DESERT

DESERT
Online at http://jdesert.ut.ac.ir

DESERT 17 (2012) 91-97

Comparison the Amount of Existing Mineral Elements in Plant Aerial Parts, Litter and Soil of Three Range Species in Taleghan Region

M. Saberi[a*], M. Jafari[b], A. Tavili[c], M.A. Zare Chahouki[c], M. Tahmoures[d]

[a] *Faculty of Natural Resources, University of Zabol, Zabol, Iran*
[b] *Professor, Faculty of Natural Resources, University of Tehran, Karaj, Iran*
[c] *Associate Professor, Faculty of Natural Resources, University of Tehran, Karaj, Iran*
[d] *MSc. Graduate, Faculty of Natural Resources, University of Tehran, Karaj, Iran*

Received: 26 December 2010; Received in revised form: 10 April 2011; Accepted: 10 July 2011

Abstract

The aim of this research was to compare the amounts of existing mineral elements in plant aerial parts, litter and soil of three range species (*Bromus tomentellus*, *Psathyrostachys fragilis, Agropyron tauri*) in order to investigate the litter effect of species on soil properties of Taleghan rangeland. The measured mineral elements include carbon, nitrogen, phosphorous and potassium. After selection of the appropriate plant species and suitable sites, random- systematic sampling method was used to plant aerial part, litter and soil sampling. Soil data were taken of 0-30 cm depth and in addition to above mineral elements, soil texture, EC, pH and lime percentage was measured in soils of the sites. The data was analyzed by analysis of variance (ANOVA), Duncan's test and t-test. Results of analysis of variance of different elements showed that the amounts of nitrogen, carbon and C/N ratio of the species litter had significant differences, so that *A. tauri* had the highest concentration of nitrogen and *B. tomentellus* had those of Carbon and C/N ratio. Results also indicated that there are significant difference among the amounts of nitrogen, phosphorous and carbon in plant aerial part of the mentioned species (P<0.01). *P. fragilis* had the highest amount of nitrogen and both *P. fragilis* and *B. tomentellus* had higher amount of carbon and phosphorous than *A. tauri*. Soil under the species and control showed significant differences so that the mentioned species improve soil productivity. Totally, *A. tauri* had the highest litter quality and decomposition rate.

Key words: Plant aerial part; Litter quality; Mineral elements; Soil

1. Introduction

For investigation and integrated management of rangeland ecosystems, comprehensive recognition of its components and correct perception of their relationships is necessary. Ecologic relationships existing in nature such as topographic factors, climate, soil, vegetation cover and microorganisms should be known. According to close relationship among ecosystem components, investigation of soil and vegetation cover interactions is vital for achievement to suitable range management projects.

The concept of litter is vegetative residues have been exposed to environmental conditions and they have been decomposed gradually (Paustina *et al.* 1977). Melillo *et al.* (1984) proposed that indices of litter quality include nutritive elements and concentration of different organic and carbonic compounds. Rowland and Plam (1997) proposed four elements (include: Carbon, nitrogen and phosphorous, potassium) are

[*] Corresponding author. Tel.: +98 915 9544760,
Fax: +98 542 2232600.
E-mail address: m_saberi63@yahoo.com

more important than other elements in determining quality of litter. Surely microorganism has original role in litter decomposition; in fact whatever the environment is more suitable for macro-organism activities; consequently, decomposition of litter becomes faster.

The role of plant tissue chemistry and its decomposition on nutrient cycling in grasslands has been reviewed and conceptualized by Wedin (1995, 1999). Jafari and Rahimzadeh (2004) investigated the relationship between litter and soil properties in habitats of *Artemisia aucheri*, *Artemisia sieberi* and *Acantholimon tragacanthinum*. They found that amount of K and P in species litters and habitat soil follow a similar trend. Franck *et al.* (1997) stated that C/N ratio was smaller in *Lolium prenne* litter rather than *Avena sativa*. They supposed that the litter quality of *Lolium prenne* was higher due to little C/N ratio. Litter quality of *Leucaena* and *Sesbania* was studied by Lupwayi and Haque (1998). They reported that mentioned plants are different in viewpoint of their N, K, and Mg amounts while little difference was observed in P and Ca amount of the two plants. They explained that decomposition speed of *Leucaena* was bigger than *Sesbania*.

Throop *et al.* (2004) reported that decrease in C/N ratio leads to increase in mineralization speed and humus formation. Rate of litter decomposition is regulated by a hierarchy of interacting physical, chemical and biotic factors (Couteaux *et al.* 1995; Heal *et al.* 1997). Raeisi *et al.* (2001) stated that mass density and much litter production of slow decomposition species causes that nitrogen content of soil absorbs by microorganism and becomes unmovable. Madritch and Mark (2004) have also examined effects of species diversity on N and C variation and concluded that N and C cycle is affected by phenotypic changes.

