CONTROLLING NITRATE LEACHING LOSSES FROM FERTILIZED SANDY REGOSOL USING NEEM (*Azadirachta indica)*

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Introduction

Intensification of agriculture with heavy and long-term use of inorganic fertilizers leads to loss of plant nutrients from soil through leaching and subsequent contamination of groundwater and surface water. In Kalpitiya Peninsula, vegetable cultivation is practised with adding high doses of fertilizers than recommended by the Department of Agriculture and irrigate frequently using either sprinklers or hose pipes. However, both practices imposed on Sandy Regosols result in high nutrient availability in soil, high leaching losses and plant uptake[1]. Consequently, such practices reduce quality of food, water and soil causing detrimental effects on the health of human beings and other living organisms.

Inhibition of nitrate formation from reduced fertilizers by nitrifying bacteria would reduce the nitrogen losses and increase the efficiency of applied nitrogen. Neem products such as neem extract and neem cake have been identified as a potential nitrification inhibitor in soils added with urea[2,3]. Hence, this leaching column study was conducted to assess the leaching losses of nitrogen in Sandy Regosols applied with different quantities of reduced fertilizers along with neem cake and neem extract under controlled conditions.

Methodology

Leaching losses of nitrate was first assessed in pots grown with onion and using a leaching column without crop. In the pot experiment, red onion was grown in pots filled with Sandy Regosols (450 g/pot) collected from Kalpitiya area. Three different fertilizer practices i) as recommended by the Department of Agriculture [100 kg of $(NH_4)_2SO_4$/ ha as basal dressing (BD) and 45kg of urea as top dressing (TD1] (DOAR), ii)a fertilizer mixture available in the market and widely used by the farmers [10 kg/ac, 125 kg/ac and 125 kg/ac as BD, TD1 and TD 2 respectively] (CR) and iii) farmer practice (FP) [40 kg urea/acre and 125 kg of fertilizer mixture/ac as BD and top dressings respectively] were imposed with three replicates. In FP and CR, top dressings were added in each 10 days after BD and in DOAR, TD 1 was added 3 weeks after BD. While plants were growing, 150 ml of distilled water was added to each pot and water drained freely through the holes in the bottom was collected. Leachates were collected three days after applying BD and subsequently at weekly intervals over one-month period and the leachates were analyzed for NH_4^+ -N and NO_3^- -N contents colourimetrically.

Potential of controlling nitrate leaching was assessed using leaching columns filled with sandy Regosols (70 g/column) without plants and imposing four treatments; T_1: control without applying fertilizer; T_2: Farmer practice for onion; T_3: T_2 + 2ml neem extract; T_4: T_2

+ 20% neem cake. Initially either neem extract or neem cake was applied with urea in T_3 and T_4 respectively. All the treatments were replicated three times. Leaching was monitored over one month and leachate was collected at three days after adding the BD followed by weekly intervals. Leachates were analyzed for NH_4^+-N and NO_3^--N contents colourimetrically and the autotrophic nitrifier population of the soil was enumerated using the Most Probable Number technique at 10 and 24 days after application of BD. Mean comparisons were done by Duncan's new multiple range test at a significant level of 0.05 using the statistical software SPSS 16.0.

Results and Discussion

Leaching losses of NH_4^+ -N increased with the increase of the amount of fertilizer applied (Figure 1) and short after applying fertilizer. However, even with the same quantity of fertilizer addition in CR and FP in TD_1, FP treated soil showed significantly high leaching losses than CR may be due to the lower accumulation of nitrate in red onion plants of FP treatment than that of CR.

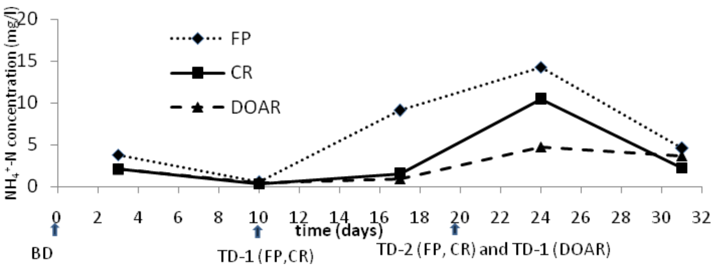

Figure 1. Leaching losses of NH_4^+ -N in soil treated with different fertilizer treatments

Leaching losses of NO_3^- -N (maximum 900 mg/l) decreased over the time (Figure 2) and it was approximately 60 times higher than NH_4^+-N losses (maximum 15). As similar to NH_4^+-N losses, higher NO_3^- -N losses were also found in FP treated pots compared to CR and DOAR.

