃)

Sowing date & month	Taichung 65				Meher			
	Growth duration		Air temperature		Growth duration		Air temperature	
	Date	Days	Cumulat.	Daily	Date	Days	Cumulat.	Daily
Nursery stage								
1. 25/3	25/3-18/4	24	406	16.9	25/3-18/3	24	406	16.9
2. 4/4	4/4-28/4	24	401	16.7	4/4-28/4	24	401	16.7
3. 14/4	14/4-8/5	24	417	17.4	14/4-8/5	24	417	17.4
4. 24/4	24/4-18/5	24	465	19.4	24/4-18/5	24	465	19.4
Vegetative stage								
1. 25/3	18/4-21/6	64	1,311	20.5	18/4-21/4	64	1,311	20.5
2. 4/4	28/4-27/4	60	1,306	21.8	28/4-27/6	60	1,306	21.8
3. 14/4	8/5-2/7	55	1,227	22.3	8/5-1/7	54	1,203	22.3
4. 24/4	18/5-9/7	52	1,197	23.0	18/5-8/7	51	1,172	23.0
Reproductive stage								
1. 25/3	21/6-19/7	28	706	25.2	21/6-21/7	30	760	25.3
2. 4/4	27/6-25/7	28	715	25.6	27/6-27/7	30	765	25.5
3. 14/4	2/7-29/7	27	695	25.7	1/7-31/7	30	771	25.7
4. 24/4	9/7-5/8	27	695	25.7	8/7-7/8	30	773	25.8
Ripening stage								
1. 25/3	19/7-27/8	39	1,004	25.7	21/7-25/8	35	896	25.6
2. 4/4	25/7-2/9	39	996	25.5	27/7-30/8	34	878	25.8
3. 14/4	29/7-8/9	41	1,038	25.3	31/7-5/9	36	911	25.3
4. 24/4	5/8-19/9	45	1,088	24.2	7/8-14/9	38	930	24.5
Total growth stages								
1. 25/3	25/3-26/8	155	3,427	22.1	25/3-25/8	153	3,374	22.1
2. 4/4	4/4-2/9	151	3,418	22.6	4/4-30/8	148	3,350	22.6
3. 14/4	14/4-8/9	147	3,376	23.0	14/4-5/9	144	3,302	22.9
4. 24/4	24/4-18/9	148	3,444	23.3	24/4-14/9	143	3,340	23.4

days longer than that earlier sowing ones in Taichung 65, while extended 2 (T_3) to 4 (T_4) days in Meher.

The total growth duration in both varieties showed that the earlier the sowing, the more was the days from sowing to harvest. Taichung 65 which sown on March 25, April 4, 14, and 24 was harvested after 155, 151, 147, and 148 days, respectively, while Meher was 153, 148, 144, and 143 days, respectively. The low temperature in early sowing tended to delay vegetative growth phase but hastened the ripening phase and vice versa for the late sowing. The growth duration of Taichung 65 was similar to that of the first crop, being 152 days, in Taiwan but longer than that 121 days in the second one (Chang et al 1966). Chang et al (1971) reported that the growth duration of IR8 grown at 3 localities was highly negatively correlated with the average of minimum temperature but positively correlated with the temperature summation.

(3) Effects on temperatures of growth stages

Table 1 shows that both cumulative and daily temperatures increased as the sowing dates delayed. This trend was especially marked in nursery and vegetative stages. As shown in Figure 1 the temperature in nursery stage of 1970 was 3-5℃ higher than that of in the past 5-year average, being ranged from 16.9° to 19.4℃ for the earliest and the latest treatments. In vegetative stage it ranged from 20.5° to 23.0℃ or similar to nursery stage which differ with 2.5℃. However, in reproductive stage, it varied 25.2° to 25.7℃ or only 0.5℃ different between treatments. In the ripening stage, the trend of different between treatments was reversed, ranging from 25.7° to 24.2 ℃ due to the rapid drop of temperature after September in which the later sowing treatments ripened. The cumulative temperature varied with duration of growth stages and the daily temperatures.

In sum, the totatl cunulative temperature required for rice growth throughout the crop season ranged from 3,427° to 3,444℃ for the earliest and the latest sowing in Taichung 65, while from 3,374° to 3,340℃ in Meher. The daily temperature averaged from crop season in the earliest and latest sowings ranged from 22.1° to 23.3℃ in Taichung 65, while from 22.1° to 23.4℃ in Meher.

(4) Effects on growth of height and number of tillers

In nursery stage (Table 5) it was found that the earlier the sowing, the shorter was the height of seedings and the less was the leaf-age at the time of transplanting. Meher showed more sensitive to low temperature which suppressed the seedling height and leaf-age.

Figure 3 show that after transplanting the growth of plant height at 30 days in the earliest sowing was about 3/4 the sown one month later in Taichung 65 and about 1/2 in Meher. However, at 45 days after transplanting the height in the earliest sowing was 2/3 the sown one month later in Taichung 65 and 5/8 in Meher. At maturity, the plant height in the latest sowing was about 9/10 the sown one month later in both varieties. This suggests that the effect of sowing on plant height is greater in Meher than in Taichung 65 and mainly during the active vegetative stage. After this stage, their differences in plant height narrow down, because of less differences in temperatures between treatments.

