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Nitrogen Leaching At the Sweetcorn Farm in the Peatland of Kalampangan, Palangka Raya, Central Kalimantan

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Abstract: *Fertilization application in farming area is potential to nitrogen loss throughleaching. The objective of this study was to know nitrogen leachingand efficiency rate in sweetcorn (Zea mays convar. saccharata var. rugosa) plantation in the peatland area.The study was carried out twice in ombrogenous peatland, from dry season to transition period and from transition period to rainy season. Nitrogen leaching was studied using alysimeter. Mean nitrogen leaching was recorded as many as 5.62 kg N ha^{-1}or 7.15 % of total nitrogen inputs and the seweetcorn growing in the peatland in Kalampangan, Palangka Raya, Central Kalimantan, was found not efficient.*
Keywords:*peatland, sweetcorn, nitrogen leaching*

I. Introduction

The use of peatland as agricultural area faces several problems, one of which is low soil fertility level. To prevent low soil fertility level, farmers apply chemical fertilizer of high concentration called high external input agriculture. For instance, in sweetcorn plantation the farmers administer Pearl NPK fertilizer with a dosage of 300 – 350 kg ha^{-1}. Intensive farming activities using much fertilizer will need sufficiently high cost and therefore, it is feared to pollute the environment. It is also enough potential to nitrogen loss (Hoffman, et al. , 1999 ;Knudsen, et al., 2006 ; Torstensson, et al., 2006 ; Zhao, et al., 2010). Nitrogen loss from fertilization averagely ranges from 0 to 17 %. (Sun, et al., 2004)and the loss from nitrogen leaching higher than 5% is categorized as inefficient.

Nitrogen loss in the farm can be affected by types of soil used.Peatland belongs to the soil type possessing large soil porosity,between 70 and 95% (Radjagukguk, 1993), so that if rain occurs the soil will not able to hold the water and percolation water under the soil surface, and as a result, nitrogen leaching occurs.Conversely, in dry season the peatland get dry quickly from evaporation causing N_2O-N fluxes.

The potential of nitrogen loss can be studied from production input and output of the farming system (Lesschen, et al., 2007). The inputs can be organic and inorganic fertilizers, soil nutrients, nutrient fixation of soil microorganisms and direct falling rainfalls. The outputs can be plant production and harvest debris (Spiess, 2001).Both input and output in the farm can be used as the most effective approach to raise production and as information on the fertilizer types and sources applied (Gaj, et al., 2012). Amount of nitrogen loss can be used as efficiency level indicator of the farming system.

II. Method

This study was conducted in the ombrogenous peatland, Kalampangan, Palangka Raya,Central Kalimantan in August 2013toFebruary 2014. Nitrogen analysis was done in the Laboratory of Soil Department, Faculty of Agriculture, BrawijayaUniversity and Analytical Laboratory, Palangka Raya University.

The study activity was conducted twice, from dry season to transition period and from transition period to rainy season. The sweetcorn planting area was 20 m x 50 m (0.1 ha), usingBonanza corn variety and planting distance of 40 cm x 70 cm. The nitrogen loss from leaching was observed using alysimeter(Barton, et al,.2005 ; Hepperly, et al,.2009 ; Zhao, et al,. 2010). Lysimeter used belongs to the Centre For International Co-Operation Management of Tropical Peatland (CIMTROP), made of steel plate of 20 cm x 30 cm placed under the plant root, 15 cm depth beneath the soil surface or exactly under the root, with a slainless of 15^0. This equipment was connected with a plastic tube to the percolation water container. The percolation water data were observed when the plant was 15, 30, 45 days old and at the harvest time.

The nitrogen flow data of the farm were studied using an input – output model (Jansen, et al., 2003; Lesschen, et al., 2007 ; Liang, et al., 2005; Spiess, 2011; Schroder 2003). The inputs wereorganic fertilizer, inorganic fertilizer and rainfalls. The outputs consisted of sweetcorn production, debris (stem, leafand root) and nitrogen leaching. For rainfall data, the rain water sample was collected from the container at each rain, then filtered on Whatman paper No.42 and the nitrogen content was analyzed in the laboratory.

Nitrogen content in the soil, biomass, raifall, and percolation water were analyzed in the laboratory, $NH_3$with titration method, while $NO_3$and $NO_2$with spectrometer.

