



## K AND Na LEACHING FROM LEAF LITTER OF *ACACIA AURICULIFORMIS* (CUNN. EX BENTH.)

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**Abstract:** *Acacia auriculiformis* (Cunn. Ex Benth.) is now widely planted in different agroforestry models. The prime use of this species is for fuel wood and to some extent as furniture timber at the northern and central part of Bangladesh. In agroforestry, trees and agricultural crops sharing the nutrients from the same piece of land. Trees uptake nutrients from the soil and some portion of that nutrient again back to the soil through the leaching process and decomposition of litter. K and Na leaching from leaf litter of *Acacia auriculiformis* was studied in the laboratory. About 16% of initial dry weight of leaf litter was lost after 168 hours. Weight loss of leaf litter, conductivity and TDS (Total Dissolve Solid) of leached water showed significant ( $p < 0.05$ ) positive curvilinear relationship with leaching time. The initial concentration of K and Na in leaf litter significantly ( $p < 0.05$ ) decreased to  $2247 \mu\text{g g}^{-1}$  and  $735 \mu\text{g g}^{-1}$  respectively after 96 hours and showed significant ( $p < 0.05$ ) negative curvilinear relationship with weight loss. The pattern of K and Na leaching from the leaf litter of *Acacia auriculiformis* might help agroforestry practitioners to add a new criteria to choose potential tree species for their farming system.

**Key words:** Agroforestry, leaf litter, nutrient return, potassium, sodium

### Introduction

*Acacia auriculiformis* is of special interest in agroforestry practices in Northern and central part of Bangladesh for its multiple uses and fast growth. It can successfully be grown on a variety of sites and in combination with a variety of crops (Das and Alam, 2001). The production in agroforestry is influenced by the soil condition, especially the availability of nutrients, moisture condition and rate of organic matter decomposition (Nair, 1984). Trees considerably improve the soil condition by adding nutrients through mycorrhiza and other symbiotic association, leaching and litter decomposition (Marschner, 1995). Trees uptake nutrients from a comparatively deep layer of soil, a portion of which is stored in plant biomass and the rest is returned to the soil as litter. The rate of nutrient addition to the soil varies with species, nutrient composition of litter and environmental conditions (Jones, 1998; Marschner, 1995). Thus, selection of an efficient tree species is a challenging issue in agroforestry.

Leaf litter contributes to nutrient return to the soil and nutrient leaching from leaf litter is the ready source of nutrient to the soil (Tukey, 1970; Mason, 1977; Park and Kang-Hyun, 2003). Information on nutrient leaching from leaf litter of different tree species will facilitate to incorporate the nutrient return efficient species with agricultural crops to maximize the total

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DOI: <https://doi.org/10.53808/KUS.SI.FRCC.2006.79-82-1s>

productivity in agroforestry. Cations are more liable to leach compared to other nutrients (anions). Among the cations, some cations are readily leach-able which are not bounded with the structural compound of plant cell such as K and Na (Marschner, 1995). Moreover, they play important roles in maintaining the water status of plant, crop yield and quality (Jones, 1998). So, the present study aimed to assess the pattern of weight loss and cations K and Na leaching from the leaf litter of *A. auriculiformis*, being the prominent tree species used in agroforestry.

## Materials and Methods

**Experimental setup:** Freshly fallen yellowish senescent leaves were collected and air-dried at room temperature for one week. Leaves were then thoroughly mixed and 38 samples (about 2 g each) were prepared. Each sample was placed in a beaker (500 ml), 200 ml of distilled water was poured into the beaker and HgCl<sub>2</sub> (50 mg l<sup>-1</sup>) was added to prevent the fungal decay (McLachlan, 1971; Otsuki and Wetzel, 1974). Thus a total 33 samples were prepared for this experiment and five samples were oven dried at 80 °C to constant weight and the air-dry to oven-dry weight conversion factor was calculated.

**Sample collection and measurements:** The time intervals among the sampling events were selected on the basis of conductivity of leached water during the preliminary study. Three replicates of leaf samples were taken out of beaker after 0, 4, 8, 12, 24, 48, 72, 96, 120, 144 and 168 hours. These samples were then rinsed in distilled water, oven-dried at 80 °C to constant weight and weighted with an electric balance (manufactured by Melter Toledo, AB 204, Switzerland). Weight loss (%) due to leaching was determined by subtracting this weight from the initial oven-dried weight (2 g x conversion factor) and samples were processed according to Allen (1974). Conductivity (μS cm<sup>-1</sup>), total dissolved solid (TDS) (mg l<sup>-1</sup>) and pH of leached water samples were measured by a Conductivity and TDS meter (Ciba-Corning Diagnostic Ltd., England) and a temperature compensated pH meter (Ciba-Corning Diagnostic Ltd., England).