Generally, in vegetation development and reclamation projects, only species adaptability is considered as a key criterion for plant selection. Adaptability to new condition is an important criterion but some other characteristics such as forage quantity and quality, production sustainability, revegetation and litter quality are other criteria that should be noted when one or more species are selecting for planting in a given area.

According to importance of organic matter in reclamation of physic-chemical attributes of soil and improvement of soil biology, every factor that affects the amount of organic matter, influences soil productivity. Soil productivity explains soil ability for provision of permanent and suitable growth of plant.

The aim of this research was to compare the amounts of existing mineral elements (carbon, nitrogen, phosphorous and potassium) in plant aerial parts, litter and soil of three range species (*Bromus tomentellus*, *Psathyrostachys fragilis*, *Agropyron tauri*) in order to investigate the litter effect of species on soil properties of Taleghan rangelands.

2. Materials and methods

Taleghan watershed is located in Tehran province between Karaj and Alamoot watersheds, with area about 1325 km^2. The region is located into 50° 36' 43" to 50° 53' 20" East longitude and 36° 5' 19" to 36° 19' 19" North Latitude. The area has an average annual rainfall of 567 mm and its annual temperature is 7c°. In summer of 2008 and after primary study and field study, 3 range types as *P. fragilis, A. tauri, B. tomentellus* was recognized.

For each range type, a key area had been detected and random-systematic sampling method was used along four transects. Soil and plant samples were taken from 10 plots along with each transect. Litter and plant aerial parts were taken from each plot and soil samplings were taken from 0-30 cm depth in underbush and among the studied species as control treatment. Samples were dried in oven at 70˚C for 24 hours in the Soil and Plant Laboratory of Faculty of Natural Resources, University of Tehran. After drying, samples were ground and C, N, P, and K were measured in plant aerial parts, litter and soil by burning in furnace, Kjeldahl Method, spectrophotometery and flame photometer method respectively.

In addition to above minerals, in the soil sites, soil texture, EC, pH and lime was measured by hydrometric method, 1:1 extract, 1:1 extract and calcimetry method, respectively. The data was analyzed by analysis of variance (ANOVA), Duncan’s test and t-test.

3. Results

The obtained results of variance analysis of various elements of *B. tomentellus*, *A. touri* and *P. fragilis* shows that the amounts of nitrogen, phosphorus, Carbon and C/N proportion in species litters have significant difference (p<0.01), (Table 1).

Table 1. Variance analysis of aerial organs attributes of the studied species

Properties	df	MS	F	Sig
N (%)	2	0.207	0.104	6.214**
P (ppm)	2	0.447	0.224	14.523**
K (ppm) K (ppm)	2	392.043	196.02	1.283ns
C (%)	2	219.250	109.625	10.103**
C/N	2	150.659	75.329	1.908 ns

**: Significant difference at 1% level *: Significant difference at 5% level
ns: non-significant difference

Variance analysis of different elements of litter of the species showed that the amounts of nitrogen, phosphorous and Carbon in aerial organs of the species had significant difference (p<0.01) (Table 2).

Table 2. Variance analysis of litter attributes of the studied species

Properties	df	MS	F	Sig
N (%)	2	1.412	0.706	7.495 **
P (ppm)	2	0231	0.116	0.622 ns
K (ppm)	2	98.010	49.005	1.4 ns
C (%)	2	1851.245	925.778	7.9 **
C/N	2	6152.409	3076.654	12.72 **

**: Significant difference at 1% level *: Significant difference at 5% level
ns: non-significant difference

The comparison of the elements in the soil sites show that the amounts of nitrogen and phosphorus have significant difference (p<0.05) and the amounts of potassium, Carbon, lime, sand, clay and silt have significant different (p<0.01) as well and only C/N proportion does not have any significant difference in the samples (Table 3).

Table 3. Variance analysis of underbush soil attributes of the studied species

Properties	df	MS	F	Sig
N (%)	2	0.116	0.58	4.462*
P (ppm)	2	146.33	70.17	4.939*
K (ppm) K (ppm)	2	468.23	234.11	13.315**
C (%)	2	13.18	6.59	11.299**
C/N	2	528.81	264.4	1.469ns
Lime (%)	2	403.18	201.59	14.982**
Sand (%)	2	4048.10	2024.1	2377.895**
Clay (%)	2	1391.10	695.54	53.332**
Silt (%)	2	1236000	618000	35.654**