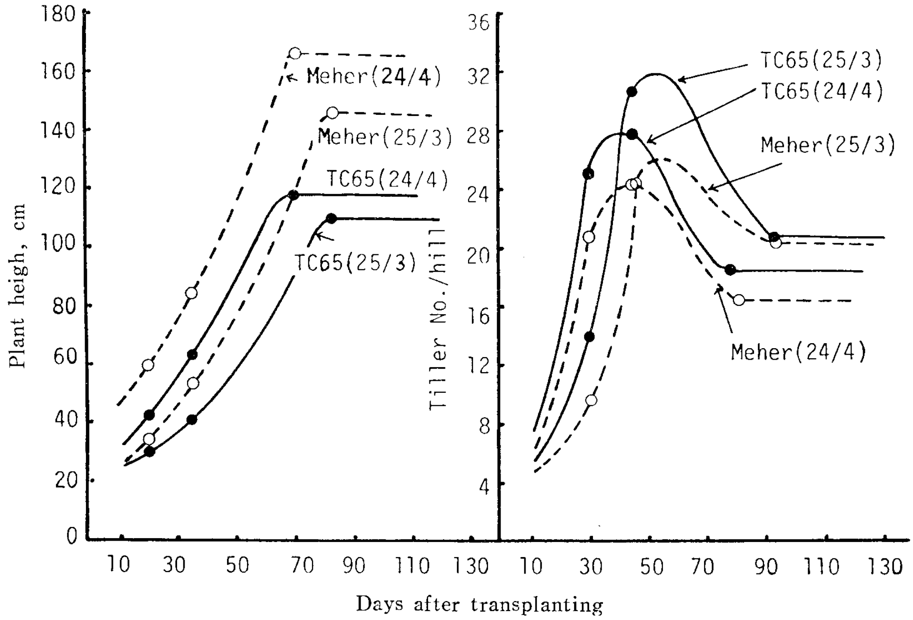

Fig 3: Effects of date of sowing on the growth of plant height and tiller number per hill of Taichung 65 and Meher, 1970.

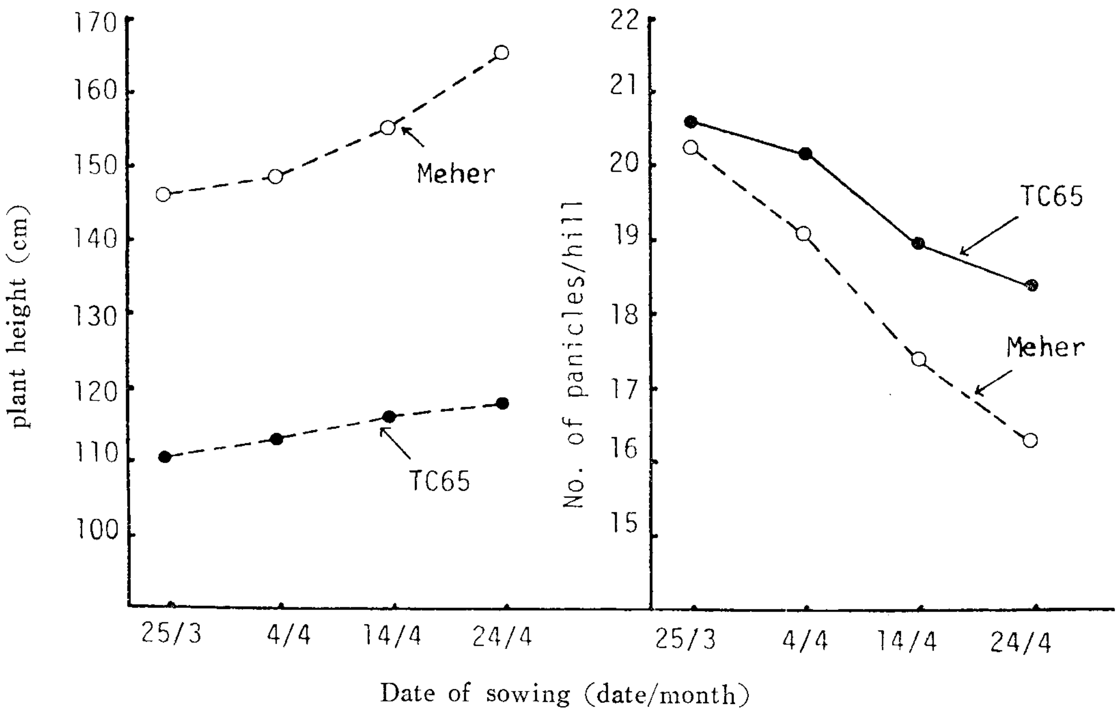

Fig 4: Effects of date of sowing on plant height and number of panicles per hill at maturity, 1970.

The growth rate of tiller number in the active tillering stage was about 1/2 the sown one month later in both varieties. However, the earier sowing tended to accelerate tillering capacity and to delay maximum tillering stage (Fig. 3). As the result, the number of panicles per hill was higher in early sowing than in late one.

