b. EXPERIMENTS ON THE DECREASE OF TOTAL AND AMMONIUM NITROGEN IN FLOODED SOILS AT DIFFERENT TEMPERATURES

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1. Influence of temperature on the decrease of total nitrogen in flooded soils

Fifteen gram samples of the soils of Taipei, Pinchen, Ilan, Yuanlin, Hsinyin, and Pintung-series taken in beakers, were supplied each with 5 mg of ammonium-nitrogen and were flooded. They were then incubated at 10°, 20°, 30°C and at room temperature, and were analyzed for total nitrogen including nitrate-nitrogen at 1-month intervals, for 2 or 4 months. The results are presented in Tables 1 and 2.

The data in Table 1 indicate that the loss of nitrogen is generally large at high temperatures and in soils having high pH-values, and it is rapid in the early period of flooding.

Table 2 shows that the loss of nitrogen in acidic soils increases when they are limed to a neutral pH-value, and that though the loss is generally rapit in the early period of flooding, in the soil of Taipei series, the loss continues longer. It is also found in the table that the loss is larger in the months of the first crop than in those of the second crop and is the least in winter months.

Table 1. The amount of decrease in total nitrogen in flooded soils supplied with 0.33 gr. NH_4-N per kgr. soil at 10°, 20° and 30°C (gr. N per Kgr. soil, mean for 8 replications)

Temperature	10°C		20°C		30°C	
Period of flooding (Month)	1	2	1	2	1	2
Soil series						
Taipei	0.08	0.09	0.25	0.35	0.30	0.39
Taipei+L	0.29	0.34	0.34	0.43	0.48	0.47
Pinchen	0	0.04	0.01	0.03	0.01	0.02
Pinchen+L	0.16	0.23	0.20	0.24	0.28	0.35
Ilan	0.10	0.14	0.25	0.29	0.28	0.36
Yuanlin	0.23	0.26	0.26	0.33	0.33	0.40
Hsinyin	0.06	0.09	0.09	0.14	0.15	0.20
Pintung	0.11	0.11	0.22	0.27	0.30	0.37
Mean	0.129	0.163	0.203	0.260	0.266	0.320

Remarks: (1) PH-value of the soils:

Taipei	Pinchen	Ilan	Yuanlin	Hsinyin	Pintung
5.6	4.6	5.8	6.8	6.8	7.0

(2) "+L" means liming to pH 7.0.

Table 2. The amount of decrease in total nitrogen in flooded soils supplied with 0.33 gr. NH_4-N per Kg. soil, at room temperature in different season (gr. N per Kg. soil, mean of 8 replications)

Season	1st crop				2nd crop				Winter	
Period of flooding (Month)	1	2	3	4	1	2	3	4	1	2
Name of month	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.
Temp. range (°C)	16-29	22-29	25-33	28-32	29-33	25-32	23-29	23-25	23-25	20-25
Soil series (pH)										
Taipei (5.6)	0.12	0.24	0.37	0.41	0.12	0.16	0.29	0.33	0.06	0.15
Taipei+L (7.0)	0.40	0.49	0.56	0.59	0.26	0.39	0.50	0.51	0.28	0.40
Ilan (5.8)	0.26	0.36	0.45	0.48	0.37	0.31	0.43	0.44	0.18	0.20
Ilan+L (7.0)	0.37	0.50	0.54	0.58	0.39	0.44	0.46	0.43	0.30	0.44
Yuanlin (6.8)	0.27	0.41	0.44	0.43	0.23	0.31	0.36	0.36	0.19	0.30
Pintung (7.0)	0.20	0.31	0.34	0.38	0.25	0.26	0.33	0.30	0.14	0.18
Mean	0.246	0.359	0.414	0.444	0.266	0.300	0.380	0.379	0.179	0.261

Remarks: "+L" means liming soil to pH 7.

