Evaluation of growth, yield, and nitrogen losses from leafy red onion cultivation with different fertilizer practices in Kalpitiya peninsula

DSGGC Swarnathilake[1,#], DMAU Dalpitiya[1], HMIK Herath[1] and DR Gimhani[1]

[1]*Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Sri Lanka*

[#]gaya.swarnathilake@gmail.com

Abstract*: Intensive agriculture practices together with increased fertilizer use have a greater impact on groundwater quality in Kalpitiya.Water demand in Kalpitiya is 70% fulfilled by groundwater extractions. The demand is ever increasing due to increase of population and agricultural practices. The permeable nature of sandy Regosols causes heavy leaching of nutrients and contamination of shallow groundwater. The aim of this study was to evaluate the effects of different fertilizer practices on growth, yield and nutrient leaching in leafy red onion grown in Kalpitiya. The Red onion is the major crop grown on a large scale. The treatments tested were T1-Farmer Used Rate of fertilizer and T2-Department of Agriculture (DOA) recommendation. The experiment was arranged in Completely Randomized Block Design with three replicates in six plots (7.2m^2). The red onion of Jaffna Local was established in a research field where lysimeters were previously installed. The leachate was collected weekly from lysimeters and analysed for leached nitrogen. Growth of plants and yield were recorded. A significant difference in leached nitrogen was observed between treatments. Furthermore, it was observed that there was a statistically significant difference between the final yield of T1 and T2 treatments. The total nitrogen leaching percentage of T2(67.88%) was lower than T1(78.86%) even though the crop yield of T2 (5069.25 kg/ac) was lower than T1(7556.95 kg/ac). The average concentration of nitrate in the leachate of T1 was 73 mg/l while that of T2 was 72 mg/l. The safe limit of nitrate in groundwater is 50 mg/l.* Recommended *amounts of fertilizer should be applied in balanced proportion and at appropriate times with soil amendments may help to absorb nutrients efficiently. Therefore, study concludes that, both practices showed leached nitrate concentrations above safe limits recommended by WHO which urges the need for change in nitrogen fertilizer management for red onion on sandy Regosols.*

Keywords: Nitrification, Groundwater Contamination, Sandy Regosol

1. Introduction

Kalpitiya in Sri Lanka belongs to the Dry Zone, receiving an average annual rainfall of 1067 mm. Sandy Regosol (WRB, FAO legend:Haplic Arenosols). is the dominant soil type in the peninsula. Kalpitiya is considered as highly productive agricultural areas of the country where food crops are grown intensively as monocultures. Onions, Chilies and Tobacco are the most widely grown cash crops in this area (Jayasingha *et al*., 2011). Red onion is the most widely grown vegetable crop in Kalpitiya on a large scale. Hybrid chillie varieties take the second place among the crops cultivated in Kalpitiya (Jamaldeen,2013). In this cultivation system, the mineral nutrients are mainly supplied with such as urea, Muriate of Potash (MOP) and