Figure 4 shows that the earlier the sowing, the shorter was the plant height, and the more was the number of tillers at maturity. Indica Meher tended to have taller stature and less panicle number than Taichung 65 when they were sown late or subjected to higher temperature and more radiation. From the view point of height and tillers increment, Japonica Taichung 65 which is developed in subtropical Taiwan having more tolerant to low temperature than that originated from tropical Indica Meher. The optimum temperature for Japonica rice was reported from 18.5° to 33.5℃ (Yamada, 1955) and for Indica ranged from 25° to 35℃ as indicated by Osada (1975) for high rate photosynthesis. Lin (1979) in a phytotron determination, under the natural light as the second crop season, showed that the largest number of available tillers was obtained from a temperature ranged from 25° to 20℃ with 25.6 in Tainan 5 and 32.0 in Taichung (N) 1 and claimed that the same results were obtained by other workers (Wu et al, 1975; lin, 1976; and Tsai, 1977 in Taiwan and Samoto, 1966; and Sato, 1970 in Japan). Since the temperature during rice crop season in Mazandaran falls mostly between 20° to 25℃, it may be considered as a high yielding climate condition.

(5) Effects on elongation of internodes

Figure 5 shows the elongation of internodesin Taichung 65 and Meher due to treatment effects are different. Elongation of internodes appeared at about 10 days prior to panicle initiation in Meher and 7 days in Taichung 65. Meher elongated earlier thus had more number of internodes, being 6, while Taichung 65 did later showed one internode less. The effect of treatments on elongation of internodes was mainly to 4 basic ones, i.e., B2 to B5 in Meher and B1 to B4 in Taichung 65. The differences of top-internode, adjacent to the panicle, in both varieties were negligible. The effect of early sowing on shortening of internodes was greater in Meher than in Taichung 65, being shortened 19.8 cm in the former and 8.0 cm in the latter as compared to the latest one.

(6) Effects on grain and straw yields

Table 2 and 3 shows the grain and straw yields and analysis of variance for grain yield, respectively.

The highest grain yield, as high as 7,625 kg/ha, was obtained from the earliest sowing which yielded 843 kg/ha higher or 12.4% more than the latest one in Taichung 65, while 6,421 kg/ha or 1,097 kg/ha higher or 20.6% more in Meher with the same treatment comparison. It was found that delaying sowing time at an intervals of 10 days decreased markedly in grain yields of both varieties especially of Meher.