The principal cause of nitrogen loss may probably be the process of denitrification, as the amount of loss due to the evolution of free ammonia was found to be too small to account for the total amount of loss; nitrification may proceed in flooded soils, and nitrate ion may be readily reduced in them.

2. Influence of temperature on the decrease of ammonium-nitrogen in flooded soils

To 30-gm samples of the soils of Taipei, Yuanlin, and Pintung-series, 21 mgr. of ammonium-nitrogen were supplied, and after flooding they were incubated at 10°, 20° and 30°C for 9 weeks. The soils were analyzed for ammonium and nitrate-nitrogen at one-week intervals. The results are shown in Table 3, and the change in the content of ammonium-nitrogen is presented in Figures 1, 2 and 3.

The result shows the following facts:

(1) The content of ammonium-nitrogen decreases in flooded soils.

(2) The decrease is slower in acidic soils of Taipei-and Ilan-series than in those of Yuanlin and Pintung-series which have a neutral pH-value. The application of lime to these acidic soils promotes the decrease.

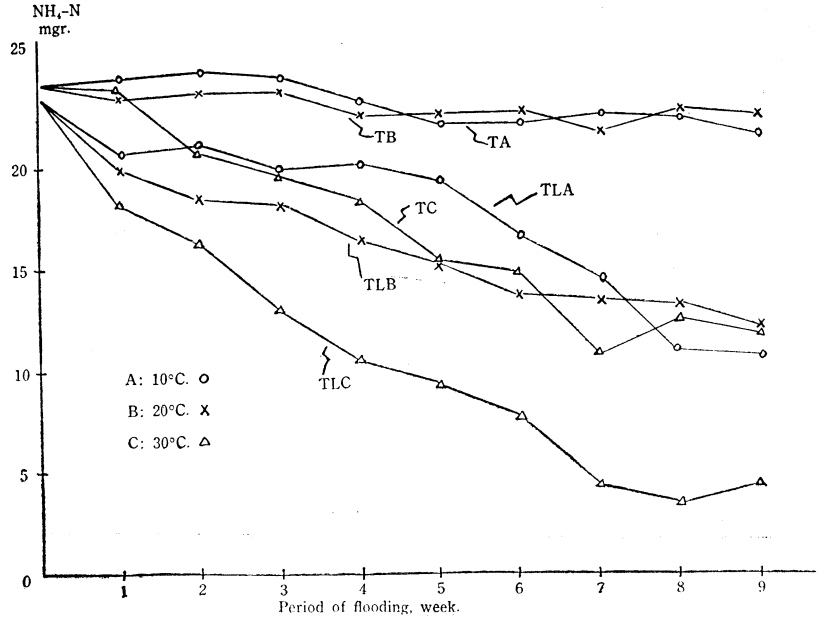
(3) The decrease in the content of ammonium-nitrogen is rapid at high temperature (30°C) while the rate of decrease is about the same at 10° and 20°C.