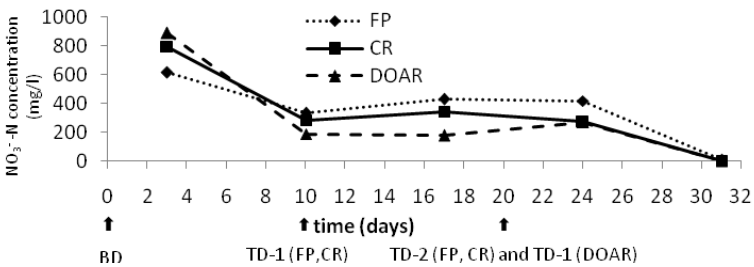

Figure 2. Leaching losses of NO_3^- -N in soil treated with different fertilizer treatments

In the leaching column study with neem amendments, FP treated soil showed significantly high ammonium oxidizer population whereas the lowest was observed in the neem amended treatments (Table 01). Nevertheless, at 24 days after BD, inhibition of ammonium oxidizer population was observed only in neem cake amended soil.

However, there was a rapid increase in the NH_4^+ -N losses in neem added treatments during 10 days after application of BD despite of comparable leaching losses of NH_4^+ -N in all treatments in three days after application of BD (Figure 3b). Even though there was no significant difference between the leaching losses of NH_4^+ -N in FP+NC and FP+NE at 10 days after BD application, they were significantly higher than that of all the other treatments. Subsequently, FP+NC showed significantly high leaching losses of NH_4^+ -N throughout the experimental period because of the high concentration of NH_4^+released due to the neem products. In addition, low nitrifier population in FP+NC and low nitrification activity that may occur due to the azadiractin, which is the active ingredient in neem may have led to accumulate NH_4^+in soil. Nevertheless, after addition of TD-1, NH_4^+ -N content in all treatments except control to which none of the fertilizers were added has increased and FP+NC showed highest losses irrespective of the similarity in the amount of fertilizer addition. Significantly high ammonium oxidizer population in FP treated soil can be the reason for lower NH_4^+-N losses and significantly high nitrate losses at 10 days after BD application. Lower NO_3^--N losses were found in FP+NC treated soil (Figure 3b) throughout the experimental period (1.09-63.45 mg/l) may be due to the lower nitrifier population in FP+NC treated soil. However, even with the addition of neem, FP+ NE treated soil showed high nitrate losses during 10 days after BD addition and subsequently it has been reduced with time (Figure 3b).

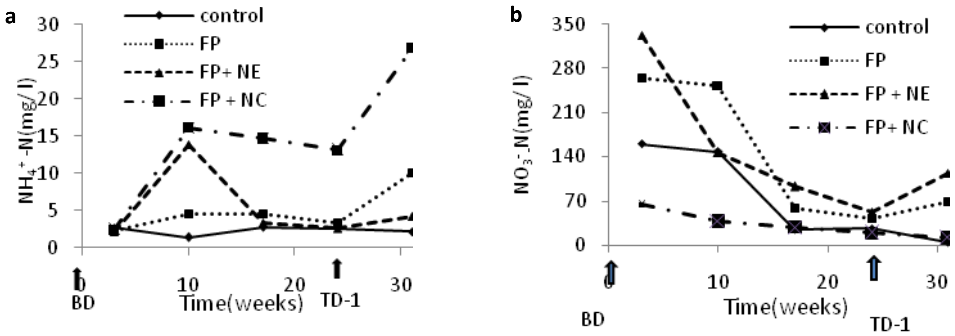

Figure 3. a) NH_4^+ -N and b) NO_3^- -N, Leaching losses of nutrients in soil treated with different neem products.

Table 01. Ammonium oxidizer population in soil as affected by different amendments

Treatment	Ammonium oxidizer population (Cells/g soil)	
	10 days after BD	24 days after BD
Control	3104[b]	318[b]
FP	4213[a]	922[a]
FP+NE	942[c]	1050[a]
FP+NC	554[c]	358[b]

The means followed by the same letter in a given column are not significantly different at P < 0.05.

Conclusions

Significantly high leaching losses of nitrogen occurs from the studied sandy regosol when urea fertilizer is applied as practiced by farmer than as recommended by Department of Agriculture. Reduction in nitrate losses can be observed with neem cake amendment to soil but not with neem extract. Therefore, neem cake can be used to control leaching losses of nitrate in Sandy Regosols.

References

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