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Absorption of Fertilizer and Soil Nitrogen by Rice Plants under the Various Cultural Conditions of Different Paddy Fields.

II. Relationships between transplanting time and absorption of nitrogen by rice plants.

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Summary

Field experiments using tagged ammonium sulfate were made to determine the relationship between transplanting time and absorption of nitrogen by the rice plants in two different fields. Experimental plots consisted of early (May 1 to 9), conventional (May 19 to 25), and late (June 10 to 14) transplantations.

The amounts of soil ammonium nitrogen in all the plots showed a tendency to decrease after transplanting. It disappeared almost completely in the early and conventional transplantations by the beginning of July. The earlier the transplanting time, the smaller the percentage of fertilizer nitrogen in soil ammonium nitrogen on the same sampling days.

Absorption of fertilizer nitrogen by the rice plants was finished by the time that most of the soil ammonia had disappeared. However, the amounts of nitrogen absorbed by the rice plants befor heading time, and the recoveries of basal nitrogen in the rice plants, were nearly the same in all the plots of the same field. Since the number of days from transplanting to commencement of ear-primordia formation was considerably smaller in the late-transplanted plot than in the other plots, the speed of nitrogen absorption by the rice plants was greater in the former plot, suggesting that late-transplanting was less favorable for raising an ideal plant type.

The remarkable increase in rice yield per unit area after World War II in Tohoku district is due in large part to the improvement of protected rice nursery care which permitted early transplanting and lessened the cold weather damage (1). Early transplanting is one of the most useful methods to increase the number of panicles and spikelets per unit area and to increase the percentage of ripened grains (2). Therefore, farmers now transplant rice seedlings about a month earlier than 20 years ago. It seems, however, that little study has been done concerning the absorption of fertilizer and soil nitrogen by the rice plants in relation to transplanting date.

The purpose of the present study using ^{15}N-tracer technique is to determine the relationships between the transplanting time and the absorption of nitrogen by rice plants.

Materials and Methods

Field experiments were conducted in Odawara field in 1971 and 1972, and in Takadate field in 1973 and 1974. The properties of the soils of these fields were described in detail in the previous paper (3).

The design of field experiments is shown in Table 1. The experimental plots consist of three different dates of transplanting, namely early (May 1 to 7), conventional (May 19 to 25), and late (June 10 to 14). The experimental methods employed for the present study are almost the same as reported previously (3).

Results and Discussion

The amounts of soil ammonia in all the plots tend to decrease after transplant-

TABLE 1. *Design of Field Experiment.*

Year	Experimental field	Transplanting time	Rice variety	Kind of seedling	Numbers of seedlings per hill	Basal application (Kg/10a)		
						N	P_2O_5	K_2O
1971	Odawara	Early (May 6) Conventional (May 24) Late (June 14)	Sasaminori	Large 〃 〃	3 3 3	7	7	7
1972	Odawara	Early (May 6) Conventional (May 22)	Sasaminori	Large 〃	3 3	7	7	7
1973	Takadate	Early (May 1) Conventional (May 19)	Sasanishiki	Small 〃	5 5	6	6	6
1974	Takadate	Early (May 7) Conventional (May 25) Late (June 10)	Sasaminori	Small Large 〃	5 3 3	7	7	7

Kind of chemical fertilizers;
N; ammonium sulfate.
P_2O_5; calcium superphosphate.
K_2O; potassium chloride.
All the fertilizers were applied to the depth of 10 cm.
Atom percentage of ^{15}N in ammonium sulfate;
2.1% for the analysis of soil ammonium and plant nitrogen.
Seedling;
Large: fifth to sixth leaf age.
Small; third leaf age.
Spacing; 30×12 cm.

