Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 3 Spl Issue III 2014: 49-52

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

Full Length Article

Concentration, flux and enrichment of elements in *Fagusorientalis* in Kelardasht, North of Iran

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ABSTRACT
Measurement and Sampling were conducted during the growing season in natural stand of *Fagusorientalis*Lipsky, and in Kelardasht region, Northern Iran. To measure and sampling gross rainfall (*GR*) and throughfall (*TF*), four and 20 respectively rain-gauges were installed. There were significant difference between incident rainfall and throughfall for $NO3^-$ and P concentrations, but concentration of K^+ was deifferent between rainfall and troughfall of *F. orientalis* stand. The average enrichment of K^+ was highest. Flux amount of NO_3^- was significant difference between *F. orientalis* stand and *GR*. The average enrichment of K^+ was highest. Forest canopy can alter the chemical composition of precipitation. In fact nutrient return to the forest floor may have played a very important role in the nutrient cycling.
Key Word: *Fagusorientalis* Lipsky, Nutrients, Canopy

Received 18.04.2014 Revised 19.05.2014 Accepted 11.06. 2014

INTRODUCTION

Chemistry of TF changes as incident rainfall passes through forest canopy. The first changes occur as rainfall contacts the forest canopy. Tree foliages absorb some chemicals from rainfall thus reducing the concentrations of these chemical in the TF and at the sometime, the concentrations of other chemicals in the TF increases as chemicals are leached from leaves or washed off leaf surface [3], [17]. Lovett et al. [10] pointed out that there are several variables that influence of these processes (e.g., precipitation amount and rate; source strength and proximity of dry deposition; precipitation acidity; precipitation chemical concentrations; tree species composition, age and nutrient status of the forest; epiphytes; leaf area; and others).

In contrast to litterfall, throughfall and stemflow add nutrients directly to the available nutrients pool without the intervention of any process of decomposition [5].Therefore, these fluxes are considered important pathways in the internal nutrient dynamics of the forests [13]. On the forest floor a knowledge of the chemical characteristics of precipitation in forested areas, gained through long-term sampling, is a necessary basis for evaluating risks to the vitality of ecosystems.

An awareness of the range of nutrient cycling strategies that exists,can only encourage the development of ecologically appropriate plantation systems with respect to the maintenance of long-term soil, site and forest productivity. The results obtained in this study can contribute to a better understanding of the internal processes in the functioning of forest ecosystems and also to the evaluation of the impact of forest disturbances on the nutrient cycling.

Caspian forests with an area ~ 2,000,000 ha. are located between –20 and 2200 m a.s.l. in north of Iran (south of the Caspian Sea). Pure and mixed beech stands are one of the most important and rich stands occurring on the northern slopes. The beech (FagusorientalisLipsky) is one of the most important commercial hardwood species in Iranian forestry, and has covers about 17.4% of Iran's forests [14]. *The objective of this study was to examine and present information on* the concentration, flux and enrichment of elements (NO_3^-, P, K^+) through the canopy of *F. orientalis* stands in Kelardasht, North of Iran. The results obtained in this study can contribute to a better understanding of the internal processes in the functioning of forest ecosystems and also to the evaluation of the impact of forest disturbances on the nutrient cycling.

MATERIALS AND METHODS

Site Description

This study was conducted during the growing season in natural stand of *Fagusorientalis* Lipsky, in Kelardasht region (1320 m above the Caspian sea level), Northern Iran. Measurement was made in a 0.5 ha of forest. Tree density for *F. orientalis* was 196 tree ha^{-1}. Mean tree height and diameter at breast height (DBH) were 9.5 m (SD: ±2.9 m) and 92.5 cm (SD: ±14.6 cm).

Four manual plastic collectors were installed in an adjacent open area to the study sites for *gross rainfall* (*GR*) sampling and for measuring and sampling of throughfall (*TF*), twenty manual plastic collectors were placed and distributed randomly underneath the canopies of *F. orientalis* stand. A fabric tour regularly cleaned was covered over the neck of collectors to prevent litter, needles and debris entering the collectors. The collectors were washed and rinsed with distilled water before being replaced. The samples taken from July to October, 2012 were examined.

