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Study on the Salt Tolerance of Rice and Other Crops in Reclaimed Soil Areas.

6. The Comparison of Growth in the Direct Sowing and Transplanting of Rice Culture in the Reclaimed Salty Areas.[1]

IM, Hyong Bin and Ung Kyu LIM
(College of Agriculture, Seoul National University)

干拓地에서 水稻 및 其他作物의 耐鹽性에 關한 硏究

6. 鹽分干拓地에서 直播法과 移秧法에 依한 水稻生育의 比較

任 綱 彬·林 雄 圭
(서울大學校 農科大學)

ABSTRACT

The Nongkwang variety was sown directly in the field by the three methods of dibbling, drill seeding and broad-casting in non-, low- and high-salty areas, and compared with the growth of transplanted rice in each areas.

The yield of rough rice was increased remarkably by direct sowing when compared with that produced by transplanting in both salty areas, but in non-salty area, the former was decreased significantly. There was no significant difference in the yields of rough rice resulting from three seeding methods of direct sowing in each area.

The direct sowing method was predominated in number of panicle, weight of panicle, ratio of matured grains, milling recovery percentage, and straw weight in both salty areas, and dicreased in panicle weight and ratio of matured grain in non-salty area.

INTRODUCTION

According to the history of rice culturing technique in Korea, direct sowing method was practised in the early days. This culture was subsequently transformed into an intensive method of transplantation under soil submerged conditions. The direct sowing method is employed the United States, some parts of Japan and on a limited scale in other countries.

In Korea the direct sowing is encuraged in dry paddy field with poor irrigation facilities as a protective measure for a drought disaster. The direct sowing under conditions is sometimes practised in the reclaimed salty area. The transplantation method is considered to be most practical under intensive farming situations with good soil environments. In other words, the transplantation method makes the growth of crown roots more vigorous, as well as the vegetative growth. Thereby the

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rice yields are greater than direct sowing method.

It is fully expected that an increased yield of the rice can be achieved by preventing severe salt damage on the injured portion of the root of rice plant due to transplantation, reducing the withering ratio due to the inability of rooting after transplantation when severe salt damage prevails and restricting the delay of rooting and the decrease of yield due to the delay of tillering in the salty area after transplantation.

In order to make a comparative study on the yield and rice growing differences from transplanting and three direct seeding methods, dibbling, drill seeding and broad-casting, experiments carried out in high-, low- and non-salty areas.

MATERIALS AND METHODS

The Nongkwang variety was sown directly in the field by the three seeding methods of dibbling, drill seeding and broad-casting, in each salty area on April 30 (seed soaking was done on the same date), as the transplanting method. The spacings were as follows:

Dibbling: 30 cm × 15 cm

Drill seeding: ridge width 30 cm, drill width 15 cm

Broad-casting: ridge width 30 cm, seeding width 120 cm

The seeding amount was 5 kg/10 a for each treatment. The plot size was 6 m × 3 m with a randomized block design of 3 replications. The total amounts each of N, P_2O_5 and K_2O after the transplantation period and seed bed period in the ordinary transplanting method were 11 kg of N, 8.5 kg of P_2O_5 and 8.5 kg of K_2O/10 a. The total amounts of P_2O_5 and K_2O were applied as basic dressing with 4 kg of N, followed with 5 kg for tillering and 2 kg before heading.

RESULTS

1) Growth at the Seedling Stage

The seedling stage of the direct sowing plots corresponds to the nursling stage in the seed bed of transplanting. The early growth in the direct sowing plots suffered from salt damages e.g., the germination ratio was partly controlled by the soil salt content. Moreover, the germination was reduced remarkably and a large number of rice plants withered in the high salty plots.

The seed roots in the direct sowing plots following germination were not rooted into the ground and drift about on the water. Furthermore the blue-green algae and others were grown abundantly due to improved fertility by the application of fertilizers and the rise in water temperatures. It is considered important, therefore, to take proper yet comprehensive measures to solve these problems.