III. Results

Input Nitrogen

The input in the farm could consisted of compost fertilizer of cow or chick manures (organic fertilizer), inorganic fertilizer (mineral fertilizer), soil nutrients and nutrient fixation of soil microorganisms (Spiess, 2001).

Total nitrogen input nitrogen for one planting period in the first sweetcorn planting was 91.60 kg N ha^{-1}coming from urea fertilizer of150 kg ha^{-1}or equivalent to 69 kg N ha^{-1}(packed urea contains 46% N),compost fertilizer of cow manure of 2 tons ha^{-1}or equivalent to 22.2 kg N ha^{-1}(from laboratory analysis, cow manure compost was 1.11% N).

The eksternal nitrogen input could also come from rainfalls (Grimshaw, et al., 2002; Raubuch, et al., 1998; Ahmad-Shah et al., 1992).The rainfalls during the first planting period reached461.79 mm andgave 0.4 kg of nitrogen ha^{-1}. The rainfall occurrence, volume and nitrogen content data in the first planting period are presented in Table 1.

Table 1 Rainfall and total N content data in the first planting period.

No	Date of Raining	Rainfalls		N Total	
		Vol (ml)	Vol (mm)	Lab. outcome (mg/l)	kg N ha^{-1}
1	13 October 2013	86	7.60	0.26	0.020
2	27 October 2013	185	16.37	0.16	0.026
3	29 October 2013	1154	102.09	0.02	0.020
4	30 October 2013	172	15.22	0.35	0.050
5	4 November 2013	975	86.25	0.30	0.259
6	8 November 2013	914	80.86	0.01	0.008
7	12 November 2013	1215	107.48	0.01	0.011
8	16 November 2013	605	53.52	0.01	0.005
	Total		461.79		0.400

Total nitrogen input for one planting period of the second sweetcorn planting was 65.55 Kg N ha^{-1}coming from Peral NPK fertilizer of 250 kg ha^{-1}or equivalent to40 kg N ha^{-1} (packed Pearl NPK contains16% N),cow manure compost fertilizer of2.200 kg ha^{-1}orequivalent to25.05 kg N ha^{-1} (from laboratory analysis, cow manure contains 1.14 % N). The rainfalls during the study reached 847.46 mm andgave 0.47kg of nitrogen ha^{-1}.Rainfall occurrence, volume, andnitrogen content data in the second study are presented in Table 2.

Table 2. Rainfalls data and total N concentrationin research II

No	Date of Raining	Rainfalls		Total N	
		Vol (ml)	Vol(mm)	Lab. outcome (mg/l)	kg N ha^{-1}
1	13 October 2013	86	7.60	0.26	0.020
2	27 October 2013	185	16.37	0.16	0.026
3	29 October 2013	1154	102.09	0.02	0.020
4	30 October 2013	172	15.22	0.35	0.050
5	4 November 2013	975	86.25	0.30	0.259
6	8 November 2013	914	80.86	0.01	0.008
7	12 November 2013	1215	107.48	0.01	0.011
8	16 November 2013	605	53.52	0.01	0.005
9	26 November 2013	1150	101.73	0.01	0.010
10	2 December 2013	1870	165.43	0.03	0.050
11	12 December 2013	1340	118.54	0.01	0.012
	Total		847.46		0.471

Direct rainfalls on the farm can either give the nitrogen or become the cause of nitrogen leaching, particularly in the peatland having big porosity. The heavier the rainfallsthe bigger the percolation water, and the higher the nitrogen leaching.

Nitrogen Output

Nitrogen output in the farm can be obtained from production and biomass and nitrogen left in the soil (Spiess, 2001). The output as skinned corn productionin the first study of sweetcorn growing,reached 22.2 $tonsha^{-1}$orequivalent to 29.1 kg N ha^{-1}(N content analysis of plant tissue was 0.96%). The rests (stem, leaf, root) were 32.88 $tonsha^{-1}$orequivalent to 47.4 kg N ha^{-1}.

The output as skinned corn productionin the second study reached 15.32 tonsha^{-1}or equivalent to 20.68 kgN ha^{-}(N content analysis of plant tissue was 0.90%), the rests (stem, leag and root) were 20.5 tons ha^{-1}or equivalent to27.68 kg N ha^{-1}(N content analysis of plant tissue was 0.90%).

Nitrogen Leaching

Nitrogen output was also obtained from the amount of nitrogen loss in the farm.The loss during the study through nitrogen leaching from percolation water is presented in Table 3.