**Nutrients in leaf litter:** Three replicates of processed leaf samples (0.1 g) were taken randomly from each treatment (samples collected at different time intervals) and they were acid digested according to Allen (1974). K and Na concentration in extracts of samples were measured by Flame photometer (PFP7, Jenway LTD., England).

**Statistical analysis:** Weight losses of leaf samples at different time were transformed to arcine. Conductivity, TDS, pH of leached water samples, and K and Na concentration in leaf litter at different time interval were compared by one way analysis of variance (ANOVA) followed by Duncan Multiple Range Test (DMRT) using SAS 6.12. Correlation and regression analysis were conducted among weight loss (%); conductivity and TDS of leached water; nutrients in leaf litter; and leaching time intervals by using SAS 6.12.

## Results

**Weight loss of leaf litter, and conductivity, TDS and pH of leached water sample:** About 16% of the initial dry weight of leaf litter was significantly ( $p < 0.05$ ) lost after 168 hours of leaching (Fig. 1). Conductivity of leached water significantly ( $p < 0.05$ ) increased to 242 μS cm<sup>-1</sup> after at the same time (Fig. 2). TDS also showed similar pattern to conductivity, and significantly ( $p < 0.05$ ) increased to 116 mg l<sup>-1</sup> at the end of this experiment (Fig. 3). pH of leached water samples dropped significantly ( $p < 0.05$ ) to 5.89 from 6.32 after 24 hours. Significant ( $p < 0.05$ ,  $r = 0.98$  to 0.99) positive curvilinear relationships were observed among leaching time; and weight loss of leaf litter, conductivity, TDS (Fig. 1 to 3). Irrespectively, significant positive relationship was

observed between weight loss and conductivity ( $r=0.98$ ,  $p<0.05$ ,  $n=10$ ); weight loss and TDS ( $r=0.99$ ,  $p<0.05$ ,  $n=10$ ).

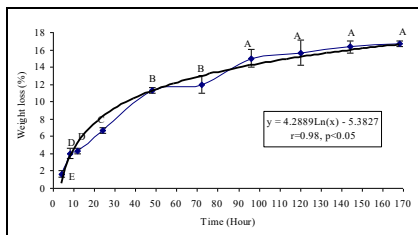


Fig. 1: Leaf litter weight loss (%) due to leaching at different duration of leaching. Means with similar alphabet are not significantly different.

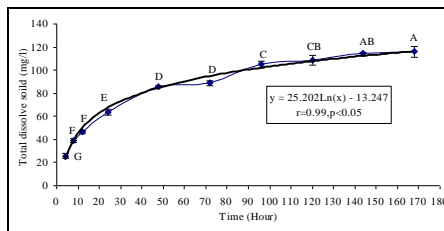


Fig. 2: Conductivity of leached water samples at different duration of leaching. Means with similar alphabet are not significantly different.

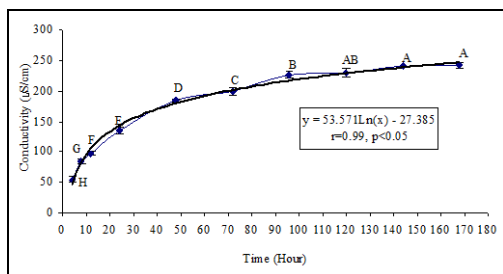


Fig. 3: Total dissolved solid in leached water samples at different duration of leaching. Means with similar alphabet are not significantly different.

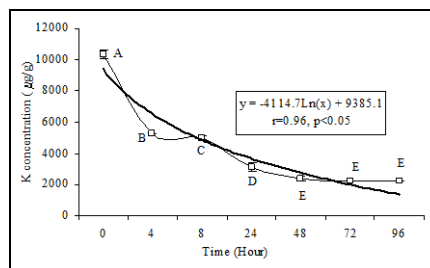


Fig. 4: K concentration in leaf litter at different duration of leaching. Mean with similar alphabet are not significantly different.

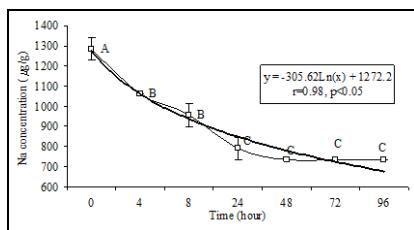


Fig. 5: Na concentration in leaf litter at different duration of leaching. Mean with similar alphabet are not significantly different.