There is no difference in the number of tillers among the dibbling, drill seeding and broad-casting plots in each salty area at the early tillering stage (transplanting stage of the ordinary culturing). However, there are great differences in the number of tillers of rice growing in each salty area. The average tillers produced were 4.1/hill in the non-salty area, 3.2/hill in the low-salty area and 1.8/hill in the high salty area. Five tillers/hill were produced in the transplanted areas. Therefore the number of tillers even in the non-salty area is also less than in case of the transplanting method.

Some seeds directly sown did not germinate or the transplanted seedlings also withered in the low-salty area. A considerable number of seedlings withered in the high-salty areas. Thus the tillers produced might be greatly controlled by the salt controlled by the salt changes in content.

There was not much difference in the plant height between each seeding method. Although there was no remarkable difference observed between each salty area the plant height was somewhat greater in the high-salty area than the low-salty area. This may be attributed to a relatively deep water condition caused by poor drainage in the experimental plots in the high-salty area. The plant height of rice in the direct sowing plots showed a trend lower than that of the seedling of nurseling bed of the transplanting method. It was very obvious in the salty areas.

2) Growth of the Tillering Stage

The growth of rice plants in the direct sowing plots from the transplanting stage to the maximum tillering stage showed a remarkable difference in each salty area from that of the growth in the transplanting plots. In other words, the growth of seedlings was greatly affected by the salt damage during the rooting stage in each salty area of the transplanting plots while the rice plant of the direct sowing was grown in good condition in this stage as a result of the development of resistance or hardness to the salty condition at the seedling stage. At this stage the plant height and number of tillers of the direct sowing plots increased remarkably.

Table 1. shows that there was no difference in the number of tillers between the seeding methods of direct sowing in each salty area. However, the number of tillers observed in the broad-casting plots in the low-salty area was small in number. In addition, there was observed a remarkable difference in the number of tillers per hill area in each salty area; e.g., 23.6 in the non-salty area, 18.0 in the low-salty area and 15.9 in the high-salty areas. In the transplanting plots under the same salt concentration above, there was found 14.5 tillers in the non-salty area, 9.2 in the low-salty area and 7.0 in the high-salty area. These data indicate almost a double increase in the total number of tillers produced in the direct sowing plots. The direct sowing methods have a definite advantage over the transplanting method as measured by the total number of tillers produced especially as the salt content rises.

No differences in growth of plant height were observed in each salty area in general. It was noted that the plant height by the broad-casting method was somewhat shorter than by the dibbling and drill seeding methods. The differences of the plant height by the direct sowing methods were remarkable between each salty area e.g., 104.7 cm in the non-salty area, 94.3 cm in the low-salty area and 74.8 cm in the high-salty areas. However, the heights were 84.7 cm in the non-salty area, 62.8 cm in the low-salty area and 54.6 cm in the high-salty area of the plots by the transplanting method.

The plant height in the direct sowing plots was also greater by about 30 percent than that of the transplanting plots. The inhibitory ratio of the plant growth affected by salt was greater in the transplanting plots than in the direct sowing plots. plant height by the direct sowing methods compared to the transplanting areas show a greater difference as the salt concentration rises. In other words, direct sowing produced great plant height than transplanting in the high-salty areas.

Table 1. Nunber of Stems and the Plant Height Under the Two Planting Methods (Direct and Transplanting).

Description	Number of stems(per hill)		Plant height(cm)	
	Transplanting stage	Max. tillering stage	Transpl. stage	Max. till. stage
Non-salty area				
Dibbling	4.2	21.0	39.5	106.2
Drill seeding	4.6	24.4	38.9	107.4
Broad-casting	3.4	25.5	38.7	100.5
Average	4.1	23.6	39.0	104.7
Transplanting	5	14.5	40.4	84.7
Low-salty area				
Dibbling	3.3	19.7	35.6	96.0
Drill seeding	2.9	21.8	35.5	94.9
Broad-casting	3.3	18.6	35.7	92.1
Average	3.2	20.0	35.6	94.3
Transplanting	5	9.2	40.4	62.8
High-salty area				
Dibbling	1.8	13.3	38.8	73.8
Drill seeding	1.8	14.9	37.9	73.9
Broad-casting	1.7	17.2	39.1	76.6
Average	1.8	15.1	38.6	74.8
Transplanting	5	7.0	40.4	54.6

3) Yield of Rough Rice

The analysis of variance is a significant difference in the yield of rough rice between treatments and salt concentrations at the one percent level. There was no significant difference between the different seeding methods of sowing.