Triple Super Phosphate (TSP) as popular external nutrient inputs. They are collectively referred as synthetic fertilizers. The fertilizer recommendations in the country have evolved, integrating synthetic and organic fertilizers in nutrient management programs over the years (Nagarajah *et al.,* 1986). The use of inorganic fertilizer has increased because of increased cropping intensity with high yielding varieties cultivated in Sri Lanka. The chemical fertilizer application rate has ranged from zero to 830% of the recommended level in different cropping systems in Sri Lanka (Kendaragama, 2006). Therefore, to fulfil the fertilizer requirement of Sri Lanka imports about 800 million kg of chemical fertilizers annually (Department of Census and Statistics, 2019). Improper application of inorganic fertilizers can cause severe groundwater pollution from percolation and runoff of surplus nutrients. Among the nutrients, Nitrate-N has emerged as one of the foremost alarming and widespread contaminants of groundwater resources in Sri Lanka. (Shukla & Saxena 2018). The soils of the peninsula are extremely permeable, consisting of 90-98% sand; hence there are no problems with drainage or water logging. The farmers in Kalpitiya struggle with issues related to less water and nutrient retention, and low organic matter content in sandy soil. Due to this infertile nature of the soil, farmers apply excessive amounts of nitrogen fertilizer expecting better yields throughout the year. The agrochemicals which are used may not perform their maximum potential to crop development since sandy Regosols are unable to retain more of them. Therefore, fertilizers leach into the shallow water sources due to the excess irrigation (Aravinna, 2006). It is reported that the farmers devote 35% of cost of production for irrigation (Melvani *et al.,*2006). However, due to large soil particles surrounded by air pockets creates with a light texture and loose structure which provide plenty of open spaces for water to move through. Therefore, the water does not pool on the surface and drains quickly. Due to the irrigation, the fertilizers, which is added to the soil may not be retain in the soil and more of the nutrient get lost through leaching (Aravinna, 2006). Ground water is the main source of water supply for domestic and agricultural needs in Kalpitiya. The surface water sources are limited in the area and not adequate for ever increasing water demand and use of surface water for drinking and other requirement are less due to poor water quality. This aggravates the risk on groundwater sustainability and quality deterioration due to alarmingly higher abstraction levels. It is reported that the water demand in the Kalpitiya area is 70% fulfilled by groundwater extractions. The demand is ever increasing due to increase of population and heavy agricultural practices (Kumarasinghe and Rajapaksha,2012). The contamination of groundwater in terms of nitrate in the area has been studied for several decades (Liyanage et al., 2000). Studies conducted in the Kalpitiya show that the leaching of chemical fertilizers from intensively cultivated land tend to increase the nitrate concentration in groundwater (Kuruppuarachchi, 1995). Indiscriminate fertilizer usage, over-extraction of groundwater and frequent application of heavy doses of irrigation have been recognized as the major reasons for groundwater contamination in Kalpitiya area (Sharma, 2009). The sandy nature of the Kalpitiya soil with neutral pH and lack of fine fraction causes limited nitrate retention, hence rapid leaching cause more vulnerable situation (Harold et al., 2006). Recent investigations revealed that nitrate levels in groundwater in some places within Kalpitiya agricultural land use is as high as 212 mg/l during dry periods and more than 50 % of the studied wells have nitrate levels exceeding the World Health Organization's (WHO) allowable limits (Jayasingha et al., 2011). Thus, it is apparent that ground water in the area could not be recommended for domestic consumptions at least during the dry season. Due to the increasing application of nitrogenous fertilizer in a closed aquifer, the population of the area is in danger of consuming potentially harmful concentrations of nitrates through their food and water (Dalpitiya et al.,2022). Excess nitrate in drinking water is known to be hazardous to human health especially infants and older children, pregnant and nursing mothers. An increasing level of nitrate in groundwater induces health related problems like gastric cancer, thinning of blood vessels, aggressive behavior, and hypertension. Liyanage et al. (2000) observed that high NO3-N in drinking water caused abnormal methemoglobin concentration (>2%) in a high percentage of Sri Lankan infants. Nitrate is converted to nitrite (NO2-N), which combines with hemoglobin to form toxic methemoglobin. This decreases the ability of blood to carry oxygen, causing the syndrome known as methemoglobinemia, also called "blue baby syndrome"(Kuruppuarachchi, 1995). The field conditions that drive nitrate leaching to groundwater, requires two major inputs: significant amount of nitrate in the soil profile and enough rainfall or irrigation water to move nitrogen beyond the root zone .In addition, nitrate leaching can also occur from mineralizing of Soil organic matter (SOM) and crop residues in the fall(Meisinger *et al*., 1991).

Strategies for reducing nitrate leaching should introduce and implement appropriate counter measures. In Kalpitiya, leaching is primarily due to low soil water and nutrient holding capacity and excessive application of highly soluble fertilizers. This present setup demands the necessity of implementing a proper groundwater management mechanism otherwise the impact on groundwater would not be reversible in the future. Therefore, the strategies should focus on ways to improve nitrogen utilization efficiency and decrease nitrogen losses is essential. This study was conducted to quantify the nitrogen leaching from red onion cultivation in Kalpitiya under grower managed fertilizer practices compared to the Department of Agriculture (DOA) recommended practices.