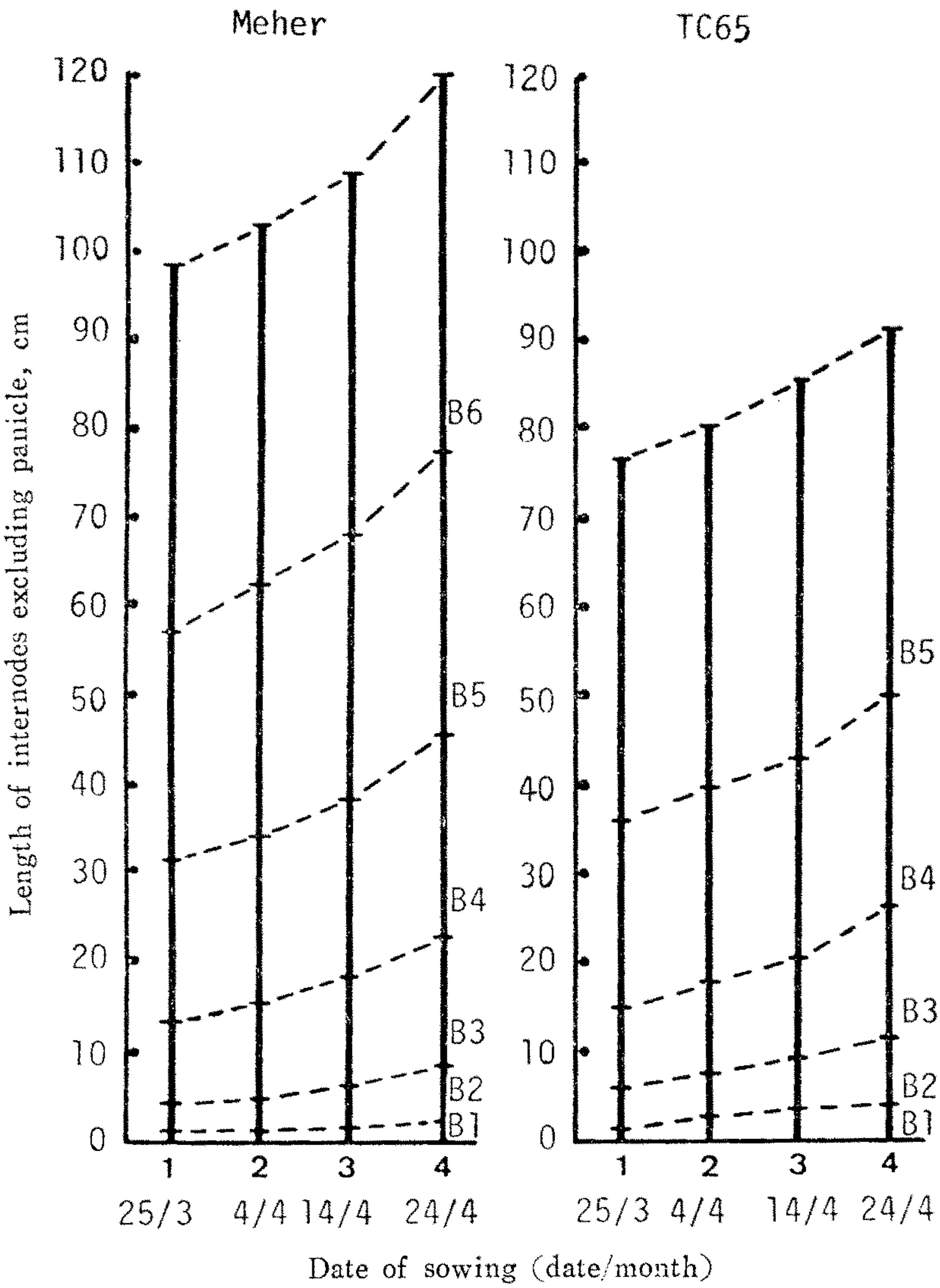

Fig 5: Effects of date of sowing on elonagtion of internodes of Taichung 65 and Meher, 1970.

Table 2. Effects of sowing date on grain and straw yields and lodging

Sowing date & month	Grain yield		Straw yield		Dry matter		Harvest index %	Loding index	
	kg/ha	Index	kg/ha	Index	kg/ha	Index		Date	%
Taichung 65									
1. 25/3	7625	112.4	8066	100.3	15691	105.1	48.6	–	0
2. 4/4	7139	105.3	8150	101.3	15289	102.4	46.7	–	0
3. 14/4	7015	103.4	8206	102.0	15221	102.0	46.1	–	0
4. 24/4	6782	100.0	8044	100.0	14926	100.0	45.6	–	0
Meher									
1. 25/3	6421	120.6	7125	87.3	13546	100.4	47.4	–	0
2. 4/4	5776	108.5	7409	90.8	13185	97.8	43.8	28/8	42
3. 14/4	5183	96.8	7863	96.3	13046	96.7	39.7	28/8	100
4. 24/4	5324	100.0	8163	100.0	13487	100.0	39.5	28/8	100

*Harvest index: (Grain yield/Dry matteer) x 100%

Table 3. Analysis of variance for grain yield

Source of variance	Degree of freedom	Mean square	Observed F	Tabulated F	
				0.05	0.01
Block	3	139,132.25	18.50***	3.86	6.99
Date (D)	3	257,024.33	34.18***	3.86	6.99
Error (a)	9	7,520.36			
Variety (V)	1	2,743,635.13	559.44***	4.75	9.33
V x D	3	22,817.96	4.65*	3.49	5.95
Error (b)	12	4,904.33			

c.v. =1.09%

LSD for comparison of between dates of sowing: 5%=237 kg/ha
1%=363 kg/ha

LSD for comparison of between varieties: 5%=135 kg/ha
1%=189 kg/ha

LSD for comparison of within sowing date & between varieties:
5%=270 kg/ha
1%=378 kg/ha

LSD for comparison of within variety & between sowing dates:
5%=311 kg/ha
1%=442 kg/ha

Table 3 indicates that the differences among sowing dates and between varieties are highly significant at 1% level and their interaction is at 5% level. The results of testing between sowing dates, between varieties, and between their combinations are shown in Table 4.

Table 4. Comparison of differences between sowing dates, varieties and their combinations.

Treatment	Grain yield				Treatment	Grain yield			
	kg/ha	Difference				kg/ha	Difference		
		kg/ha	Significant				kg/ha	Significant	
Between sowing dates					Between sowing dates x varieties				
1.March 25	7023	+970	+16.0%	a	TC 65 1.25/3	7625	+843	a*	a**
2.April 4	6458	+405	+6.7	c	2. 4/4	7139	+357	a	c
3.April 14	6099	+47	+0.8	d	3.14/4	7015	+233	a	cd
4.April 24	6053	0	0	de	4.24/4	6782	0	a	d
Between varieties					Meher 1.25/3	6421	+1097	c	a
					2. 4/4	5776	+452	c	c
Taichung 65	7140	+1464	+25.8%	a	3.14/4	5183	–141	c	e
Meher	5676	0	0	d	4.24/4	5324	0	c	e

*Within sowing dates & between vraieties, **Within varieties & between sowing dates. LSD see page 160.

The differences between sowing dates indicated that rice plant sown on March 25 (T_1) yielded nearly 1 ton/ha or 16% more than that sown one month later (T_4). Statistically there was highly significant differences at 1% level between the eariest and other 3 dates of sowing. Rice sown on April 4 (T_2) outyielded the sown 20 days later (T_4) by 405 kg/ha or 6.7% and differed at 1% significant level, but at 5% significant level when it compared with that of sown 10 days later (T_3). The trend coincided with the results of past experiment made by ARES (Mojtahedi, 1969).

Grain yields between varietal means showed that Taichung 65 outyielded Meher by nearly 1.5 ton/ha or 25.8% which differed at 1% significant level.