In non-salty plot, seed broad-casting resulted in decreasing the yield compared with the two other methods. The causes are presumed to be lodging due to the tillering of many stems. The average grain yield was 495 kg/10 a for the three direct sowing methods. This is comparable to 561 kg from the plots of standard transplanting. In the case of direct sowing, an average decrease of 66 kg resulted.

In the low-salty plot, the average of the three direct sowing methods showed an increase of 259.8 kg/10 a when compared with the transplanting method (Table 2). In the high-salty plot, average of the three methods showed an increase of 193.2 kg/10 a when compared with the transplanting method. In the low- and high-salty areas, direct sowing produced much more rice yields compared with transplanting, but some 12 percent decrease in yield was noted in the non-salty plot when direct sowings were made.

In the non-salty, low- and high-salty experimental plots, dibbling produced the highest amount of rice followed by drill seeding, broad-casting seeding appeared to produce less but was not significantly different.

It was noteworthy that direct sowing in both high- and low-salty plots attained much better

Table 2. Yield and Various Agronomic Characteristics in the Direct Sowing Experiment.

Description	Date of heading	Culm length (cm)	Length of panicle (cm)	No. of panicle	Wt. of panicle (gr)	Wt. of 1,000 grains (gr)	No. of grains per panicle
Non-salty							
Dibbling	8.22	104.7	20.1	14.0	1.69	26.0	69
Drill seeding	〃	107.3	20.1	21.8	1.08	26.9	43
Broad-casting	〃	105.3	20.3	26.4	0.81	28.4	31
Average	〃	105.8	20.2	20.7	1.19	27.1	48
Transplanting culture	8.24	99.6	20.9	13.0	2.00	26.1	80
Low-salty							
Dibbling	8.25	105.7	19.6	12.9	2.06	26.8	82
Drill seeding	〃	98.8	19.8	17.7	1.45	27.7	54
Broad-casting	〃	100.0	19.0	15.9	1.61	26.9	63
Average	〃	101.5	19.5	15.5	1.71	27.1	66
Transplanting culture	8.28	77.1	19.0	8.2	1.69	26.0	67
High-salty							
Dibbling	8.28	80.6	19.8	12.4	1.63	26.7	64
Drill seeding	〃	87.9	21.5	14.3	1.34	26.5	53
Broad-casting	〃	89.6	20.6	17.0	1.07	26.4	43
Average	〃	86.0	20.6	14.6	1.35	26.5	53
Transplanting culture	8.30	71.9	18.8	8.0	1.27	23.7	66

Description	Ratio of matured grain(%)	Milling turn out percent	Wt. of rough rice kg/10a	Wt. of brown rice kg/10a	Wt. of broken rice gr/3.3m²	Wt. of straw kg/3.3m²	Rough rice/ straw(%)
Non-salty							
Dibbling	83.8	74.0	511	378	52.3	4.03	42
Drill seeding	87.5	77.9	511	398	31.3	3.33	51
Broad-casting	87.6	75.9	464	353	42.0	3.88	50
Average	86.3	75.9	495	376	41.9	3.48	48
Transplanting culture	91.4	80.3	561	450	18.3	3.04	61
Low-salty							
Dibbling	91.5	77.4	574	445	35.9	3.48	54
Drill seeding	95.6	78.1	554	432	28.9	3.16	58
Broad-casting	90.9	80.2	552	443	31.3	4.07	45
Average	93.0	78.6	560	440	32.0	3.57	52
Transplanting culture	93.7	79.0	300	237	4.7	1.65	61
High-salty							
Dibbling	92.2	77.5	436	338	32.3	2.18	67
Drill seeding	90.2	78.5	413	324	21.7	2.23	62
Broad-casting	89.6	76.6	391	300	30.2	2.19	59
Average	90.7	77.5	413	321	28.1	2.20	63
Transplanting culture	74.4	68.5	220	151	60.1	1.50	49

result when compared with the transplanting method in the plot in the same salt concentration areas.

