

Assessment of rice cropping systems impacts On the properties of moderately acid sulfate soil In the plain of reeds

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ABSTRACT

The study was conducted to assess the impact of rice cropping systems on properties of moderately acid sulfate soil in the Plain of Reed. The research results showed that after 8-10 years of triple rice cultivation had a trend to decrease the thickness of the top soil and increase the thickness of the hardpan as well as top soil bulk density compared to the double rice systems. Triple rice cultivation also had an effect on increment of organic matter, total nitrogen and phosphorus. However, the available nitrogen seemed to be deficient at the early stage of rice plant in Summer-Autumn and Autumn-Winter crops, especially of the triple rice with partial dike. Low molecular weight organic acids and ferrous iron were the main toxicities to rice plant in Summer-Autumn and Autumn-Winter crops of the triple rice systems. Flooding and alluvium have been natural resources in the Plain of Reeds. Annually, the deposited alluvium on the field of double rice systems without dike and triple rice with partial dike was about 5.66-6.47 t/ha containing 22.7-25.1kg N, 6.4-7.8kg P₂O₅, 6.6-7.8kg K₂O, 1.5kg CaO and 3.2-3.6kg MgO.

Keywords: Plain of Reeds; Acid sulfate soil; Rice cropping systems; Soil properties.

1. BACKGROUND

Acid sulfate soil is a main soil group in the Plain of Reeds and mostly used to grow rice. At present, there have been three main rice cropping systems on this soil namely: (i) double rice (two rice crops per year) without flood controlled dike, (ii) triple rice (three rice crops per year) with partial flood controlled dike and (iii) triple rice with full flood control dike. Rice cropping systems of triple rice have been established for 8-10 years. Up to now, there have been still contrary ideas on the flood control dike construction to grow 3 rice crops per year on acid sulfate soils in the Plain of Reeds, especially on soil fertility, including the acidity drainage and alluvium deposit. This study was conducted to assess the influence of the above rice cropping systems on properties of acid sulfate soil in the Plain of Reeds..

2. CONTENTS AND RESEARCH METHODS

Soil samples of three rice cropping systems of (i) double rice without dike, (ii) triple rice with partial dike and (iii) triple rice

with full flood control dike at My An village, Thap Muoi district, Dong Thap province were analyzed for physical and chemical properties. Soil samples were collected from 20 different fields of each systems with 1 sample per field from 5 bias points. Soil samples were taken before sowing of rice.

The quantity and quality of alluvium from rice cropping systems of double rice without dike and triple rice with partial dike were assessed through 10 samples for each system. The alluvium samples were taken in flooding season 2007.

3. RESULTS AND DISCUSSION

The study results showed that after 8-10 years of three rice crop cultivation per year, the thickness of the topsoil had a trend to decrease to 14.5-14.7cm compared to 17.2 cm of the double rice system (Table 1). Meanwhile, the thickness of the hardpan as well as topsoil bulk density of theses systems had a tendency to increase.

Cultivation of three crops per year also had an effect on increment of soil organic matter, total nitrogen and phosphorus (Table 2). This could be related to the farmers' practices during growing three rice crop per year. They often buried straws of previous season rice in Summer-Autumn and Autumn-Winter crops and used high amounts of nitrogen and phosphorus fertilizers (Nguyen Duc Thuan *et al.*, 2008). However, soil analysis showed that the available nitrogen seemed to be deficient at the beginning stage of rice plant in Summer-Autumn and Autumn-Winter crops, especially in the triple rice system with partial dike (Table 3). Contents of low molecular weight organic acids and ferrous iron were very high, higher than toxicity

level (Nguyen Duc Thuan *et al.*, 2008) in Summer-Autumn and Autumn-Winter crops of the triple rice system (Table 4).

Flooding and alluviums have been natural resources in the Plain of Reeds. In spite of this, at the study area, the alluvial concentration in flood water and alluvial quantity deposited on fields of the double rice system without dike and the triple rice system with partial dike were not much as compared to those in An Giang province (Tran Thuong Tuan *et al.*, 2000). In the study area, the alluvium deposited annually on these systems was about 5.66-6.47 t/ha containing 22.7-25.1kg N, 6.4-7.8kg P₂O₅, 6.6-7.8kg K₂O, 1.5kg CaO and 3.2-3.6kg MgO (Table 6).