**: Significant difference at 1% level *: Significant difference at 5% level
ns: non-significant difference

3.1. The comparison of inorganic elements existing in plant aerial parts, litter and underbush soil

The maximum amount of nitrogen in litter and aerial organs exists in *A. tauri* and *P. fragilis* and the minimum amount of it exists in *B. tomentellus* and *A. tauri*. The amount of N existing in litter and aerial organs of three species are higher than soil nitrogen content (Figure 1). From the viewpoint of phosphorus amount existing in the litter and aerial organs, *P. fraghis* and *B. tomentellus* have the minimum of the element (Figure 2). The highest amount of potassium of litter and aerial organs is related to *P. fragilis* and *B. tomentellus* and *A. tauri*. About the content of soil potassium *A. tauri* species has the highest content and *P. fragilis* has the least content of K (Figure 3). From the viewpoint of carbon content in litter and aerial organs, *B. tomentellus*, and *P. fragilis* has the highest amount of Carbon and *A. tauri* species has the least amount of it, while the amount of carbon in underbush soil of *B. tomenterllus* is the highest and Within *P. fragilis* is the least (Figure 4).

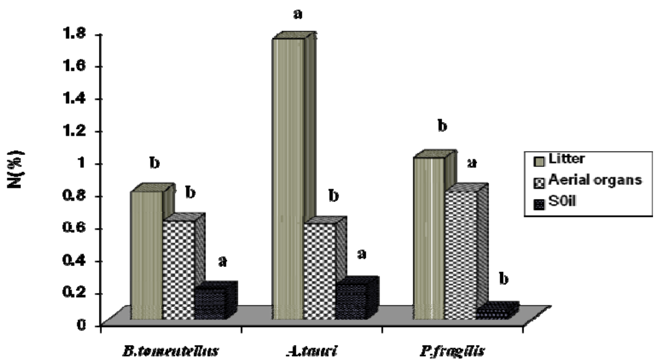

Fig. 1. Comparison of the mean amount of Nitrogen in litter, aerial organs and soil of the species

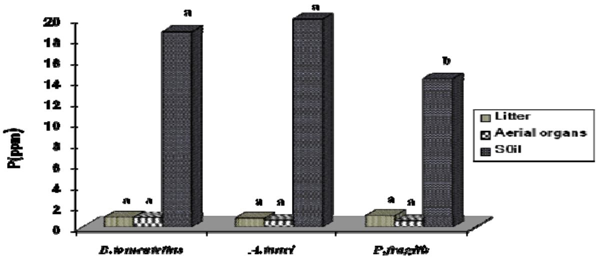

Fig. 2. Comparison of the mean amount of Phosphorous in litter, aerial organs and soil of the species

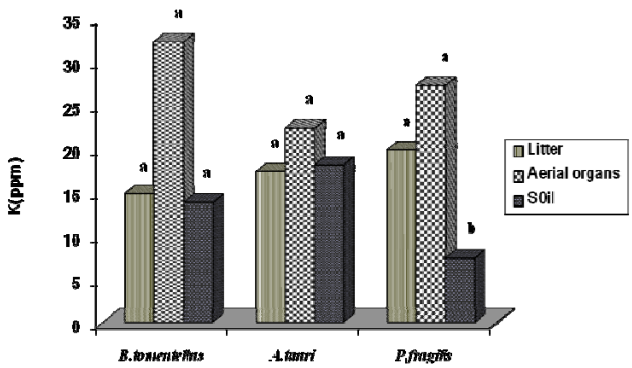

Fig. 3. Comparison of the mean amount of potassium in litter, aerial organs and soil of the species

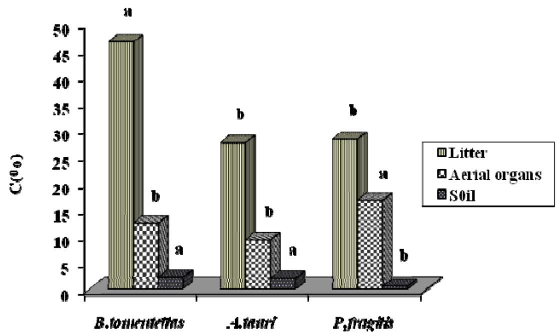

Fig. 4. Comparison of the mean amount of carbon in litter, aerial organs and soil of the species

About C/N proportion, *B. tomentellus* and *P. fragilis* have the highest amount of C/N in their litter and aerial organs, and *A. tauri* species has the least amount of the mentioned proportion. Also *B. tomentellus* has the highest content of C/N in its underbush soil and *P. fragilis* has the least content (Figure 5).