**Cations in leaf litter:** Rapid loss of K from the leaf litter was observed after 48 hours of leaching, over this period K concentration in leaf litter was decreased by 77% from  $10343 \mu\text{g g}^{-1}$  to  $2391 \mu\text{g g}^{-1}$  (Fig. 4). Similarly, Na concentration in leaf litter decrease by 43% from  $1285 \mu\text{g g}^{-1}$  to  $550 \mu\text{g g}^{-1}$ . But, the rapid loss of Na from leaf litter was observed after 24 hours (Fig. 5). K and Na concentration in leaf litter showed significant ( $p<0.05$ ,  $r = -0.96$  to  $-0.98$ ) negative curvilinear relationship with time (Fig. 4 to 5).

## Discussion

The initial rapid weight loss of leaf litter is associated with the leaching loss of both inorganic and organic compounds (Tukey, 1970). The conductivity and TDS values of a solution are the rough estimation of cations and dissolved organic substances (Allen, 1974). The positive curvilinear relationships among the weight loss of leaf litter; conductivity; TDS and leaching time are similar to the findings of Park and Kang-Hyun (2003), where weight loss (%) and subsequent loss of

inorganic and organic substance from the leaf litter increased with longer leaching time and this losses ceased at certain time.

Different cations showed different rate of leaching, which depends on the characteristics of individual nutrient, environmental factors, initial concentration in litter (Tukey, 1970; Marschner, 1995) and nutrients' involvement in the structural properties of respective plant cell (Meyer *et al.*, 1973). K accumulates in physiologically active tissues (leaves, buds and roots) (Marschner, 1995) and this could be the reason for comparatively low concentration of Na in leaf litter. Leaching is the preliminary stage of litter decomposition and it ceases at certain time (Mason, 1977). This statement was supported by the present study where a significant ( $p < 0.05$ ) negative curvilinear relationship was observed among the weight loss and nutrients concentration in leaf litter. Irrespectively, Park and Kang-Hyun (2003) also observed similar negative relationships among the rate of weight loss and subsequent loss of inorganic substance from the leaf litter during the leaching process.

### Conclusion

The amount of nutrient/cations addition to the soil is the combined action of leaching and decomposition of litter, which might ensure the sustainability of soil fertility. In this study, the knowledge of cations (K and Na) leaching from the leaf litter of *Acacia auriculiformis* might help agroforestry practitioners to add a new criteria to choose potential tree species for their farming system. For limited lab facility and time constraints, other important nutrients could not be measured. However, to get a complete picture about the cations release efficiency, decomposition of leaf litter of this species should be investigated.

**Acknowledgement:** Authors wish to thank Forestry and Wood Technology Discipline and Soil Science Discipline of Khulna University for the logistic support throughout the study.

### References

- Allen, S.E. 1974. *Chemical Analysis of Ecological Materials*. Blackwell Scientific Publication, Oxford, 565 pp.
- Das, D.K. and Alam, M.K. 2001. *Trees of Bangladesh*. Bangladesh Forest Research Institute, Chittagong, 342 pp.
- Jones, J.B.Jr. 1998. *Plant Nutrition Manual*. CRC Press, New York, 149 pp.
- Marschner, H. 1995. *Mineral Nutrition of Higher Plants*. Academic Press, New York, 889 pp.
- Mason, F.C. 1977. *Decomposition*. The Institute of Biology's Studies in Biology no. 74. Edward Arnold Limited, London, 58 pp.
- McLachlan, S.M. 1971. The rate of nutrient release from grass and dung following immersion in lake water. *Hydrobiologia*, 37: 521-530.
- Meyer, B.S.; Anderson, D.B.; Bohning, R.H. and Fratiane, D.G. 1973. *Introduction to plant physiology*. D. Van Nostrand Company, New York, 464 pp.
- Nair, P.K.R. 1984. The role of trees in soil productivity and protection. pp 567-589. In: Nair, P.K.R. (ed.), *Agroforestry Systems in the Tropics*. Kluwer Academic Publishers, London.
- Otsuki, A. and Wetzel, R.G. 1974. Release of dissolved organic matter by autolysis of a submersed macrophyte, *Scirpus subterminalis*. *Limnology and Oceanography*, 19: 842-845.
- Park, S. and Kang-Hyun, C. 2003. Nutrient leaching from leaf litter of emergent macrophyte (*Zizania latifolia*) and the effects of water temperature on the leaching process. *Korean Journal of Biological Science*, 7: 289-294.
- Tukey, H.B.Jr. 1970. The Leaching of Substances from Plants. *Annual Reviews*, 21: 305-321.