The differences of grain yields between combinations of sowing dates and varieties showed that the earliest one, either in Taichung 65 or in Meher, gave the highest yield which differed very significantly from other 3 dates of sowing. Taichung 65 in T_2 differed at 5% significant level from T_4 but no difference from T_3 and so between T_3 and T_4. In meher, a highly significant difference was seen between T_2 and other 2 later sowings, but no difference between T_3 and T_4.

The differences of straw yields between sowing dates in Taichung 65 did not show very clear trend whereas in Meher it increased 14.6% as the sowing dates delayed one month. Regardless of Taichung 65 outyielded Meher by 1.5 ton/ha, straw yield in the former increased merely 0.5 ton/ha more than the latter. It suggests that Taichung 65 has more economic value in partitioning grain to straw ratio and give higher harvest index, with 45.6 to 48.6%, than that Meher, with 39.5 to 47.4% (Table 3). The biological dry matter weight of Taichung 65 in this temperate climate reached as much as 15.0 to 15.7 ton/ha which is about 50% more than that in subtropical Taiwan (Huang, 1976). Remarkable decreases of harvest index in Meher as caused by delay of sowing dates was mainly attributed to elongation of internodes and decreasing in 1000-grain weight and increasing in percentage of unfilled grain number (Table 5).

(7) Effect on lodging

Table 2 shows that no lodging occurred in Taichung 65, regardless of dates of sowing, while in Meher lodging took place on August 28 in T_2, T_3, and T_4 when rice plant was at yellowish, dough to yellowish, and dough ripening stages, respectively. The causes of lodging in Meher were attributed to (1) the later sowing tended to increase the plant height, (2) the suppress of dew on such a tall and leafy canopy, and (3) more translocation of carbohydrates from source of leaves and stem to the sink of grain in Indica rice during ripening stages than that in japonica one, thus caused driedup of lower leaves, weakened stems and apt to be lodging. Regarding the third cause, Chang et al (1982) showed that the number of green leaves at maturity correlated significantly with grain yields of Indica Taichung sen 2 and Japonica Tainan 5 in the second crop of Taiwan, with ranges of 5.6 to 19.5 leaves per hill in the former variety and of 30.1 to 44.8 leaves in the latter. Lian et al (1970) indicated that the content of carbohydrate in straw at 91 days after transplanting in the first crop decreased from 14.1 to 9.2% as the rates of nitrogen increased from 30 to 150 kg/ha in Japonica Chianan 8 and from 17.8 to 13.9% in semidwarf Indica IR 8, while at harvest, the content droped from 7.0 to 3.4% in Japonica variety and only from 3.8 to 2.8% in Indica rice.

(8) Correlation analyses

Grain yields of Taichung 65 and Meher due to treatment effects in relation to air temperatures, plant growth, and agronomic characters are given as in Table 5.

Air temperature: The daily temperature during vegetative, reproductive, and total growth stages was negatively correlated with grain yield of Taichung 65 at significant level of 1%, 5%, and 5%, respectively, while of the Meher was at 10%, 5%, and 10%. respectively. In nursery stage, the correlation coefficients of both varieties also tended to have negative relationship, while in ripening stage was likely in positive. This suggests that the effect of temperature due to treatments was mainly during vegetative and reproductive stages. To grow rice under a lower temperature condition before reproductive stages but to ripen under a higher temperature environment seemed to be beneficial for high yielding.

The cumulative temperature related to grain yields of Taichung 65 and Meher were, however, not so clear and identical as that daily temperature. Since they were greatly affected by duration. Neverthless, Meher showed in negative correlation during reproductive stage at 5% significant level and in positive during total growth stage at 10% level.

Daigo (1945) reported that the grain yield in Nagano Prefecture, Central Japan, which lattiude (36°30′N) is same to Mazandaran, was highly correlated with mean air temperature during the active growth stage (May-June). On the contrary, murata (1964, 1979) showed that rice yield was negatively correlated among the whole prefectures with the mean temperature during August-September period which ranging between 22°-26℃. Another negative correlation of temperature from panicle initiation to heading with the number of spikelets were also observed by Samoto (1966) and that of Suzuki and Nakamura (1975). In sum, temperature influence on grain yield varies with place, climate Condition, and growth stages. The most suitable air temperatare of

Table 5. Correlation analyses between grain yields and temperatures, plant growth, and agronomic characters.

