Comparative study on runoff N, P from organic and conventional rice-wheat rotation field in the tai lake region in china

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Key words: Organic agriculture, Runoff N and P, Agricultural non-point pollution

Abstract

The runoff N, P from organic and conventional rice-wheat rotation field in terms of equal N input was studied through field plot test in Tai lake region. The results showed that in the rice-wheat rotation field the runoff TN from organic and conventional field was 56.15kg/hm^2 and 77.90kg/hm^2 respectively, 27.9% less from organic field; for the runoff N coefficient, in organic field, rice season it's 7.19% and wheat season 9.12%, in conventional field, rice season it's 9.74% and wheat season 16.75%; the runoff TP from organic and conventional field was 2.38 kg/hm^2 and 1.03 kg/hm^2, respectively, 131.06 % more from organic field; for the runoff P coefficient, in organic field, rice season it's 0.84 % and wheat season 0.14%, in conventional field, rice season it's 1.1 % and wheat season 0.05 %. In rice field, NH_4-N was the main form of runoff TN and in wheat field, NO_3-N was the main form of runoff TN. Analysis suggested that more runoff P from organic field was because of more P input from organic fertilizer in case of equal N input in organic and conventional field.

Introduction

Agricultural non-point pollution has long been a major concern among the environmental issues. The study about Tai lake exogenous pollutants showed that industrial pollution only took up a small proportion which was 10%~16%, and agricultural non-point pollution accounted for 59% of the total pollutants [1]. Thus, the local government implements a project of comprehensive management of Tai lake water environment. In this project, it declared the plans about construction of one kilometer organic agriculture ecological circle around Tai lake to reduce agricultural non-point pollution [2]. This paper compared the N, P runoff regular patterns in organic and conventional rice-wheat rotation fields to provide the scientific proof of how to reduce non-point source pollution in the Tai lake region through developing organic agriculture.

Material and methods

The experiment located in Wanshou village, Changzhou city, where is 5 km far away Tai lake. The climate in the region is the typical semitropical and warm temperate climate, characterized by the annual average temperature 15.8 ℃, the annual average precipitation 1091.6 mm, and the total annual sunshine 1940.2 h. Rice-wheat rotation is the main cropping model in this area.

Three treatments as organic, conventional and control were set from summer of 2011(rice season) to spring of 2012 (wheat season). Each treatment had three 30m^2 repeated plots. It applied the equal quantity of N input in the organic and conventional treatments. The total N input amount

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was 300kg per hectare in rice season and 185kg N per hectare in wheat season, which were the usual input amounts of local farmers. Runoff samples were collected from each sampling point when there was runoff resulting from heavy rain and water drainage during the growth season for nitrogen and phosphorus test. The Runoff Coefficient of N and P were accounted as following formula:

$$\text{Runoff Coefficient（%）} = \frac{(\text{Runoff amount in test treatments} - \text{Runoff amount in CK})*100\%}{\text{Input N or P amount}}$$

Results and Analysis

Comparison of crop yield among three treatments

The results of wheat and rice average yield in three treatments were showed in Table 1. Compared to the conventional sites, organic rice yield was reduced by 3.1 %, and organic wheat yield was increased by 25.5 % which had the significant difference.

Table.1 Comparing crops' average yield during three treatments (Dry weight, kg/hm^2)

Treatments	Rice yield	Wheat yield
CK	9200.40 a	3579.84 a
CONV.	21178.80 b	7294.12 b
ORG.	20523.30 b	9154.07 c

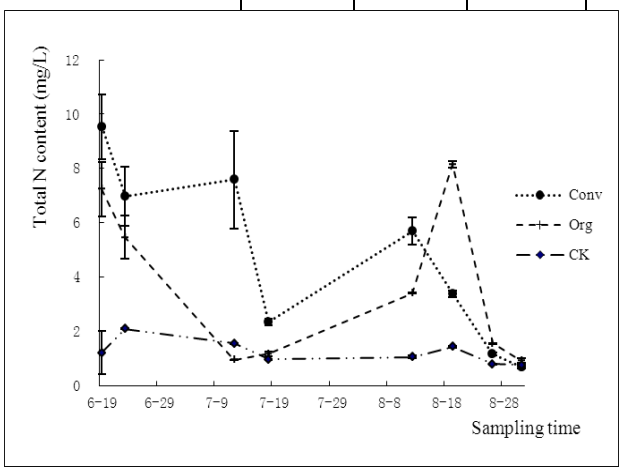
Note: No significance difference among the mean values with the same letter in the same column (P<0.05)