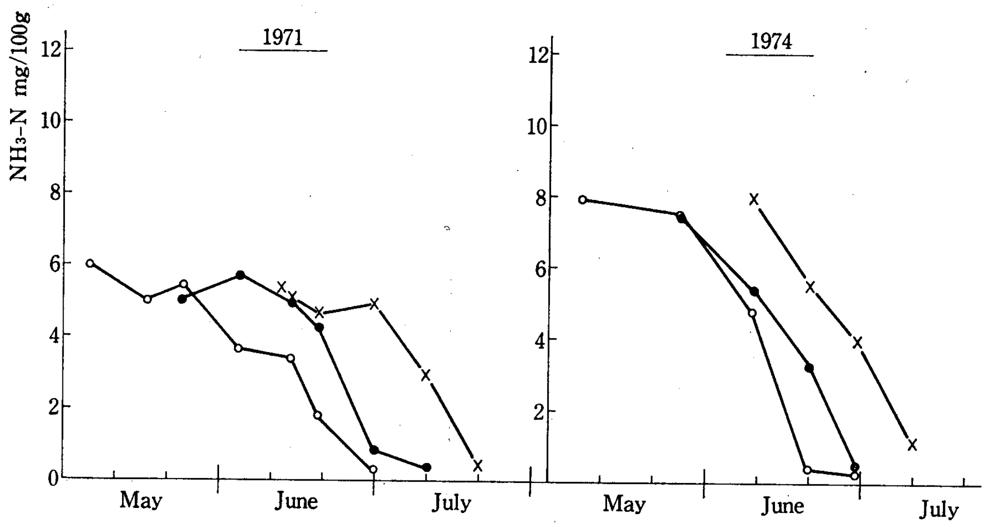

Fig. 1. The amounts of soil ammonium nitrogen.
o—o Early transplantation, •—• Conventional transplantation,
×—× Late transplantation.

ing as seen in Fig. 1. The later the plansplanting date, the more rapid the decrease of soil ammonia, mainly because of the more rapid growth of rice plants in the late transplanting. In contrast to the Odawara plots, the difference in the amounts of soil ammonia between the plots transplanted at the early date and those transplanted at the common date is neglegibly small in the earlier growth stage in the Takadate plots. This small difference is probably due to the suppression of nitrogen absorption of small seedlings (third leaf age) under the low temperature, and the lesser amount of ammonia existing in the soil solution (3). Soil ammonia disappeared in the early and conventional transplantations by the end of June, and in the late transplantation at the beginning of July.

Table 2 shows that the percentage of fertilizer nitrogen in soil ammonium niotrogen is greater in the plots of Takadate than in those of Odawara. This indicates that the loss of applied nitrogen and the amount of mineralized nitrogen

TABLE 2. *The Percentage of Basal Nitrogen in Soil Ammonium Nitrogen.*

Field	Sampling date	Experimental plot (transplanting date)		
		Early	Conventional	Late
Odawara	1971 May 24	37%	%	%
	June 5	28	48	
	June 19	19	32	50
	June 30		17	44
	July 10			36
Takadate	1974 May 26	64	90	
	June 9	58	71	
	June 20		56	71
	June 29			67
	July 10			48

