Evaluation of Nitrogen Leaching Losses from Leafy Red Onion Cultivation Under Growers' Practice of Fertilizer in Kalpitiya

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Abstract - Loss of Nitrogen due to leaching has become not only a critical problem in agriculture, but also a major environmental and health problem in Sri Lanka. Nitrogen (N) is the most dynamic nutrient which leads to a rapid downward movement in soil in the forms of nitrate (NO_3^-) and ammonium (NH_4^+). Sandy Regosol (WRB, FAO legend: Haplic Arenosols) is the dominant soil type in Kalpitiya, where vegetable cultivation is intensively practiced. Red onion is a major short-term crop widely cultivated in Kalpitiya with excessive use of fertilizer. A Promising problem in red onion cultivation is the leaching of nutrients, especially N, since this crop is mostly grown in sandy textured soils. This study was conducted to evaluate the contribution from red onion grown in Kalpitiya to contaminate groundwater through N leaching under the management practices of growers. The leached NO_3^- throughout the season was 338.48 kg/ha whereas leached NH_4^+ throughout the season was 4.68 kg/ha. The concentration of NO_3- in leachate fluctuates over the growing season and NO_3^- in leachate was ranged from 35.1 mg/L - 160 mg/L which was higher than the WHO permissible level of NO_3^- (50 mg/L) for drinking water in most sampling events. According to the results, 422.62 g of applied N was leached per 100 kg of leafy red onion harvested from the growers' practices of fertilizer. The nitrogen leaching percentage during the season was 81.87% according to the grower managed fertilizer practice. This is mainly due to the intermittent application of nitrogenous fertilizer throughout the season. These findings highlight the need for a novel fertilizer management approach for reducing nitrogen leaching in red onion cultivation in Kalpitiya peninsula.

Keywords: Groundwater, Nitrate leaching, Sandy Regosol

I. Introduction

Intensive agricultural practices in Kalpitiya have caused excessive usage of fertilizers. The excessive permeability sandy Regosol soil and the over irrigation due to the presence of semi-arid climatic conditions in the area have a greater impact on groundwater quality in Kalpitiya. Red onion is one of the most widely grown cash crops in Kalpitiya which is highly responsive to fertilizer. Onion demands a high level of nutrients, often requires the supply of soluble fertilizers [1]. However, higher doses of applied inorganic fertilizer alone generates several deleterious effects on the environment and human health. It should be replenished in every growing season because inorganic fertilizers are rapidly lost by either volatilization or leaching in drainage water and it causes dangerous environmental pollution by NO_3^- accumulation in underground water [2]. Farmers in the Kalpitiya area add an excessive amount of chemical fertilizers expecting higher yield from the low fertile sandy soil. Since 1990s, the groundwater aquifers in Kalpitiya remain contaminated with higher levels of nitrate due to intensive agricultural practices and the nitrate pollution in Kalpitiya area is considerably higher than the other agricultural areas of the country [3]. Therefore, this study was conducted to evaluate the contribution from red onion grown in Kalpitiya to contaminate groundwater through N leaching under the fertilizer management practices of growers.

II. Materials And Methods

This study was carried out in Kandakuliya agricultural land in Kalpitiya from 2020 to 2021. Lysimeters covering a 0.28 m^2 land area by each was installed 90 cm below in the 7.2 m^2 plots before planting of Jaffna Local variety. Fertilizer was applied according to the grower practice which was five split applications of urea at 100 kg/ha, Triple super phosphate at 250 kg/ha, onion fertilizer (N:P:K-12:9:9) at 125 kg/ha, blue granules (N:P:K-12:12:17) at 62.5 kg/ha and calcium nitrate at 62.5 kg/ha in ten days intervals. This was replicated three times in 7.2 m^2 plots. Irrigation was done twice a day and leachate samples of each replicate was collected from lysimeters at weekly intervals and leached volume was measured. The NO_3^- and NH_4^+concentrations of collected leachate were analysed using ion selective electrodes (CPI 505, Elmetron, Poland). Applied irrigation water volume and its NO_3^- and NH_4^+concentrations were also measured. Both fertilizer and irrigated water were considered as input source of nitrogen and total N input was calculated. The Leafy red onion harvest was recorded 48 days after planting.

III. Results And Discussion

The concentration of NO_3^- and NH_4^+in irrigated water were 6.88 ppm and 1.80 ppm respectively. The concentration of NO_3^- in leachate was ranged from 35.1 mg/L - 160 mg/L. The nitrate concentration in the leachate was higher than the WHO permissible level of NO_3^- (50 mg/L) for drinking water in all samplings except 1st and last week (Fig. 1). The leached NO_3^-throughout the season was 338.48 kg/ha whereas leached NH_4^+ throughout the season was 4.68 kg/ha. The leached nitrogen percentage was calculated by dividing the leached nitrogen amount by total input nitrogen. The total input N amount was 97.8 kg/ha during the season. It was found that 81.87% of applied N has been lost throughout the season. Intermittent application of nitrogenous fertilizer may cause for the high N leaching throughout the growing season.

According to the calculation, 422.62 g of applied N was leached per 100 kg of leafy red onion harvested according to the growers' practices of fertilizer management.

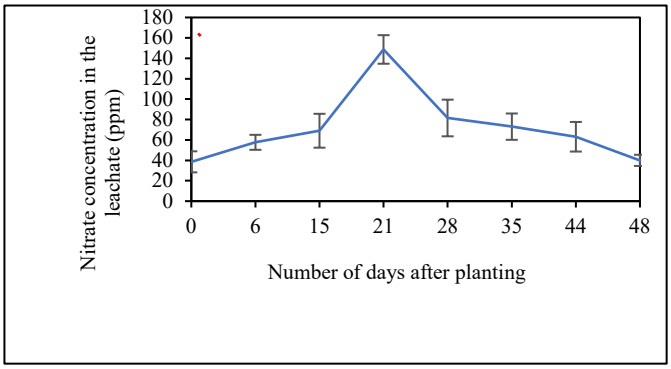

Fig.1 Variation of average nitrate concentration throughout the cropping season

IV. Conclusion

Results of this study reveal that the concentration of nitrate in leachate is substantially higher in the red onion cultivated land of Kalpitiya peninsula. The over application of nitrogen fertilizer along with frequent irrigation caused higher levels of nitrate leaching. This concludes the need for a novel fertilizer management approach for reducing nitrogen leaching in this red onion cultivation system. It also highlights the necessity of adequate treatment of groundwater that removes excess nitrate prior to use for drinking purposes.

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