Measuring elements in the lab

The samples collected in one month were combined and four samples were selected for each forest. The samples were immediately filtered and stored at 4°C. Chemical analysis of *GR* and *TF* for nitrate (NO_3^-) was carried out by the Kjeldahl (Thermo Fisher, Germany), and total Phosphorus (P) was determined by UV/V Spectrophotometer (SQ-2800, US). Potassium (K^+) were determined using the Flame Photommeter (Jenway pf7, UK).

The mounts of nutrients elements fluxes per event were estimated by the concentration of each element in *TF* ($mg.L^{-1}$) multiplied by the mount of *TF* per event (Drapelova, 2013). Mean *TF* depth was calculated using the twenty *TF* measurements. Enrichment ratio was defined as the ratio of element concentrations of *TF* over the element concentrations of *GR*[1].

Nutrient elements

There was significant difference between incident rainfall and through fall for NO_3^- concentration. In fact amount of nitrate was lower for throughfall compared to rainfall. The leached amount of P was significantly higher on the through fall than rainfall. The concentration of K^+ was increased after passing through the canopy, but there was no significantly difference in throughfall of stand and rainfall for this element (Figure 1).

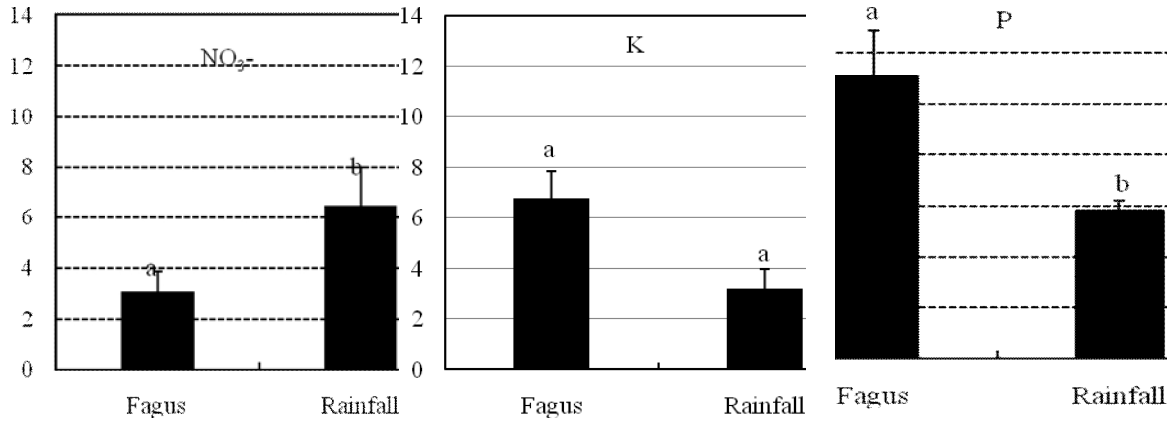

Fig. 1. Mean concentration of nutrient elements (NO_3^-, P and K^+) during the study period, from July to October 2012 in *F. orientalis* in Kelardasht forest.

Flux of elements

Our results suggested the NO_3^- flux per event in the *F. orientalis* stand was lower than that of *GR*. No statistical difference was observed between P and K^+ at the *GR* and *TF* of *F. orientalis* stand.

Elements	Amounts of nutrient elements fluxes per event	
	***Fagusorientalis* stand**	**Rainfall(*GR*)**
Nitrate (NO_3^-) ($mg.m^{-2}$)	81.3 [19.9] $_a$	233.5 [54.8]$_b$
Phosphorus (P) ($mg.m^{-2}$)	288.2 [45]$_a$	209 [14.6]$_a$
Potassium (K^+) ($mg.m^{-2}$)	176.5 [27.6]$_a$	114.8 [29]$_a$

Enrichment

In this study was measured enrichment. K^+ had the highest rate of enrichment and NO_3^+ showed the least (Fig. 2).