2. Methadolgy and Experimental Design

A. Location and Duration

The experiment was carried out in Kalpitiya agricultural area as a field experiment during 2021-2022.The experimental location situated at an elevation from 1m above mean sea level. The site was established with lysimeters previously installed. The monthly mean temperature at Kalpitiya during the experimental period was 30°C while the mean rainfall during the experimental period was 83 mm during the research period.

B. Experimental Design

The site selected for the experiment had leaching monitoring lysimeters with 0.28 m^2 area installed 90 cm below the soil surface. Jaffna Local variety of the red onion was taken as the planting material for the experiment. The treatments were arranged in a randomized complete block design and replicated three times.

C. Crop Establishment and Treatment Application

Prior to the planting of red onion bulbs, compost application was done at the rate of 10 t/ha for both treatments. Treatment 1 was applied with farmer used rate of fertilizer which was Urea- 100 kg/ha, TSP-250 kg/ha, Onion fertilizer (12:9:9-N: P: K)-125 kg/ha, Blue granules (12:12:7-N: P: K)-62 kg/ha and Calcium nitrate(N-15,5%,CaO-26%)-62 kg/ha were applied at weekly intervals. Treatment 2 was applied with Department of Agriculture recommendation of fertilizer application (DOA) (Table 1). According to the DOA recommendation, application of weedicides and the pesticides were done as needed. Irrigation was done two times per day, in the morning and evening using sprinklers.

Table 1. DOA recommended fertilizer requirement of red onion in Kalpitiya

Fertilizer application	Urea (kg/ha)	TSP (kg/ha)	MOP (kg/ha)
BD	68.5	100	50
TD 1 (3WAP)	65		
TD 2 (6WAP)	65		25

BD- Basal Dressing, TD 1- First Top Dressing, TD 2- Second Top Dressing; TSP-Triple Super Phosphate, MOP- Murate of Potash, WAP-Weeks after planting, DOA (Chemical fertilizer (100%) + Compost (10t/ha)

D. Collection and Analysis of Leachate and Irrigation Water

Prior to planting, initial leachate samples were collected form each plot. Leachate samples from individual outlets were collected continuously using an electric pump and the total volume was measured. Leachate samples were obtained at 7 days intervals. For the NO_3^- and $NH4^+$ analysis a representativecomposite sample of the leachate was collected from each plot. Irrigation water was sampled weekly during the cropping season. $NO3^-$N and $NH4^+$N in the leachate as well as in the irrigation water were determined using ion selective electrodes (CPI 505, Elmetron, Poland)

E. Determination of growth and yield parameters

Two growth parameters, namely, plant height, and number of leaves were taken as vegetative measurements in weekly intervals to track the growth performances of the plants. The plant height was measured from the base of the plant to the tip of the fully emerged leaf sheath. The number of leaves was recorded by counting the fully opened leaves. Data collection was commenced a week after planting and continued weekly until 51 days. At the end of cropping season, leafy red onion yield, which consisted of the whole plant with bulb and green leaves of the plant were harvested.

F. Testing of Perishability

At the time of harvesting, ten uniform plants were collected from each plot and perishability was checked by storing them under refrigerated conditions and normal atmospheric conditions with and without paper coverings. Records were taken on weight of consumptive quality material remaining from the storage. This was continued for 3 weeks after harvesting of leafy red onion.

G. Statistical Analysis

To verify the statistical significance of all parameters, mean values± SD were calculated. Statistical comparison of mean values was performed by General Linear Model (GLM) of ANOVA followed by Least Significant Difference (LSD) Test using R software.

3. Results and Discussion

Crop growth and yield as a result of different fertilizer practices were found to be different. The losses of nitrogen in terms of nitrate leaching were also different between the two treatments.