Items observed	Taichung 65			Meher		
	Range#	Mean	r	Range#	Mean	r
Daily air temperature, ℃						
Nursery stage	16.7-19.4	17.6	-.727	16.7-19.4	17.6	-.555
Vegetative st.	20.5-23.0	21.9	-.998***	20.5-23.0	21.9	-.928*
Reproductive st.	25.2-25.7	25.6	-.954**	24.2-25.7	25.2	-.953**
Ripening st.	25.7-24.2	25.2	.822	25.8-24.5	25.3	.584
Total growth st.	22.1-23.3	22.8	-.989**	22.1-23.4	22.8	-.910*
Cumulative air temperature, ℃						
Nursery stage	406-465	422	-.721	406-465	442	-.545
Vegetative st.	1311-1227	1260	.848	1311-1172	1248	.856
Reproductive st.	715-695	703	.515	760-773	767	-.961**
Ripening st.	996-1088	1032	-.770	878-930	904	-.573
Total growth st.	3376-3444	3416	.010	3374-3302	3342	.900*
Plant growth, cm						
Seedling ht. cm	16.2-18.5	17.4	-.978**	18.8-24.3	21.6	-.917*
Seedling age	4.53-5.08	4.86	-.985**	4.50-4.96	4.72	-.890
30 days ht. cm	29.9-41.8	35.6	-.897	32.9-59.8	47.2	-.932*
45 days ht. cm	40.8-64.0	52.6	-.948*	53.6-83.6	68.6	-.906*
Harvest ht. cm	109.8-117.8	114.1	-.971**	145.5-165.3	153.6	-.780
30 D til.no./hi	13.9-24.1	21.0	-.920*	9.7-20.7	16.9	-.926*
45 D til.no./hi	30.5-27.9	29.5	.783	23.2-24.0	23.8	-.239
Harv.pan.no./hi	20.6-18.4	19.6	.905*	20.3-16.3	18.3	.916*
Days to 50% hd	116-103	109.3	.948*	118-105	111.3	.931*
Days to maturity	155-147	150.3	.917*	153-143	147.0	-981**
Yield components						
Pan. no./hill	20.6-18.4	19.6	.905*	20.3-16.3	18.3	.916*
Grain no./pan.	87.8-83.2	85.1	.957**	93.0-89.9	91.3	.955**
1000-gr wt. gm	28.3-28.8	28.5	-.248	23.5-25.0	24.3	-.788
Unfil-gr no. %	7.0-13.4	9.25	-.801	6.6-10.2	8.30	-.870
Other characters						
Panicle wt. gm	2.58-2.43	2.51	-.149	2.33-2.13	2.23	.578
Pan. length cm	19.0-19.5	19.2	-.250	2.46-25.9	25.2	-.853
Straw yield t/ha	8.04-8.2	8.12	-.122	7.13-8.16	7.64	-.906*
Dry matter t/ha	15.7-14.9	15.3	.993***	13.6-13.1	13.3	.577
Harvest index %	48.6-45.6	46.8	.993***	47.4-39.5	42.6	.988**
Lodging index %	0	0	0	0-100	60.5	-.986**

n=4, :r.10=.900,*:r.05=.950,***:r.01*.990

#Ranges are from early to late sowing

day/night is seemed to be 26°/18℃ (22) under controlled condition.

Plant growth: Delaying dates of sowing brought about a higher daily temperature before reproductive growth stage, thus resulted in taller plant height from sowing to harvest time. The treatment effect on plant height at various growth stages was almost constantly correlated with grain yield in negative way, ranging from 5% to 1% significant levels, regardless of varieties and growth stages.

Though the late sowing obviously increased the number of tillers before active tillering stage (30 days after transplanting), due to higher temperature, but declined after maximum tillering stage (45 days after transplanting). Therefore, the relationship of tiller to grain yields of both varieties showed in negative at 5% significant level before active tillering stage, but gradually changed in positive thereafter and reached at 5% significant level at maturity.

The early sowing under lower temperature delayed the date of 50% heading for 13 days and date of maturity for 8 days in Taichung 65, and for 13 days and 10 days, respectively, in Meher. Both growth durations were significantly correlated with grain yields of both varieties at 5% level. Similar result of delaying growth duration but increasing percentage of spikelets under low temperature of 26°/18° was reported by IRRI (22).

Yield components: Yield components which significantly correlated with grain yields were seen in number of grains per panicle at 1% level and number of panicles per hill at 5% level in both varieties, but nearly negative with the weight of 1000 grains and percentage of unfilled grain number. It may say that early sowing leads to an increase in tiller and panicle number and grain number per panicle but decreases in 1000 grain weight and unfilled grain number.

Other characters: Grain yield of Taichung 65 showed very close correlation with dry matter and harvest index at 1% significant level, while of Meher was significantly correlated with harvest index in positive and lodging index in negative at 5% level and straw yield in negative at 10% level. This suggests that to increase harvest index either by using high yielding potential cultivars, especially of dwarf stature, as well as to sow earlier are likely important for increasing grain yield of rice.

Dates of planting: The final effects of date of planting on grain yields of Taichung 65 and Meher are plotted in Figure 6. There was significant negative correlation (r=-.9636) between grain yield and bate of trasplanting in Taichung 65, whereas nearly negative correlation (r=-.8996) was observed in Meher. The test of hypothesis for the confidence of linearity of regression between grain yield and date of planting, assuming that β<O, is made as follows:

Taichung 65: $F_t = 25.88^{**}$

Meher: $F_m = 8.47^{*}$

Where theoretical F 0.05, 1 & 4 =7.71

F 0.01, 1 & 4 =21.20

Therefore, the confidence of negative linear relationship between grain yield and date of planting for Taichung 65 was highly significant and still reliable for Meher.