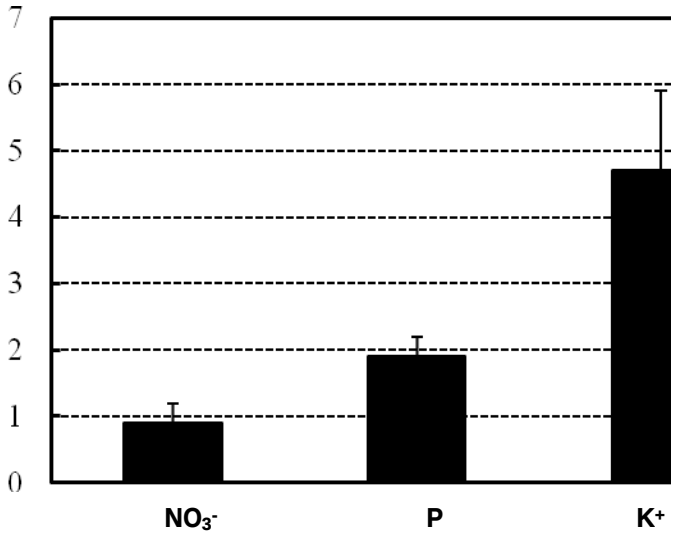

Fig. 2. Mean enrichments of nutrient elements (NO_3^-, P, and K^+) during the study period, from July to October 2012 in the *F. orientalis*natural stand in Kelardasht Forest.

DISCUSSION

Forest canopy can alter the chemical composition of precipitation. In this study the nitrate (NO_3^-) concentration in rainfall is more than through fall. The result is consistent with Fan and Hung [6]. They stated that nitrates are absorbed by the canopy. According to the Mustajarvi et al. (2008), trees with large canopy, affects the processes of *N* flux as through fall passed down through the canopy. Nitrate entering ecosystems as dry fall out or in precipitation can to some extent, compensate for deficiency of this element [8]. Higher concentration of phosphor (p) in the through fall of stand than rainfall in our study, indicate that this nutrient was transported of canopy by through fall. The reason for this, is the increasing concentration of leaching process [15]. On the whole, parts of the nutrient return to the forest floor via through fall. Infact through fall may have played a very important role in the nutrient cycling.

Balestrini et al. [2] based on research on *Fagussylvatica* found that Concentrations of these elements was increased through the canopy, and amount of K^+ the greatest increase. Deposition washed from the canopy was reason for this increase. Based on the analysis of precipitation chemistry, this study revealed the contributions of dry deposition and canopy exchange through fall, and evaluated the possible effect of emission sources and stand characteristics on through fall[6].

Enrichment of elements in the through fall has been attributed to dissolution and washout of atmospheric materials deposited on the canopy [5], [13] or exchanges between rainfall and elements in internal plant parts [11].

This study showed that the NO_3^- flux per event was different between *F. orientalis* stand and *GR*. Factors are effective on the mount of flux, such as nutrient uptake by canopy, canopy area, leaching of nutrients from leaves and branches Are effective on the amount of flux [13], [9].

It can be said, the difference in these results with other studies was because of differences in characteristics of throughfall and availability of elements by throughfall[13], [1]. Actually, the amount of rainfall and rainfall intensity is higher, the higher of flux [16].

CONCLUSION

The concentration of P and K^+ was increased after passing through canopy and NO_3^- was absorbed by canopy. Results showed that K^+ had the highest rate of enrichment. In this study canopy exchange was the most important factor regulating throughfall and deposition. characteristics of throughfall and availability of elements by throughfall are important factors in the amount of flux. The quantity and quality of nutrients returned depends upon the elemental mobility, the internal nutrient resources and the morphological traits of the vegetation during the different stages of nutrient cycling [7].

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