N and P runoff amount and coefficient in the rice growth season

During the rice growth season, total precipitation was 931.9 mm, thus it induced 8 times runoff, and the total volume of runoff was up to 21200 L per treatment plot. The runoff N content and loss amount during the growth season were continuous monitored and the results showed in Table2 and Figure1. In the study site, total runoff N loss amounts were 29.55kg·hm^{-2}, 37.20kg·hm^{-2}, 7.97kg·hm^{-2} in organic, conventional and control treatment respectively during the rice growth season, and NH_4-N took the main ratio. The runoff N coefficients were 7.19% and 9.74% respectively in organic and Conventional treatments. Compared to conventional treatment, organic rice runoff TN loss amount reduced 20.56%. In Figure2, the results of runoff TP loss showed that total runoff P loss amounts were 2.01 kg·hm^{-2}, 0.87kg·hm^{-2} and 0.43kg·hm^{-2} in organic, conventional and control treatment respectively during the rice growth season. In organic rice treatment, runoff TP loss amount was 131.03% more than that of the conventional one. The runoff P coefficients were 0.84% and 1.1% respectively in organic and Conventional treatments.

Table.2 Runoff N, P loss Amounts and Coefficient during the rice season

Treatment	Loss Amounts (kg/hm^2)						Loss Coefficient（%）	
	TN	TDN	NO_3-N	NH_4-N	TP	TDP	TN	TP
CK	7.97	5.34	2.36	2.50	0.43	0.37	-	-
CONV.	37.20	33.53	9.03	20.34	0.87	0.78	9.74	1.1
ORG.	29.55	27.65	2.93	22.43	2.01	1.90	7.19	0.84



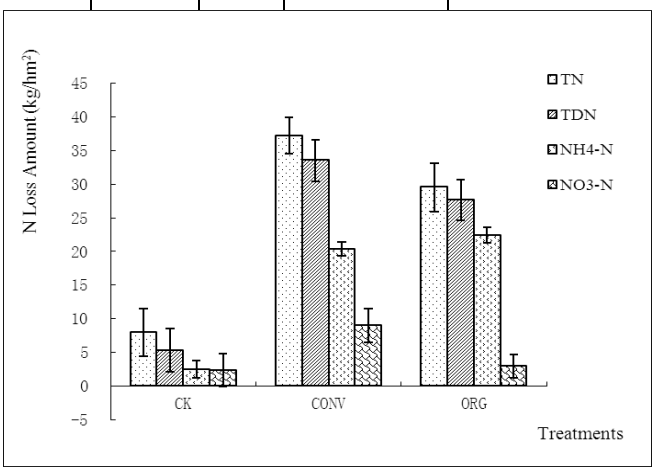


Figure.1 The N content and N loss amount in runoff water during rice growing season