(9) Discussion

Despite of the fact that early planting in this temperate zone may lead to an increase in grain yield at an amazing level, cold damage of seedling is very common, since the temperature during nursery stage is usually too low for germination of seeds and growth of seedlings. Protection of nursery by covering PVC film is, therefore, a prerequisite for early sowing. On the other hand, the late planting, even it does free from cold damage during nursery period, but will suffer unfavorable climate, especially of frequent rainfall and cloudy weather associated with a rapid drop of temperature and shortening of daylength, during the ripening period, thus results in decrease of grain yield. The fact of yield differences may be elucidated by the results obtained from this experiment in comparison with the yield data sampled from Pilot Rice Farm[8] as in Figure 6.

If taking the grain yield of Meher in Pilot Farm, being 4.32 t/ha, which transplanted on May 21 as 100% then that of planted one month later decreased by 1.63 t/ha or 37.7%, while of the date of planting experiment which planted on April 18 or 33 days earlier, being 6.42 t/ha, outyielded the said Pilot Farm by 2.10 t/ha or 48.7%. The correlation between grain yield and planting dates in Pilot Farm was negatively significant at 5% level with regression coefficent of 59.1 kg/ha/day or 0.9% day in reducing yield as planting date delayed, whereas in experimental farm with 38.8 kg/ha/day or 0.6% day. The pooled correlation and regression coefficients in the said two farms was negatively very significant at 1% level (r=-.9777) and reduction in yield at 59.4 kg/ha/day or 0.9%/day. Chang et al (1976, 1980) showed that grain yield reduced at 1.0% in the second crop rice of west coast area when planted one day delayed. Weather condition of the second crop in Taiwan is rather similar to that in Mazandaran. However, Taichung 65 in date of planting experiment showed reduction of yield with 26.5 kg/ha/day or 0.35%/day only. This suggests that Indica Meher is more responsive to temperature or date of planting.

Another evidence of low yield due to too late sowing and transplanting was from fertilizer test conducted in the Extension Farms (Table 6).

Table 6. Grain yield as affected by the date of transplanting under various rates of N-application in extension farms.

N kg/ha	Transplanted in early to mid-May Avrage of 3 farms			Transplanted in early to late June Average of 2 farms		
	kg/ha	Index		kg/ha	Index	
0	4200	100*	100*	3275	100*	78.0*
40	4640	111	100	4190	127	90.3
80	5060	121	100	3800	116	75.1
120	5203	124	100	3690	113	70.9

* and ** indicate without N and transplanted in early to mid-May as the check (100%), respectively.

The result indicates that under 120 kg/ha of N, Meher transplanted during early to mid-May

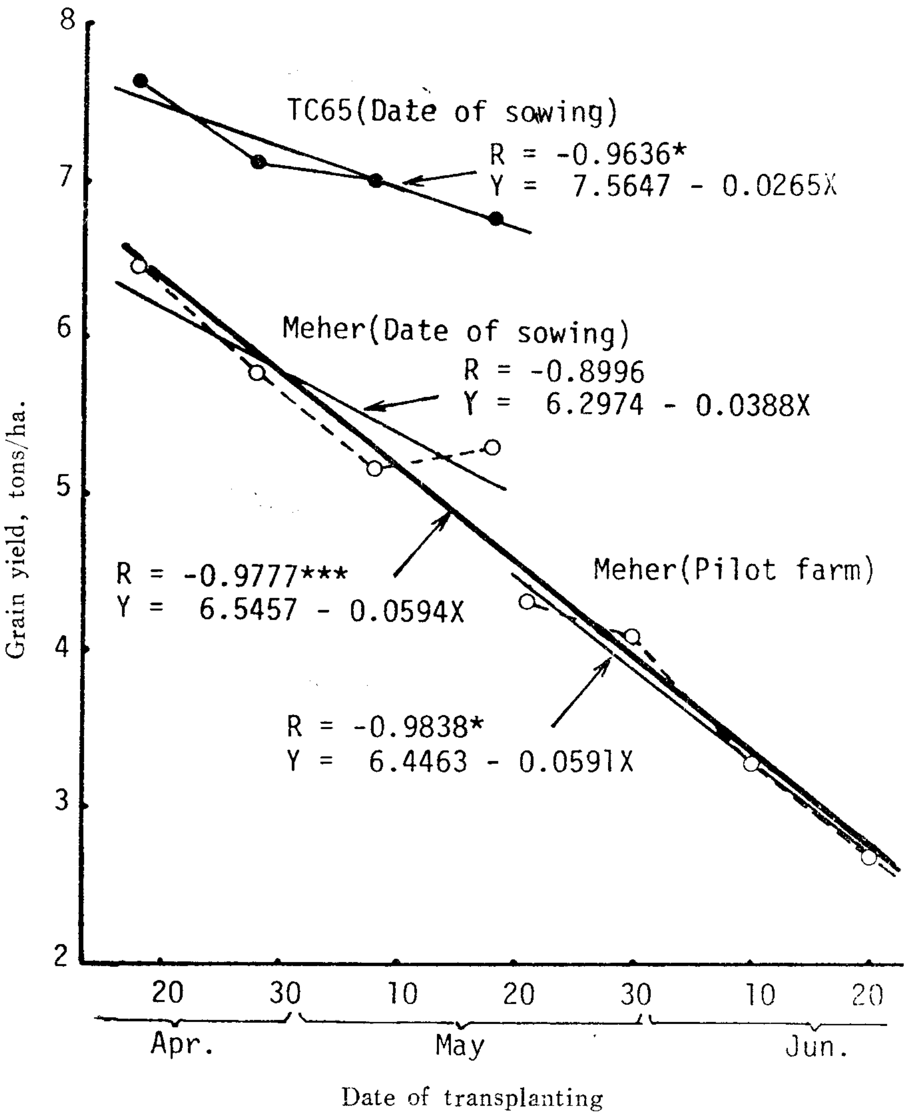

Fig 6: Influence of delaying transplanting time on the grain yields of Taichung 65 and Meher, 1970.