Table 3N leaching from water per location during the study.

Observation Time	Percolation water volume (ml)	Total N content (mg l^{-1})	Percolation water volume (l ha^{-1})	N Total (kg ha^{-1})
		……………………………..Planting Period I ……………………………..		
15thday	843	7.68	140,833	0.11
30 thday	342	3.60	56,999	0.21
45 thday	6,890	0.51	1,148,328	0.59
Harvest	6,900	0.32	1,149,995	0.37
Total	14,977	12.17	2,496,155	2.28
		……………………………..Planting Period II ……………………………..		
15th day	48	3.96	8,000	0.03
30thday	10,835	2.00	1,805,826	3.61
45thday	5,350	1.48	891,633	1.32
Harvest	8,860	2.70	1,476,660	3.99
Total	25,093	10.14	4,182,119	8.95

Nitrogen leaching in the first planting period was lower than that in the second period, since planting was done from dry season to the transition period.The rainfalls during the first period were low so that the dissolved nitrogen and loss through the percolation water was also low.In the second period, high rainfalls caused high dissolved nitrogen and high nitrogen leaching from percolation water.

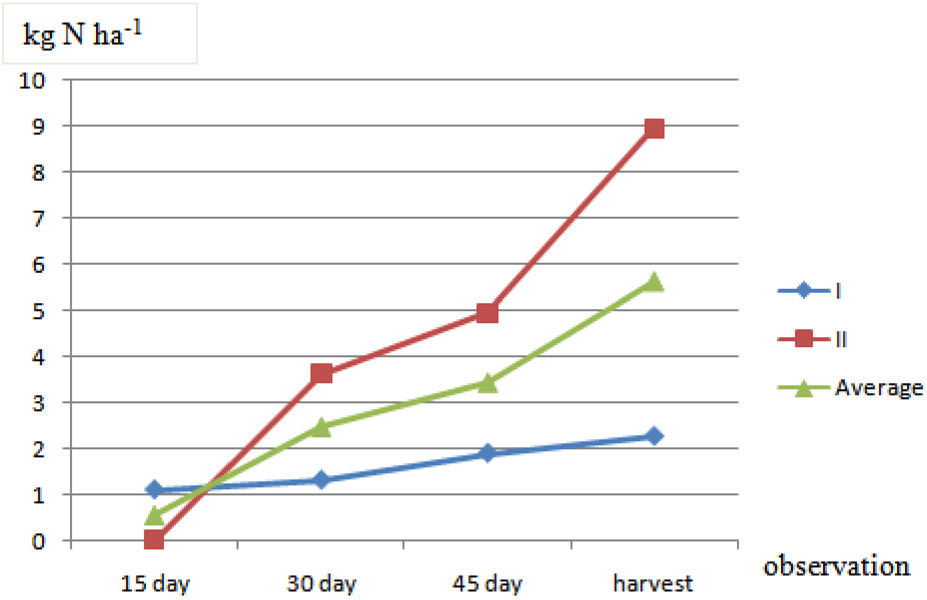

Figure1. Nitrogen leaching graph

The olderthe plant age, the higher the nitrogen leaching, and up to the harvest, the average nitrogen reaches 7.15% of the total nitrogen input.

IV. Discussion

Nitrateunabsorbed by the plant will be denitrified, nitrate (NO_3) reduction process.In anaerobic condition, this process is catalyzed by denitrifying microorganisms and gradually altered to nitrite (NO_2), Nitrous Dioxide (N_2O), Nitrous Oxide (NO), and N_2. Denitrification process is one of nitrate(NO_3)loss route from soil solution through nitrogen leachingand occurs only in anaerobic condition (Luo et al., 1999; Regina, 1996; Rückauf et al., 2004). N_2O,NO or N_2gases will go into the atmosphere through soil evaporation (Firestone, 1982 ; Zech et al., 1997 ; Regina, 1996).

The nitrogen leaching data in this study was possibly higher due to sufficiently big peatland porosity causing groundwater movement vertically down to lower part of the groundwater or could also move horizontally. The horizontal groundwater movement could not be possibly held by the lysimeter, so that the modification of the lysimeter used is proposed for future study.

V. Conclusion

Mean nitrogen leaching was 5.62 kg N ha^{-1}or 7.15 %of total nitrogen inputs.The sweetcorn growing in the peatland of Kalampangan, Palangka Raya, Central Kalimantan was not efficient.

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