4) Differences of Agronomic Characteristics of Rice in Direct Sowing and Transplanting

a) Heading and Maturing Periods

In Table 2 is indicated that the heading period from direct sowing was three days earlier than from transplanting in both non-salty an both salty plots. Furthermore, the direct sowing plots were heading two or three days later when the salt concentration was higher. In other words, in low-salty areas the heading period came three days later than in the non-salty area and in high-salty area two days later than in the low-salty area. When direct sowing was employed, the period of maturing came some three days earlier than that of transplanting in each experimental area. The higher salt concentration, the more delayed was found.

b) Length of Culms and panicles

In all areas the growth of rice from direct sowing produced longer length of culms when compared with transplanting. Direct dibbling in the non-salty area produced culms some 6 cm longer (6 percent) than from the transplanting method. In the low-salty plot, the culms were 28 cm longer (31 percent) and in the high-salty plot 9 cm longer (19 percent).

Direct sowing in the low-salty area produced longer culms and an increased yield of rough rice compared with transplantings. It appeared that direct sowing in salty plots has a close relationship with growth in height and yields of rough rice grains.

The panicles were longer when the rice was grown from direct sowing in the high- and low-salty areas than from transplanting. And the length of panicles was longer than from direct sowing in the non-salty area when the rice was transplanted. In salty plots, the length of culms was shorter as the salt concentration became higher in the transplanting method. In the case of direct sowing, there was no difference in the length of panicles between salty areas.

c) Length of Internodes, Leaves and Roots

In each experimental area, direct sowings produced longer top and root systems compared with transplanting. The length between each node is shown in Figure 2. Length of nodes is proportionately longer in the case of direct sowing in the non-salty plots than in those transplanted. In both salty plots, transplanting resulted in bringing about shorter length of nodes in the lower stems compared with direct sowing, thus making the total culm length shorter. The contraction of nodes in the lower plant parts in transplanted plots was attributable to a retarded elongation of the culms in the early growth stage as a result of salt damage.

Table 3 shows a comparison of length of the leaves in each experimental areas. Length of leaf was conspicuously longer in the case of direct sowig than in transplanting. In addition, a comparative observation was made at both non-salty and both salty plots on the number of active leaves in the maturing stage. In the non-salty plots less leaves where observed than in salty plots. Also there were more dead leaves. Furthermore, it was noted that there were more leaves in the low-salty area than in the high-salty area. It is apparent that leaves of the rice plants in the low-salty areas are more active photosynthetically at the maturing period than those grown on the non-salty plots.

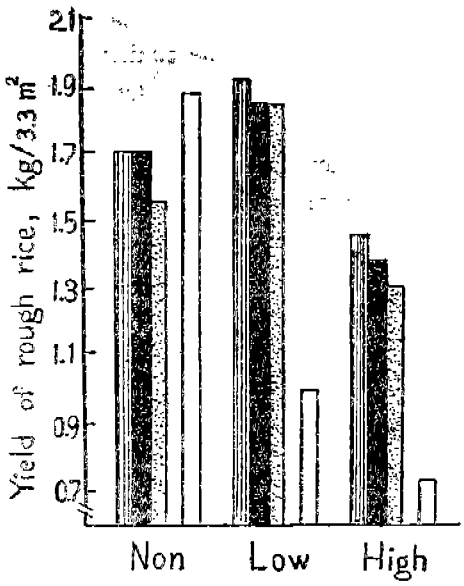

Fig. 1. Rough rice yields in the three each direct sowing method and transplanting.