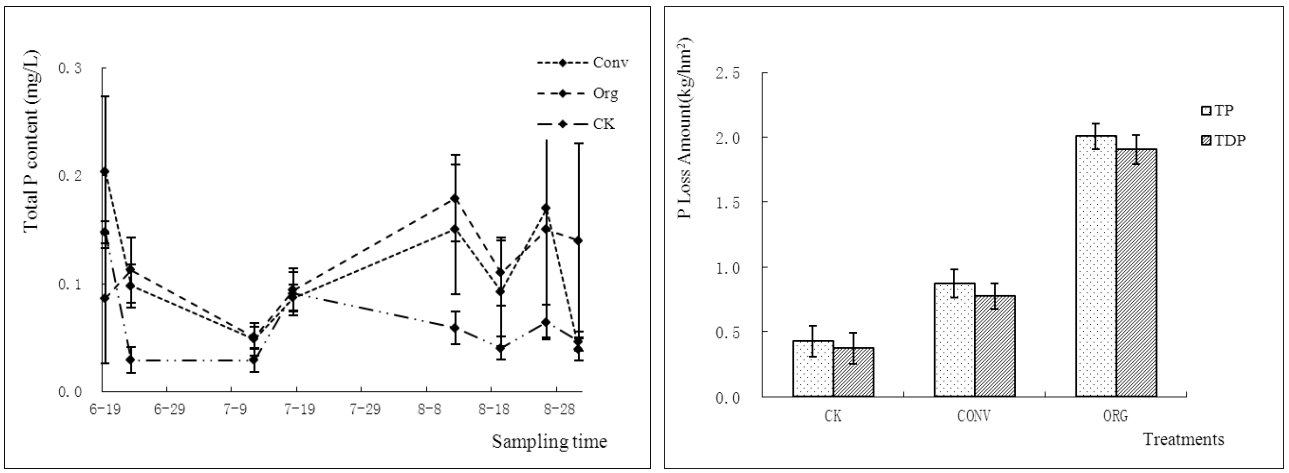


Figure.2 The P content and P loss amount in runoff water during rice growing season

N and P runoff amount and coefficient in wheat growth season

During the wheat growth season, the total precipitation was 343.4 mm, thus it induced 5 times runoff, and the total volume of runoff was around 6 800 L per plot. The results of runoff N content and loss amount during wheat growth season were showed in Table 3 and Figure 3. In the wheat growth season, total runoff N loss amounts were 26.6kg·hm^{-2}, 40.7kg·hm^{-2}, 9.72kg·hm^{-2} in organic, conventional and control treatment respectively during the wheat growth season, and the runoff N coefficients were 9.12% and 16.75% respectively in organic and Conventional treatments. Different from rice season, NO^3-N took the main ratio. Compared to conventional treatment, runoff TN loss amount in organic site decreased 34.64%, which the amount reduced 14.1 kg·hm^{-2}. In Figure 4, the results of runoff TP loss during the wheat growth season showed that total runoff P loss amounts were 0.37kg·hm^{-2}, 0.16kg·hm^{-2}, 0.15kg·hm^{-2} in organic, conventional and control treatment respectively, and the runoff P coefficients were 0.14% and 0.05% respectively in organic and Conventional treatments. Organic wheat runoff TP loss amount was 131.25 % more than conventional treatment.

Table.3 Runoff N, P loss Amounts and Coefficient during the wheat season

Treatment	Loss Amounts (Kg/hm^2)						Loss Coefficient（%）	
	TN	TDN	NO_3-N	NH_4-N	TP	TDP	TN	TP
CK	9.72	8.57	7.64	0.25	0.15	0.15	-	-
CON.	40.7	38.63	29	1.82	0.16	0.15	16.75	0.05
ORG.	26.6	25.41	20.8	0.46	0.37	0.36	9.12	0.14