Table 1. Impact of rice cropping systems on soil physical properties

Cropping systems	Thickness of topsoil (cm)	Thickness of hardpan (cm)	Soil texture of topsoil			Bulk density of topsoil (g/100cm ³)
			Clay (%)	Silt (%)	Sandy (%)	
Double rice without dike	17.2±1.2	4.8±0.5	30.9±3.7	68.3±3.7	0.8±0.2	93.1±3.9
Triple rice with partial dike	14.5±0.8	7.6±1.2	34.3±2.6	64.6±2.5	1.1±0.3	98.7±4.1
Triple rice with full dike	14.7±1.1	7.1±0.5	45.6±2.9	53.4±2.9	1.0±0.1	99.6±3.4

Table 2. Impact of rice cropping systems on soil chemical properties of topsoil

Cropping systems		Double rice without dike	Triple rice with partial dike	Triple rice with full dike
1	OC (%)	2.43 ±0.14	4.03 ±0.23	3.29 ±0.25
2	Total N (%)	0.24 ±0.01	0.30 ±0.02	0.30 ±0.02
3	Total P ₂ O ₅ (%)	0.09 ±0.01	0.08 ±0.01	0.11 ±0.01
4	Total K ₂ O (%)	1.49 ±0.10	1.43 ±0.12	1.51 ±0.14
5	Total S (%)	0.43 ±0.11	0.97 ±0.11	0.56 ±0.08
6	CEC (meq/100g)	19.70 ±0.4	21.00 ±0.4	22.50 ±0.7
7	TPA (meq/100g)	12.10 ±2.3	24.20 ±2.4	14.10 ±2.2

Table 3. Effect of rice cropping systems on soil available nutrients

No	Cropping systems	Available N (mgN/100g)	Available P ₂ O ₅ (mgP ₂ O ₅ /100g)	Available K ₂ O (mgK ₂ O/100g)
1	S-A crop' 2007			
	Double rice without dike	5.69 ±1.44	8.57 ±1.50	10.61 ±1.36

	Triple rice with partial dike	4.80 ±0.95	8.33 ±2.63	13.73 ±2.97
	Triple rice with full dike	4.96 ±1.30	7.55 ±0.86	14.50 ±3.47
2	A-W crop' 2007			
	Triple rice with partial dike	4.18 ±1.14	7.35 ±1.64	16.48 ±3.61
	Triple rice with full dike	4.74 ±0.99	5.43 ±1.40	22.08 ±2.60
3	W-S crop' 07-08			
	Double rice without dike	7.64 ±0.43	9.42 ±1.66	32.56 ±6.52
	Triple rice with partial dike	7.31 ±0.76	8.96 ±1.34	26.27 ±4.49
	Triple rice with full dike	6.49 ±0.52	8.74 ±1.85	24.02 ±6.65

Note: S-A: Summer-Autumn; A-W: Autumn-Winter; W-S: Winter-Spring.

Table 4. Effect of rice cropping systems on soil toxicities

Cropping systems		pH _{KCl}	Fe ²⁺ (ppm)	Al ³⁺ (ppm)	Organic acids (ppm)
1	S-A crop' 2007				
	Double rice without dike	4.19±0.22	1.354±272	297.0±67.9	106.1±38.0
	Triple rice with partial dike	4.70±0.29	1.457±283	216.2±35.1	150.0±31.2
	Triple rice with full dike	4.52±0.19	1.510±280	181.9±68.5	133.0±50.2
2	A-W crop' 2007				
	Triple rice with partial dike	4.87±0.22	1.658±327	197.0±42.2	212.7±30.8
	Triple rice with full dike	5.10±0.28	1.462±332	101.0±35.6	125.0±29.8
3	W-S crop' 07-08				
	Double rice without dike	5.36±0.09	848±177	64.7±9.0	51.3±27.8
	Triple rice with partial dike	5.32±0.07	916±302	79.5±7.0	64.3±25.3
	Triple rice with full dike	5.13±0.07	973±253	93.1±8.2	91.4±28.9

Table 5. Effect of rice cropping systems on alluvium quantity deposited
(flood season 2007)

Cropping systems		Alluvium quantity deposited	
		Thickness (cm)	Quantity (t/ha)
1	Double rice without dike	0.250±0.015	6.47±0.62
2	Triple rice with partial dike	0.216±0.027	5.66±1.16

Table 6. Effect of rice cropping systems on alluvium nutrients deposited
(flood season 2007)

Cropping systems		Alluvium nutrients deposited				
		N (kg/ha)	P ₂ O ₅ (kg/ha)	K ₂ O (kg/ha)	CaO (kg/ha)	MgO (kg/ha)
1	Double rice without dike	25.1±3.7	7.8±2.4	7.8±1.2	1.5±0.3	3.6±0.4
2	Triple rice with partial dike	22.7±5.0	6.4±1.5	6.6±1.3	1.5±0.4	3.2±0.7

4. CONCLUSIONS

Cultivation of triple rice had a trend to decrease the thickness of the topsoil and

increase the thickness of the hardpan as well as the topsoil bulk density.

Cultivation of triple rice also had an effect on increment of soil organic matter, total nitrogen and phosphorus. The soil available nitrogen was deficient at the beginning stage of rice plant in Summer-Autumn and Autumn-Winter crops, especially in the triple rice system with partial dike. Low molecular weight organic acids and ferrous iron were the main toxicities to rice plant in Summer-Autumn and Autumn-Winter crops of the triple rice system.

After annual flood, the alluvium deposited on the field of the systems of double rice without dike and triple rice with partial dike was about 5.66-6.47 t/ha containing 22.7-25.1kg N, 6.4-7.8kg P₂O₅, 6.6-7.8kg K₂O, 1.5kg CaO and 3.2-3.6kg MgO (table 6).

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