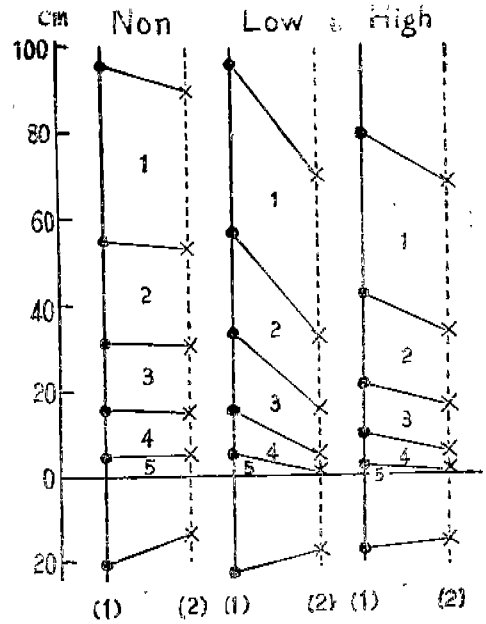

Fig. 2. A comparison of the length of internodes and roots in (1) direct sowing and (2) transplanting. Numbers are in order of internodes from top portion.

It is clear that functions in the top parts of rice plants are effected favorably at the maturing stage with an increase in grain yields of rough rice in the low-salty areas. In each experimental area, direct sowing produced less withering of leaves and better growth of roots than the transplanted plots. (Table 3)

d) Number of Panicles and Grain Numbers per Panicle

Since the number of panicles per hill is unclear in the cases of broad-casting and drill seedings a comparison was made between direct sowing and transplanting in the non-, low- and high-salty areas by counting the number per unit area.

In each experimental area, the same amount of seeds were sown. Dibbling resulted in produucing less number of panicles per plot when compared with drill seeding and broad-casting. The non-salty and high-salty areas produced more panicles when broad-casting than from the drilled method. The average number of panicles by the seeding methods of direct sowing produce more panicles than by transplanting. Again the former has tremendously more panicles. The number of panicles produced compared to transplanting were 20.7 to 13 in the non-salty area, 15.5 to 8.2 in the low-salty area and 14.6 to 8 in the high-salty area. It was noteworthy that direct sowing in the high- and low-salty areas practically doubled the number of panicles produced from transplanting. The salty conditions in the salty areas were responsible for plant withering at the rooting stage and thereby delaying tillering. Direct sowing in salty areas was observed to markedly increase the number of panicles produced.

The number of grains per panicle by the three different direct seeding methods in the non-salty area were observed. The results indicate that dibbling produced the largest number of grains per

panicle followed by drill seeding and broad-casting, respectively. In this experiment with Nong-kwang variety, it was found that experimental areas which has many panicle showed less number of grains per panicle and vice versa in the case of the non-salty plot, transplanted plots produced more grains per panicle than direct sowing.

In the low-salty area, dibbling resulted in the production of more grains per panicle than drill seeding and broad-casting. The average number of grains per panicle from the three different direct sowing was almost indentical with that of transplanting.

In the high-salty area, dibbling topped other methods in producing more grains panicle. Drill seeding and transplanting produced almost same number of grains per panicle. When compared with the average among the three different direct sowing methods, direct sowing produced less grains panicle than transplanting.

Dibbling in each experimental area resulted in producing less number of panicles and more grains per each panice while drill seeding in each area produced less grains per panicle than dibbling.

e) Weight of Panicles and Weight of 1,000 Grains

Rice from dibbling produced heavier weight of panicles than the other seeding methods and transplanting in non-salty area. But the weight of grains produced by the three seeding methods in direct sowing were lighter than the weight produced by transplanting. In the low-salty area, dibbling produced the heaviest weight of panicles. The weight was heavier than panicle grown from transplanting in the low-salty area. In the high-salty area, dibbling produced heavier weight of panicles than transplanting followed by drill seeding. The average weights among three direct methods of sowing were heavier than from transplanting.