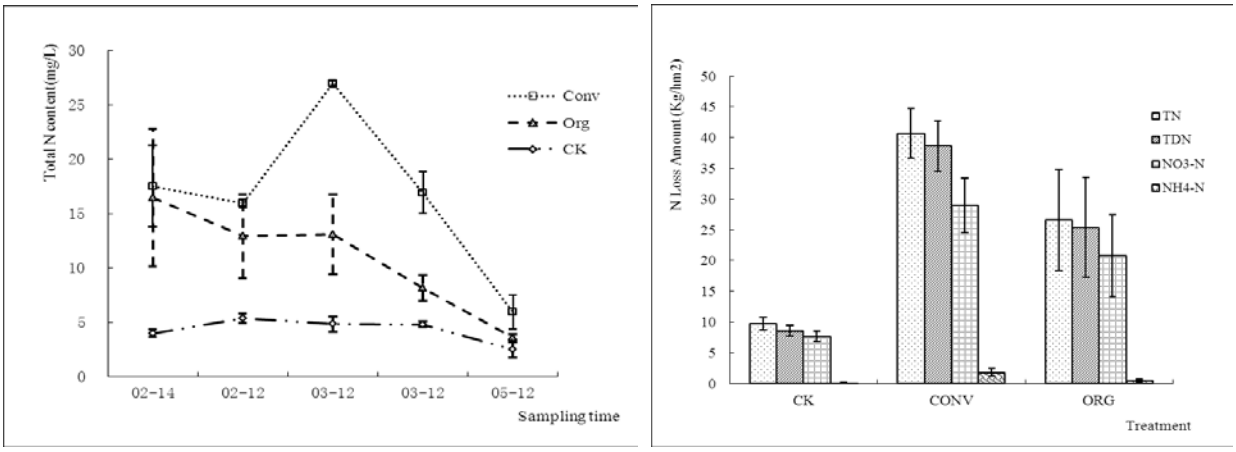


Figure.3 The N content and N loss amount in runoff water during wheat growing season

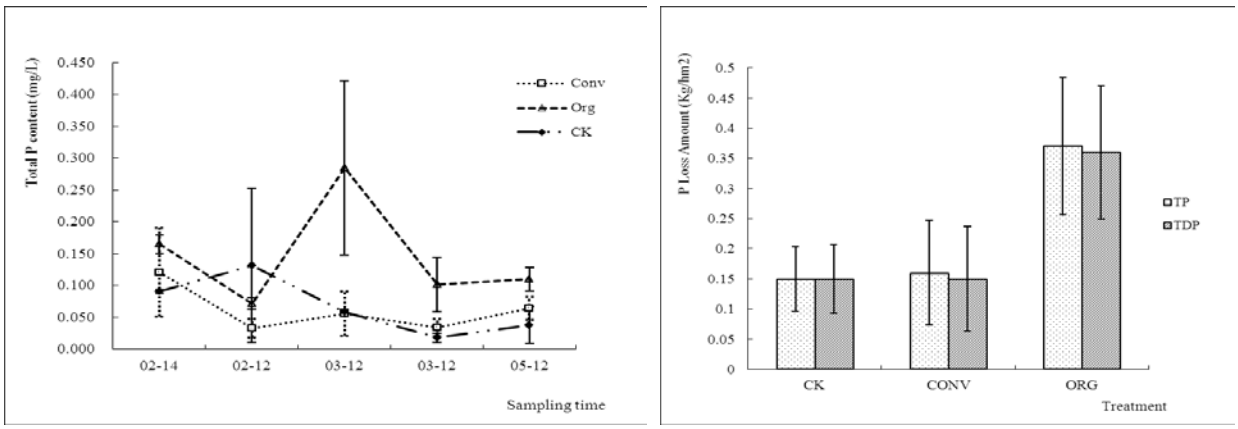


Figure.4 The P content and P loss amount in runoff water during wheat growing season

Conclusion and Discussion

In the Tai lake region, total runoff N loss amount was 77.90Kg·hm^{-2} in fertilized rice-wheat rotation cropland, and 56.15Kg·hm^{-2} in the organic treatment, which was 27.92 % less than conventional treatment. It proved that organic farming could reduce runoff N drainage. Total runoff P loss amount in fertilized rice-wheat rotation cropland was 1.03 kg·hm^{-2} and 2.38 Kg·hm^{-2} in the organic treatment, which was 131.06 % more than conventional one. The preliminary analysis indicated that organic fertilizer could take along overmuch P into cropland and induce higher output of runoff phosphorus. So, construction of organic agriculture ecological circle around Tai lake region should pay attention to the risk of more runoff P drainage through organic fertilizer application. It suggested that to meet crop's demand for N meanwhile avoiding heavy P input through planting leguminous green manure and choosing high N and low P content organic fertilizer is very important for organic agriculture development in the view of agricultural non-point pollution control.

Reference

[1] Tianwei Xu (2009): Organic agriculture development and agriculture non-point pollution control [J]. Environmental Protection and Circular Economy, 4(29): 45-47.
[2] Jiangsu Province Governmental Document (2009): The implementation plans for water environment comprehensive control of Tai Lake watershed.