A. Growth and yield parameters

Plant height is generally correlated with life span and time of maturity and is a major determinant of ability to compete for light. The differences in plant height among treatments were significant. T1 reported the higher mean value for plant height, while T2 showed the lower mean value. Mean values for number of leaves of the treatments were significant. The T1 showed the higher mean value for number of leaves compared to T2 (Table 2). This may be due to the additional nutrient supplied to the red onion plants in T1.

Table 2. Plant growth and development parameters

Treatment	Plant Height (cm)	Number of Leaves
T1	31.72[a]	31.35[a]
T2	24.47[b]	24[b]

The mean values followed by different subscript letters along the columns are significantly different at P<0.05

B. The yield of Red Onion

The average yield of Jaffna Local red onion in Sri Lanka is 6000 kg/ac (Anon,2011). According to the results, there was a significant difference between the yield of T1 and T2(Figure 1). The results revealed that, the average yield of red onion from farmer used rate(7556.95 kg/ac) is higher than the Department of Agriculture recommended application(5069.25 kg/ac).The farmers who followed split applications of nitrogenous fertilizer throughout the cropping season were able to get higher yield than DOA recommendation. Split application of nitrogen has been reported to be one of the methods to improve nitrogen-nutrient use by the crop while reducing the nutrient loss through leaching and volatilization. However heavy fertilization does not always result in higher yield; moreover, it decreases the nitrogen use efficiency. Excessive nitrogen causes vigorous vegetative growth resulting in lodging of plants,increased susceptibility to insects,pest and diseases that ultimately reduce the yield (Tolessa *et al*., 2002).

Table 3. Average remaining weight percentages under different storage conditions

Treatment	Remaining weight percentage under four conditions			
	Air dried without a paper wrap	Air dried in a paper wrap	Refrigerated without a paper wrap	Refrigerated in a paper wrap
1	50.68±3.34	44.74±5.82	40.96±5.91	40.95±6.54
2	49.75±2.28	52.08±7.11	36.95±1.88	34.74±5.37

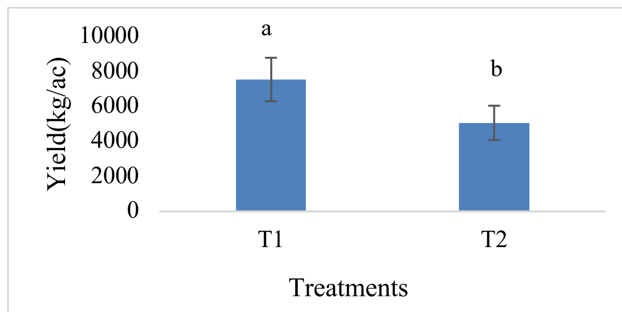

Figure 1. Harvested leafy red onion yield of the two treatments

C. The Perishability of the harvest

The mass of fresh material remaining as a fraction of initial storage mass of harvest was considred as an indication of perishability. The mean values for plant remaining percentages under different conditions are given in the Table 3. There was no significant difference of remaining weight percentage between treatments under various conditions. The T1 showed a higher remaing weight percentage both under atmospheric and refrigerated conditions compared to T2 which was not significant.