The weights of 1,000 grains showed no differences in each experimental area from different seeding methods. In the non-salty and low-salty areas, direct sowing generally produced heavier grain weights than transplanting. In the high-salty area, transplanting had distintively lighter weight than direct sowing.

f) Ratio of Matured Grains, Milling percentages and Weights of Broken Rice Grains

There was no marked difference of matured grains from the three different methods of direct sowing. In the non-salty area, transplanting produced more matured grains than the direct sowing methods. In general, direct sowing and tansplanting produced the ratios of 90 to 95 percent in matured grains in the low-salty area. But direct sowings in the high-salty area showed far better ratios than by transplanting. Generally, the ratios of matured grains is higher by direct sowing than tranplanting in the salty areas.

There was no marked difference in the milling percentage from different direct seedings and transplanting. In the non-salty area the milling percentage from the transplanting produced was better than that in the direct sowing grain. In the low-salty area the milling percentages were almost same but direct sowing was higher in the high-salty area.

In both non-salty and low-salty areas, transplanting produced less amount of broken rice compared with direct sowing. In the high-salty area, direct sowing produced less droken rice.

The increase of broken rice in transplanting in the high-salty area may be attributable to delay of tillering, beading and maturing due to salty damage and the low temperature of fall before

complete maturity.

Table 3. Length of Leaves in the Direct Sowing and Transplanting Plots at Maturing Stage.

	Culturing method	Leaves (from top)				
		1st leaf	2nd leaf	3rd leaf	4th leaf	5th leaf
		cm	cm	cm	cm	cm
Non-salty area	Direct sowing (Average)	29.9 △	43.5 △	49.0 △	45.2 △	37.0 ●
	Transplanting	29.5 △	40.4 △	42.8 △	45.3 ●	38.3 ●
Low-salty area	Direct sowing (Average)	28.0 ○	44.6 ○	47.9 ○	45.6 △	37.0 ●
	Transplanting	26.1 ○	34.7 ○	31.8 △	28.1 ●	21.9 ●
High-salty area	Direct sowing (Average)	27.9 ○	32.9 △	33.7 ●	33.3 ●	33.2 ●
	Transplanting	25.9 ○	34.6 △	35.5 ●	29.1 ●	29.4 ●

○ : Living leaf, △ : Living half of leaf, ● : Completely withered leaf

g) Straw Weight, Weight of Rough Rice/Straw Weight Ratio

Table 2 shows that there was no difference of straw weight between direct sowing and transplanting in the non-salty area. But in the low- and high-salty areas, direct sowing produced more straw weight. Therefore, it may be calculated that the ratio of the weight of rough rice vs. straw weight in the non-salty and low-salty areas are smaller in direct sowing as more straw weight resulted. In the high-salty area, the ratio is higher in direct sowing than transplanting.

DISCUSSION

According to Inouye et al. (1966, 1967) germination of the rice seeds was decreased or retarded in the dry paddy field when excessively wet or the soil was submerged in the rainy season. If they this wet condition is maintained, the germinated seeds even managed to grow as the coleoptile. the growth of foliage leaves and roots, and the growth is not uniform, and will result in decrease of yields. Direct sowing with soil submerging of the salty area may present different results from that of laboratory experiments where seeds were treated with common salt and given adequate humidity and temperature.

Rice seeds easily sprout under comparatively high-salty conditions. But the conditions would be very disadvantageous to rice during its yound seedling stage lacking salt tolerance ability (Ishizuka 1956, Kapp 1947, Pearson et al. 1957, Pearson 1959, Shimoyama et al. 1956). In the high-salty conditions, seedlings would be unable to develop roots in the paddy field. In this situation it would suffer from salt damage if irrigated water is reduced and the salt concentration increases. It would also suffer from the interruption of respiratiom from the presence of an excessive increase in irrigated water.