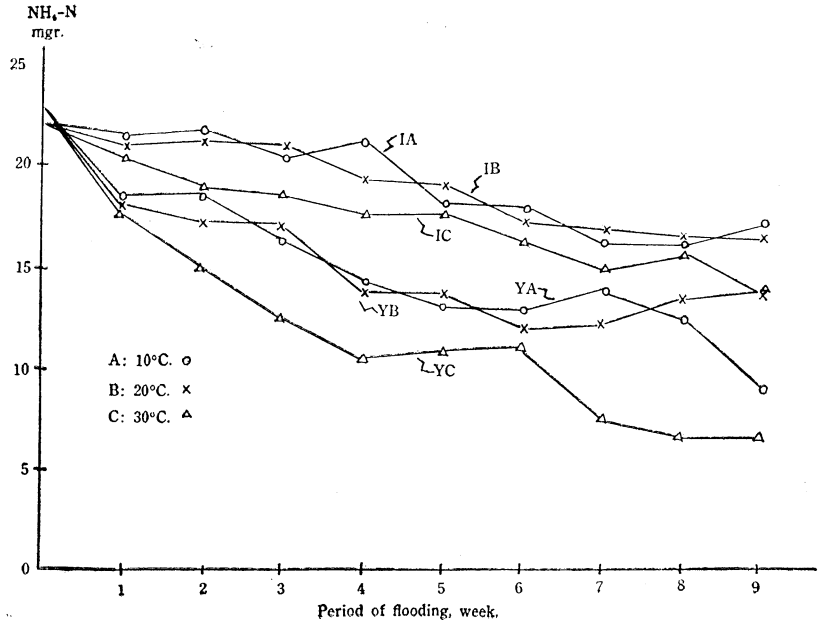
(4) The content of nitrate-nitrogen in flooded soil usuall low, less than 1 mgr. in 30 gr. soil supplied with 21 mgr. ammonium nitrogen. But in the soils of Ilan and Pintung-series some nitrate can be accumulated in the later period of flooding. This indicates that nitrification can proceed even in flooded soils. Thus it is found that the process of denitrification is possible in flooded soils, though nitrate-nitrogen has not been supplied.

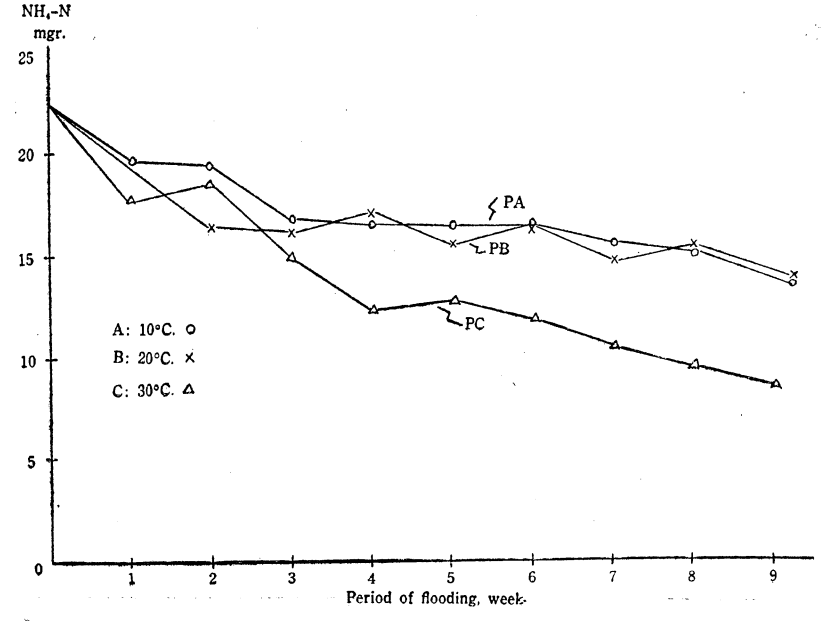
Table 3. Change in the content of NH_4-N and NO_3-N in flooded soils at 10°, 20° and 30°C (mgr. N in 30 gr. soil)