D. Nutrient Leaching

1. Analysis of leached Nitrate and Ammonium(kg/ac)

There was a significant difference (P<0.05) in mean value of cumulative nitrate leaching as well as cumulative ammonium leaching between T1 and T2 throughout the cropping season (Table 4). Hydrolysis, volatilization, nitrification and denitrification are the important processes that decide the fate of applied urea in soil. Once urea is applied to soil, it hydrolyses to form NH4 + . Nitrification converts NH4 + into NO2 - and the nitrite is transformed into NO3 – (Khalil *et al*., 2009). This nitrate is susceptible to leach due to excessive permeability in the soil and freequent flush of water through irrigation. Depending on soil pH, moisture, and application methods, urea undergoes chemical transformation to produce either NH4+ or NO3-(Calvert *et al.,*2002). Nitrogen loss from urea as NO3- is one of the most important pathways because NO3- is extremely mobile. Leaching of NO3- from urea leads to increase in NO3- concentration in groundwater. Because NH4+ is positively charged, it is held by the negative sites of soils. Therefore, NH4+ leaches less in mineral soils which are particularly high in clay. Due to the absence of clay content in coarse-textured sand in Kalpitiya, NH4+ leaching is significant. The leaching loss of nitrogen can be reduced by minimizing the amounts of NH4+ and NO3- in the soil in at a given time (Omar *et al.,*2015) while providing enough N to plants. The main differences in the two fertilizer management system used in the experiment were total input nitrogen fertilizer amount and the time of fertilizer application.Total input nitrogen for T1 and T2 were 84.89 kg/ha and 91.31 kg/ha respectively. Five split applications of fertilizer were applied for T1 at weekly intervals (Referred to as urea-100 kg/ha, TSP-125 kg/ha, Onion fertilizer-125 kg/ha, Blue granuels-62 kg/ha, Calcium-62 kg/ha) while for T2, recommended urea dosage was applied as Basal dressing:68.5 kg/ha at the planting, Top dressing 1:65 kg/ha at 3 weeks after planting and Top dressing 2:65 kg/ha at 6 weeks after planting. Nitrogen leaching pattern (Figure. 2) corresponds to the differences in application of fertilizer in these treatments.

2. Analysis of Leached Nitrogen Percentage

Leached nitrogen percentage was calculated by dividing the leached nitrogen amount by total input nitrogen. Both irrigated water and nitrogenous fertilizer were considered as input sources of nitrogen. According to the results, there was a significant difference (P<0.05) in leached nitrogen percentage between T1 and T2. The higher nitrogen leached percentage was observed in T1(78.86%) while the lower leached nitrogen percentage was observed in the T2(67.88%). Intermittent application of nitrogenous fertilizer for T1 may cause for the higher nitrogen leaching percentage throughout the cropping season. The total amount of N leached in the form of nitrate and ammonium during the cropping season as percentage of applied N in each treatment was calculated and presented in the Table 4. The higher N leached was recorded in T1, which represents the rate of fertilizer application by growers.

Table 4. The cumulative leached nitrate, ammonium, and leached nitrogen percentage throughout the season

Treatment	Mean Nitrate (kg/ac)	Mean Ammonium (kg/ac)	Mean Leached Nitrogen Percentage (%)
T1	137.63^{a}±21.44	6.59^{ab}±1.77	78.86 ^{a} ± 12.45

T2	126.01[ab]± 3.46	5.86 [b] ±0.88	67.88 [ab]±1.01

LSD value 0.05

3. Concentration of Nitrate in the leachate

The concentration of NO_3- in leachate fluctuated over the growing season in both treatments (Figure 2). Both treatments showed higher concentration of nitrate in the leachate than WHO standard of <50 mg/l (dashed line-Figure 2) for potable water in the latter part of the growing period.

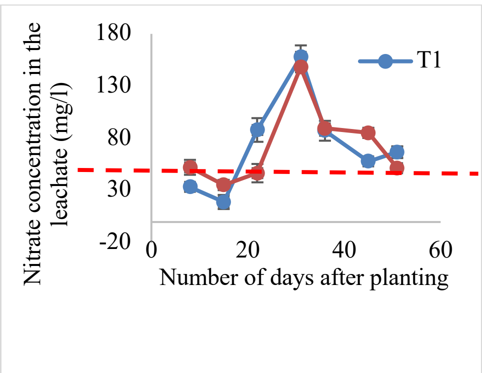

Figure 2. Leachate NO_3^- concentration throughout the cropping season

Rapid increase in leaching losses of nitrogen in the form of nitrate (NO_3^--N) corresponds with the fertilizer application (Figure.2), and after a short duration of applying fertilizer (TD1 in 22 DAP). Furthermore, the T2 comparatively showed a higher concentration of nitrate (NO_3^- -N) in leachate upto 14 days after application of basal dressing.