According to Inouye et al. (1967), deep submerging of the soil influence adversely respiration due to the decrease of oxygen content which lowers metabolism in young seedlings and thus detering the growth of rice seedlngs. In direct sowing culture, these water conditions and salty situations

are the most difficult problems to correct for the normal growth of ricce seedlings.

A comparison was made in the present research on the growing conditions from the seed bed to transplanting period with direct sowing methods on using experimental paddy field and the same amount of seeds per unit area. The experiment consisted of five plants per hill, and 72 hills per 3.3 m^2 in the transplanting areas. At that time direct sowing in the non-salty plots consisted of 4.1, 3.2 plants per hill in the low-salty area and 1.8 in the high-salty area. In the non-salty area, no great differences were found in the number of plants per hill. Many yound rice seedlings of direct sowing plots were found dead in the low- and high-salty areas 44 days after the seeds were sown. Direct sowing in the low-salty area compared with direct sowing in the non-salty area showed that 22 percent of the seedlings were dead and 55 percent were dead in the high-salty areas.

It was found that growth of rice until the transplanting stage (5 to 6 leaves) in the case of direct sowing met very critical condition in each experimental area compared with transplanting. It was noteworthy that damage conditions were severe as the salt content rises. Direct sowing plants showed better growth than transplants in the rooting and tillering stages. When the number of stems in the maximum tillering stage was compared, the number in low- and high-salty areas doubled that of the trans-planting plots.

The length of roots was observed. In general, direct sowing showed longer roots and more number than the transplanted plots in both the low- and high-salty areas and non-salty area (See Figure 2). Fujii (1963) also found the same in the Japanese non-salty paddy fields. That is direct sowing increased the number of roots 14 percent with the roots 16 percent longer than in the transplanting plots. He maintained that direct sowing has comparatively a more shallow root system than transplanted seedlings. As the rice grows, he noted, direct sowing culture resulted in many small roots in the upper part of the soil.

Culm length in the maturing period was longer from the direct sowing in each experimental area than in transplanted plots. This may cause more lodging seeds sown on the surface of ground produce roots which are unable to grow deeply and the rice plants are apt to fall or tend to collapse as the culms have longer nodes near the base of the rice plants.

In the present experiment, it was found that direct sowing in the non-salty areas resulted in lodging. No lodging was observed in the low- and high-salty areas. Although the length of culms was longer from the direct sowings in the low-salty areas, there was no lodging. This is thought to be attributable, as mentioned beforer to the healthy growth of stems and the compact condition of the soil in the salty areas after drainage and drying at maturing stage.

Direct sowing increased the length of the panicles and culms and the number of panicles per unit area through the gradual growth in the tillering stage. Transplanted plants produced around 53 to 55 percent as many panicles as the direct sowing plants.

Fujii (1963) made a comparative study of direct sowing and transplanting in the non-salty paddy fields. He found that the number of panicles per hill was practically the same but direct sowing plants produced larger weight of grains per panicle than tranplanting. In the present research, direct sowing produced more panicles per plant with less weight of panicle and fewer

grains per panicle. It appears that this was due to a more dense planting in the non-salty area in order to comparing with salty experimental areas. But direct sown rice grown in the low-salty area produced heavier panicles than in transplanted areas, while the number of grains per panicle were almost the same. However the weight of 1,000 grains were a little heavier with more broken rice and an increase in weight of straw (Choi et al. 1963 a, b). In the high-salty area, direct sowing produced heavier grains, less grains, less grains per panicle, a higher percentage of matured grains and milling percentage with heavier weights of straw and less broken rice (Iwaki 1956, Ota et al. 1955, Shimoyama et al. 1956).

In summary, direct sowing in salty paddy fields resulted in a larger number of panicles, less grains per panicle, heavier weight of panicle, higher percentage of the matured grains, higher milling percentage, and heavier straw weight than produced in transplanted plots.

According to Fujii (1963) direct rice sowing required 13 percentage less labor than transplanted plots. Since the current research project employed small plots for direct sowing, no precise production costs were made.