Soils eries	Taipei			Taipei+L			Ilan			Yuanlin			Pintung		
Temp., °C	10	20	30	10	20	30	10	20	30	10	20	30	10	20	30
							NH_4-N								
Period of flooding (week) 0	24.2	24.2	24.2	23.4	23.4	23.4	22.2	22.2	22.2	23.1	23.1	23.1	22.5	22.5	22.5
1	24.5	23.6	24.5	20.8	20.0	18.1	21.7	21.2	20.5	18.7	18.1	18.2	19.7	19.5	17.9
2	24.8	23.8	20.8	21.2	18.4	16.3	22.0	21.5	19.1	18.7	17.4	15.1	19.5	16.5	18.7
3	24.5	23.8	19.5	19.8	18.4	13.0	20.6	21.1	18.8	16.6	17.2	12.8	16.9	16.1	15.0
4	23.2	22.6	18.2	20.1	16.3	10.5	21.5	19.5	17.8	14.5	13.9	10.8	16.6	17.1	12.3
5	22.1	22.6	15.3	19.3	15.4	9.3	18.4	19.3	17.9	13.3	13.8	11.0	16.5	15.4	12.8
6	22.1	22.8	14.9	16.6	13.8	7.8	18.2	18.4	16.5	13.1	12.1	11.2	16.5	16.5	11.9
7	22.6	21.7	10.9	14.4	13.4	4.2	16.6	17.0	15.1	14.0	12.3	7.7	15.4	14.7	10.5
8	22.6	22.8	12.6	10.9	13.3	3.2	16.6	16.8	15.8	12.4	13.5	6.8	15.1	15.3	9.6
9	21.7	22.6	11.9	10.7	12.2	4.4	17.4	17.0	14.0	10.1	14.0	6.7	13.6	13.8	8.6
							NO_3-N								
Period of flooding (week) 0	0.6	0.6	0.6	0.7	0.7	0.7	0.1	0.1	0.1	1.3	1.3	1.3	0.7	0.7	0.7
1	0.7	0.4	0.7	0.7	0.6	0.3	0.4	0.7	0.3	0.5	0.6	0.4	0.3	0.7	0.2
2	0.6	0.6	0.3	0.3	0.6	0.4	tr.	0.6	0.8	0.8	0.3	0.7	0.9	0.6	0.7
3	0.5	0.3	0.5	1.0	0.4	0.7	0.6	0.8	1.0	0.7	0.6	0.6	0.5	0.6	0.2
4	tr.	0.4	0.5	tr.	0.7	0.5	tr.	0.6	1.1	0.3	0.5	0.7	0.4	0.6	0.3
5	1.2	0.5	0.2	0.5	0.2	0.6	0.2	0.4	1.1	0.4	1.1	0.5	0.4	1.4	0.4
6	0.4	tr.	0.9	—	0.4	0.7	0.4	1.3	1.8	1.6	0.2	0.5	0.2	1.2	0.5
7	0.3	0.4	0.2	0.2	0.5	0.4	1.3	2.7	4.2	tr.	1.5	2.2	2.5	2.9	0.5
8	tr.	0.2	tr.	tr.	—	0.3	tr.	0.9	4.4	tr.	tr.	0.5	0.2	0.4	0.4
9	—	0.7	0.2	0.5	0.4	0.5	0.2	0.5	4.2	0.4	0.2	tr.	0.2	tr.	2.1

Remarks: (1) The soils were supplied with 21 mgr. of NH_4-N.
(2) "+L" means liming soil to pH 7.0.




NH4-N
mgr.
25
20
15
10
5
0
IA
IB
IC
YA
YB
YC
A: 10°C. o
B: 20°C. ×
C: 30°C. Δ
1
2
3
4
5
6
7
8
9
Period of flooding, week.


NH4-N
mgr.
25
20
15
10
5
0
PA
PB
PC
A: 10°C. o
B: 20°C. ×
C: 30°C. Δ
1
2
3
4
5
6
7
8
9
Period of flooding, week.

DISCUSSION

Hsu: Loss of other elements in addition to nitrogen and loss of inorganic nutrients by leaching should also be investigated.

Yen: I am going to carry out a lysimeter experiment for the purpose of investigating nutrient loss in soil leaching solution.

Ku: How is the relationship between nitrogen loss and soil microbes?

Yen: In my experiments, the principal cause of nitrogen loss is probably denitrification which is caused by soil microbes.

Chiu: If the nitrogen loss is caused by denitrification, sterilized soil samples may not show denifrification. Did you make a check plot of sterilized soils to acertain that nitrogen loss in your experiment is due to denitrification?

Yen: I did not try the sterilized soil samples.

Hsu: The loss of nitrogen is increased as temperature gets higher. That is probably one of the causes of low yield of rice in tropical soils.