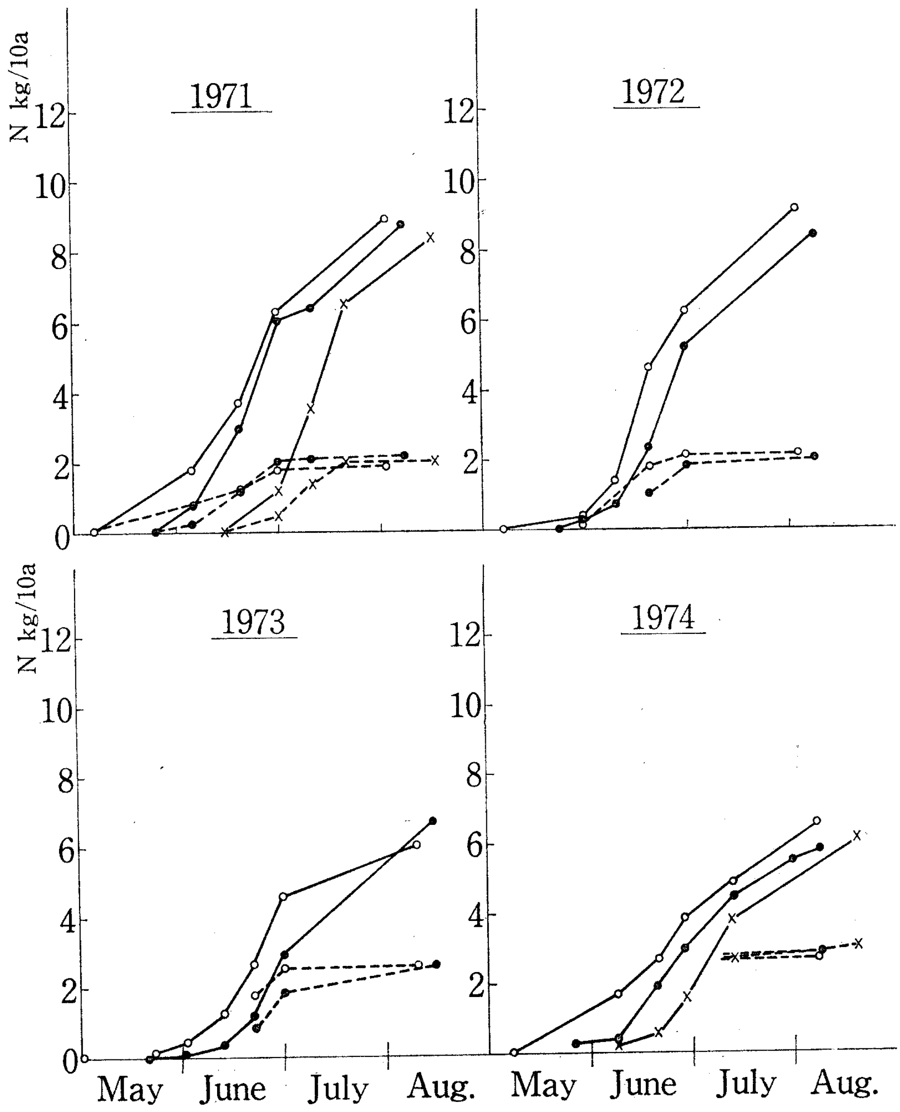

Fig. 2. Amounts of nitrogen absorbed by rice plants.
o—o Total nitrogen absorbed by rice plants transplanted at the early date.
•—• Total nitrogen absorbed by rice plants transplanted at the conventional date.
×—× Total nitrogen absorbed by rice plants transplanted at the late date.
o---o Fertilizer nitrogen absorbed by rice plants transplanted at the early date.
•---• Fertilizer nitrogen absorbed by rice plants transplanted at the conventional date.
×---× Fertilizer nitrogen absorbed by rice plants transplanted at the late date.

are smaller in Takadate than in Odawara (3). In both fields, however, the earlier the transplanting time, the smaller the percentage of fertilizer nitrogen on the same sampling days.

Nitrogen uptake by the rice plants from transplanting to heading time is shown in Fig. 2. It is obvious that the earlier the transplanting, the earlier the nitrogen absorption of the rice plants. However, the absorption speed at the commencement of ear-primordia formation is greater in the late transplantation than in the others.

The amounts of nitrogen absorbed by the rice plants until heading time are 8–9 Kg/10a in Odawara plots, and 6–7 Kg/10a in Takadate plots, indicating that there is no relationship between the amounts of absorbed nitrogen and transplanting time. Absorption of fertilizer nitrogen by the rice plants was finished by the time that most of the soil ammonia had disappeared. The amounts of fertilizer nitrogen absorbed by the rice plants are about 2 Kg/10a in Odawara plots, and 2.7 Kg/10a in Takadate plots. Therefore, the amounts of soil nitrogen absorbed by the rice plants until heading time are about 6–7 Kg/10a in Odawara plots and about 3–4 Kg/10a in Takadate plots, indicating the difference in the supply of soil nitrogen between these fields.

As expected from the percentage of basal nitrogen in soil ammonium nitrogen (Table 2), the ratio of basal nitrogen to total nitrogen absorbed by the rice plants decreased with the lapse of time after transplanting as seen in Table 3. However, the ratio is considerably greater in Takadate than Odawara. For example, it is 22–24 percent in Odawara, and 39–48 percent in Takadate at heading time.

The recoveries of basal nitrogen in the rice plants are 27–31 percent in Odawara, and 40–43 percent in Takadate. However, it should be noted that the recoveries are not related to the transplanting time in either field. The difference in the recoveries between fields is due mainly to the difference in the ammonium absorption equilibria of these paddy soils (3).

Takahashi, Wada, and Shoji (4) showed that the amount of nitrogen per unit area absorbed by the rice plants grown in the field was a function of the accumulated effective thermal index (AETI) consisting of an exponential equa-

TABLE 3. *The Ratio of Basal Nitrogen to Total Nitrogen Absorbed by Rice Plants (A) and Recovery of Basal Nitrogen in Rice Plants (B).*

Field	Sampling date	(A)			(B)		
		Early	Convent.	Late	Early	Convent.	Late
Odawara	1971 June 5	44%	%	%	%	%	%
	June 19	32	41				
	June 30	28	34	41			
	July 10		33	40			
	July 20			30			
	heading	22	23	24	26.7	30.6	28.3
Odawara	1972 May 30	44					
	June 19	39	42				
	June 30	34	35				
	heading	24	24		31.0	28.7	
Takadate	1973 June 21	65	71				
	June 30	55	64				
	headnig	43	39		42.7	43.2	
Takadate	1974 July 10			71			
	heading	42	48	46	39.6	40.3	43.0

tion for the early growth stage and a linear one for the middle and late growth stages. The crossing point of these equations was the AETI of about 400. On the other hand, soil ammonia decreased exponentially and almost all of it disappeared at the AETI of 400, or at the commencement of ear-primordia formation. Since the number of days from the transplating to the commencement of ear-primordia formation is considerably smaller in the late transplantation, the speed of nitrogen absorption by the rice plants is greater in this plot. Therefore, late-transplanting is less favorable for raising an ideal plant type. On the contrary, since early-transplanting is favorable for tillering, it is evident that the number of spikelets per unit area can be increased easily.

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