In both non-salty and salty areas the yield of rough rice was greater when direct planting by dibbling was used, followed by drill seeding and then broad-casting. However there was no significant difference between the three direct sowing methods when compared with drill seeding.

A comparison was made in each experimental area on the yield of rough rice between drill seeding and transplanting. In the non-salty area direct sowing resulted in a decrease of 10 kg of rough rice per 10 a. In both low- and high-salty plots direct sowing resulted in increases of 224 kg and 193 kg, respectively. Therefore, transplanting appears to be more favorable in the nonsalty plot, and direct sowings in the salty paddy fields.

摘 要

農光을 供試하여 微砂質壤土의 無鹽分區와 低 및高鹽分區(四月末 鹽分濃度 0.5% 및 1%)의 干拓地에 點播, 條播 및 撒播의 3樣式의 直播法과 移秧法에 依한 適期栽培를 하여 그들의 生育을 比較하였든바 結果는 다음과 같다.

雨鹽分區에서는 어느 樣式에 依한 直播栽培도 移秧栽培보다 精租收量이 顯著히 增加되었으나 無鹽分區에서는 移秧法이 有意하게 增收되었다. 그리고 直播의 3樣式間에는 無鹽分區와 鹽分區들에서 다같이 有意한 收量差는 없었다.

鹽分區들에서는 直播法은 移秧法에 比하여 穗數가 많었고, 穗重이 무거웠으며 稔實率과 精玄比率이 높았고 藁重도 무거웠으나 無鹽分區에서는 穗重과 稔實率이 떨어졌다.

LITERATURE CITED

1. Choi, H. O. et al. 1963. Stock improvement experiment of rice for reclaimed soil area. Crop Exp. Stat. Suwon, Res. Rept., 149—158.
2. _____. et al, 1963. Stock improvement experiment of rice for reclaimed soil area. The protest of productivity of the stock varieties for reclaimed soil area. Crop Exp. Stat. Suwon, Res. Rept., 159—181.

3. Fujii, M. 1963. A study on the direct sowing culture of rice, 16 years research from 1947. New Sci. Lit. Pub. Japan, 1-52.
4. Inouye, J. and T. Katayama. 1966. Studies on the emergence of rice seedlings in the direct sowing culture. I. On the elongation of plumule through soils after germination. Proc. Crop Sci. Soc. Japan 34(3), 237-242.
5. _____, T. Anayama and T. Katayama. 1967. Studies on the emergence of rice seedlings in direct sowing culture. 2. Effect of submersion treatment on the emergence of plumule. Proc. Crop Sci. Soc. Japan. 36(1), 25-31.
6. Ishizuka, Y. and A. Danaka. 1963. Nutritional physiology of rice. 13-15.
7. Iwaki, S. 1956. Studies on the rice plants. Mem. Ehime Univ. Sect. VI. 2(1), 1-156.
8. _____, 1956. Studies on the salt injury in rice plant. Mem. Ehime Univ. Sect. VI. (Agr) 7(1), 141-149.
9. Kapp, L. C. 1947. The effect of common salt on rice production. Arkansas Univ. Agr. Expt. Stat. Bull. 465.
10. Ota, K., T. Ogo and K. Sasai. 1955. Studies on the saline injury on crops. IX. On the influences of the saline irrigation water upon the shape of rice kernels. Okayama Prefect Agr. Expt. Stat. Spec. Bull. 51, 21-26.
11. Pearson, G. A. and L. Bernstein. 1957. Salinity effects at several growth stages of rice. Agron. Jour. 51, 654-657.
12. _____. 1959. The salt tolerance of rice. Soil Sci. 87, 198-206.
13. Shimoyama, T. and T. Ogo. 1956. Studies of the saline effects on crops. II. On the effects on the growth and the harvest of the rice plant as produced by the saline irrigation at different growing periods. Okayma Prefect Agr. Expt. Stat. Spec. Bull. 54, 21..28.