4. **Conclusion**

Results indicate that, the nitrogen leaching percentage of farmer practiced fertilization was significantly higher (78.86%), when comparing with Department of Agriculture recommended (T2) treatment (67.88%). However, farmer practiced fertilizer treatment (T1) shows the significantly higher yield and growth performance with compared to the Department of Agriculture recommendation (T2). The concentration of nitrate in leachate is above the accepted standards irrespective of the treatments. Leaching of NO3-N is economically and envir onmentally undesirable. Therefore,recommended amounts of fertilizer should be applied in balanced proportion and at appropriate times with soil amendments may help to absorb nutrients efficiently while maximising the yield. Moreover, this study concludes that, both practices showed leached nitrate concentrations exceeds the safe limits recommended by WHO which urges the need for change in nitrogen fertilizer management for red onion crop on sandy Regosols to minimize leaching losses.

References

Anon. (2011). Performance report of Jaffna district. Provincial Department of Agriculture,Sri Lanka.

Aravinna, A.G.P., (2006). Assessment of impact of pesticides on water catchments and groundwater in some selected areas of Sri Lanka, Doctoral dissertation, University of Sri Jayewardenepura, Nugegoda.

Calvert, D.V., He, Z.L.,Alva,A.K.,Li,Y.C and Banks,D.J.(2002).Clinoptilolite zeolite and cellulose ammenments to reduce ammonia volatilsation in a calcareous sandy soil. *Plant and Soil*, vol.247, no.2, pp.253-260,2002.

Choudhury A.T.M.A. & Kennedy I.R. (2005). Nitrogen fertilizer losses from rice soils and control of environmental pollution problems. *Communications in Soil Science and Plant Analysis* 35: 1625 – 1639

Dalpitiya, D.M.A.U., Herath,H.M.I.K & Swarnathilake,D.S.G.G.C. (2022).Effect of Different Fertilizer Practices on Growth, Yield and Nitrogen loss from Leafy Red Onion

(*Allium cepa*) grown in Kalpitiya Peninsula. *Proceedings of 20th Agricultural Research Symposium (2022). Faculty of Agriculture and Plantation Management Management.Wayamba university of Sri Lanka,Makandura,Gonawila.*

Department of Census and Statistics, (2019). Statistical Data Sheet – 2019, Department of Census and Statistics, Colombo, Retrieved from http://www.statistics.gov.lk/DataSheet/2019 DataSheet_En.pdf

Harold, M.E., Sogbedjib, J.M. and Schindelbecka, R.R. (2006). Effect of manure application timing, crop, and soil type on nitrate leaching. *Journal of Environmental Quality,* 35(2), 670– 679

Jamaldeen,N.(2013). Keep middlemen out, say Kalpitiya farmers, retrieved from https://archives.sundayobserver.lk/2013/07/14/fea09.asp

Jayasingha, P., Pitawala, A. Dharmagunawardhana, H.A. (2011). Vulnerability of coastal aquifers due to nutrient pollution from agriculture: Kalpitiya, Sri Lanka. *Water, Air, and Soil Pollution*, 219(1-4), 563−577.

Kendaragama, K.M.A. (2006). Crop Growing Environments in Sri Lanka with Special Emphasis on Plant Nutrient Use. J. Soil Sci. Soc. Sri Lanka, 18, 1-18.

Khalil M.I., Guster R. & Schmidhalter U. (2009). Effects of urease and nitrification inhibitors added to urea on nitrous oxide emission from a loess soil. *Journal of Plant Nutrition and Soil Science.* 172: 651 – 660.

Kumarasinghe, K.M.S.M and Rajapakse.R.R.G.R (2012).Impact on groundwater quality in Puttalam area due to over abstraction and improper agricultural practices.Water resource board,2A,Hector Kobbakaduwa Mawatha,Colombo 07

Kuruppuarachchi, D. (1995). Impact of irrigated agriculture on groundwater resources of Sri Lanka. Proc. *Sri Lanka Association for Advancement of Science,* 51, 53-54.