outyielded transplanted during early to late June by 1.5 t/ha or 29.1%. The one month earlier transplated showed linear relationship between grain yield and rate of N from 0 to 80 kg/ha, whereas planted one month later, the maximum rate of N response to grain yield was up to 40 kg/ha only.

Therefore, the early sowing is one of the most important cultural practices which will substantially contribute to the high yield of rice in temperate northern Iran. Furthermore, a partial application of this new culturarl practice will play a buffer role to the problem of shortage of labourers during transplanting. However, implementation of early sowing requires techniques and materials for cold protection during the nursery stage.

Summary

The purpose of this experiment is to compare the effectiveness of various dates of sowing on the growth and yield of two leading rice cultivars in the temperate northern Iran.

An experiment of split-plot design with 4 dates of sowing as Main-plot and two rice varieties as sub-plot each in 4 replications was conducted at Amol RES in 1970.

The results strongly suggested that the earlier the sowing, the higher was the grain yield obtained. Meher sown on March 25 and transplanted on April 18 was able to be harvested on August 25 and yielded 1.1 t/ha or 20.6% more than that sown one month later. Taichung 65 sown on March 25 and transplanted on April 18 gave 0.84 t/ha or 12.4% more than that sown one month later. In Pilot Rice Farm, Meher transplanted on June 20 yielded 1.6 t/ha or 37.7% less than that transplanted one month before. The pooled analysis of correlation between grain yields from both farms of experiment and Pilot Project was highly significant and with negative regression coefficient at 59.4 kg/ha/day in reduction of yield as planting date delayed. In the extension farm, Meher planted during early-mid May outyielded the planted during early-late June by 1.5 t/ha or 29.1% under the same rate of N-fertilization.

The early sowing tended to inhibit the plant height but accelerated the tillering capacity, resulting in increasing number of paniclesper unit area and number of grains per panicle. In pilot Rice Farm and extension farms, Meher transplanted during June showed that the reduction of yield was mainly caused by unfavorable weather prevailing during the ripening stage and resulted in an increase of unfilled grains and reduction of grain weight.

It is recommended that the rice growers in this province should sow seeds as early as possible and use cold protected nursery. Late sowing and transplanting should be avoided.

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伊朗北溫帶稻作之研究

I.水稻種植時期效果試驗

張學琨　洪信雄　林文雄

摘　要

稻作產量受生育期間之氣候影響很大，故如何在最適宜之季節栽培，爲獲致最高收量之要訣。Mazandaran（馬省）位於伊朗北部與Caspian Sea（裡海）南北爲鄰，稻作面積12萬公頃，爲伊朗最重要稻作地區。北緯35～37度之間，年平均氣溫在15～18℃，最低2月在7～8℃，最高8月在26～28℃，於稻作之月份在5月初至10月中旬，年雨量700～1000mm，但僅1/3降落在稻作期間，所幸灌溉水源充足。8月前之氣候極爲乾旱，甚利水稻生育，但9月後即入多雲時雨，氣溫驟降，日照漸少之氣候，不利水稻之成熟。唯馬省農民尚無早植及秧田保溫之習慣，故均於5～6月間插秧，9～10月收割，故因冷害及短照而減產。

本試驗目的在比較不同種植時期對水稻品種間之生育及產量之影響情形，俾供改進當地稻作時期，以提高單位產量。試驗採用裂區設計，時期爲主區，品種爲副區，重複4次，在Amol稻作試驗場實施。結果如下：

本稻越早植產量越高，當地秈稻Meher於3月25日播種，4月18日插秧，可於8月25日收成，公頃產量達6.42公噸比一個月後種植者5.32公噸增產21%。稉稻臺中65號與Meher同時種植，可於8月27日收成，產量高達7.63噸，比一個月後種植者6.78公噸增產12%。在農民示範田，Meher於5月21日插秧，收量4.32公噸，比一個月後插秧者2.69公噸增產38%。在推廣農戶之施肥示範田於5月初至中旬插秧者氮肥施用120公斤/公頃時，收量5.20公噸比6月上至下旬插秧者3.69公噸增產29%差異均極顯著。

早植有抑制株高之生長率，但促進分蘗能力，結果增加單位面積總穗數。在農民之示範田Meher於6月插秧者，因在結實期後，受上述不良氣候之影響，導致不稔粒之增加及產量之減少。

因之欲提高馬省稻作產量，宜在4月間儘早播種，並採用保溫秧田，於5葉期即5月間插秧，儘量避免晚植。