Liyanage, C.E., Thabrew, M.I. and Kuruppuarchchi,D.S.P.(2000). Nitrate pollution in ground water of Kalpitiya; an evaluation of the content of nitrate in the water and food items cultivated in the area. *Journal of the National Science Foundation of Sri Lanka,* 28(2), 101−112.

Meisinger, J.J., Hargrove, W., Mikkelson, R.L., Williams, J.R. and Benson, V.W. (1991). Effects of cover crops on groundwater quality. In Cover crops for clean water. *Proceedings of international conference on cover crops for clean water*, Tennessee, 57–68.

Melvani, K., Chandrasekera., K., Mudannayake, R. (2006).The role of trees in the bioremediation of drinking water-a research experiment in Nawakkaduwa, Kalpitiya. *Proceeding of the 32nd WEDC, Loughborough University, United Kingdom*. pp.304-312

Nagarajah, S., Emerson, B.N. & Abeykoon, V. (1986). Water quality of wells in Jaffna and Kilinochchi. *Journal of Tropical Agriculturist (Sri Lanka),* 144, 61-78

Omar, L.,Ahmed,O.H., and Majid,N,M,A.,(2015).Improving ammonium and nitrate release from urea using clinoptilolite Zeolite and compost produced from agricultural wastes. *The Scientific World Journal*, vol.2015, Article ID574201,12 pages,2015.

Sharma, K. D. (2009). Groundwater management for food security. Current Science, 96(11), 1444-1447

Shukla S. Saxena A. 2018 Global status of nitrate contamination in groundwater: its occurrence, health impacts, and mitigation measures. In: *Handbook of Environmental Materials Management (Hussain C. M., ed.).* Springer International Publishing, Dordrecht, the Netherlands, pp. 1–21. https://doi.org/10.1007/978-3-319-58538-3_20-1.

Tolessa D, Tesfa B, Wakene N, Tenaw W, Minale L, Tewodros M, Birtukan M, Waga M (2002). A review of fertilizer management research on maize in Ethiopia. Enhancing the Contribution of Maize to Food Security in Ethiopia: *Proceedings of the Second National Maize Workshop of Ethiopia,* 12-16 November 2001, Addis Ababa, Ethiopia: Ethiopian Agricultural Research Organization (EARO) and International Maize and Wheat Improvement Center (CIMMYT).

Acknowledgment

The authors wish to acknowledge the 'Accelerating Higher Education Expansion and Development (AHEAD)' DOR No.51 (STEM) Grant (No 6026-LK/8743-LK) for giving the financial assistance for the study.

Authors Biography

Mrs.Gayathri Swarnathilake obtained her

bachelor's degree from the Faculty of Agriculture & Plantation Management of Wayamba University of Sri Lanka in 2017. She is interested in product development and nutrient leaching. She is currently a M.Phil. student and her M.Phil. research is centered on Development of an eco-friendly nitrogen fertilizer management system to reduce nitrate leaching from sandy Regosols in Kalpitiya, Sri Lanka.

Indika K. Herath is a Professor in Soil & Environmental Sciences at the Faculty of AgriculturePlantationManagement of the Way amba University of Sri Lanka. She obtained her B.Sc. (Agriculture) and M.Sc. (Tropical Soil Management) from the University of Peradeniya, Sri Lanka. She obtained her Ph.D. from Massey University, New Zealand. She is an author of over 100 scientific publications and a recipient of many national and international awards.

D.R. Gimhani received her PhD in Plant biotechnology from Wayamba University of Sri Lanka, and she completed her PhD study at the International Rice Research Institute under the Global Rice Science Scholarship. She received her B.Sc. in Agriculture from Wayamba University of Sri Lanka and her M.Sc. from University of Peradeniya. Currently, she is serving as the Head of the Department of Biotechnology, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka.

Ms.Asantha Dalpitiya is an Agriculture graduate from the Faculty of Agriculture & Plantation Management, Wayamba University of Sri Lanka. Her research interests are soil and plant nutrient