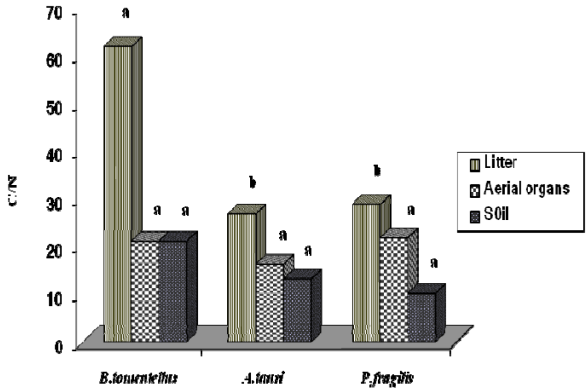

Fig. 5. Comparison of the mean amount of C/N proportion in litter, aerial organs and soil of the species

3.2. The comparison of physical- chemical attributes of soil in underbush soil samples and control area.

The results of pedology study showed that underbush soil of *Bromus tomentellus* has loam-clay- sandy texture, the amount of lime is 29.7%, the amount of EC is 0.66 ds m^{-1} and its pH is about 7. The amount of carbon content of underbush soil is 2.35%. Also about productive elements of soil, the amount of nitrogen is 0.19 % and the amounts of phosphorus and potassium are 18.7 and 13.83 ppm respectively. For soil of control area of the species, the soil texture is loam- clay- sandy. The amounts of lime, pH and EC are 8.64 %, 7.05, and 0.6 ds m^{-1} respectively (Table 4).

The pedology studies also show that the texture of underbush soil of *P.fragilis* is loamy. The amounts of lime, EC and pH are 14.79%, 0.78 ds m^{-1} and 7.18 in order. Also the phosphorus and potassium contents of the underbush soil are 14.2 and 7.41 ppm respectively. The soil texture of the control area for the species is clay, and the amount of lime, EC and pH are 7.81%, 0.41 ds m^{-1} and 7.2 in order. The amount of phosphorus and potassium are 16 and 14.38 ppm respectively (Table 4).

Results of pedology studies also indicated that texture of underbush soil of *P.fragilis* is loam-clay-sand. The amounts of lime, EC and pH are 5.26%, 0.67 ds m^{-1} and 6.75 in order. Also the phosphorus and potassium contents of the underbush soil are 20.6 and 19.52 ppm respectively. The soil texture of the control area for the species is loam-clay, and the amount of lime, EC and pH are 9.27%, 0.39 ds m^{-1} and 7.22 in order. The amount of phosphorus and potassium are 12.9 and 11.86 ppm respectively (Table 4).

4. Discussion and Conclusion

The comparison of existing inorganic matter in plant aerial parts and litter with underbush soil of the species showed that the amount of nitrogen, Potassium, organic matter and C/N ratio in litter and aerial organs in three species are higher than underbush soil, but the amount of phosphorus in underbush soil is higher than litter and plant aerial parts. This result corresponds with the findings of Hajibagloo (2006). Hanteh (2002) showed that the amounts of soil potassium and phosphorus are raised as a result of adding plant aerial parts to underbush soil.

The amount of existing nitrogen in litter and plant aerial parts of the three species is higher than underbush soil. This means decomposition process has begun recently and therefore the elements did not return to the soil, and also the elements do not resist leaching and then lost easily.

Contrary to nitrogen and potassium, Phosphorus is resistant against leaching and it is not lost rapidly. Also because of difficulty of phosphorus absorption by plant species by comparison of other elements, amount of phosphorus becomes higher in soil rather than litter and aerial organs. The amount of potassium is only higher in underbush soil of *A. tauri* species. The amount of potassium of underbush soil and soil of the control area showed a significant difference so that underbush soil had the higher amount of potassium. Alexander (1977) stated that because of lack of potassium in making of structural compound of litter, it is washed rapidly by physical process and its dynamic does not depend on biological activities.

Table 4. T- independent test between soil characteristics in underbush and control sites

		P. fragilis		*A. tauri*		*B. tomentellus*	
Properties		Mean	Sig	Mean	sig	Mean	Sig
pH	underbush	7.18	**	6.7	ns	7	ns
	control area	7.2		7.2		7.05	
EC(ds m^{-1})	underbush	0.78	**	0.6	ns	0.66	**
	control area	0.41		0.39		0.6	
N (%)	underbush	0.11	**	0.24	ns	0.19	**
	control area	0.07		0.09		0.14	
P (ppm)	underbush	16	**	20.6	ns	18.7	ns
	control area	14.2		12.9		16	
K (ppm)	underbush	14.3	**	19.5	ns	13.83	**
	control area	7.4		11.8		14.3	
C (%)	underbush	1.57	**	2/3	ns	2.3	**
	control area	0.68		1.38		1.6	
C/N	underbush	14.5	ns	15.19	**	21.2	**
	control area	10.11		13.2		11.6	
Lime (%)	underbush	14.79	**	5.26	ns	7.2	**
	control area	7.81		9.27		8.6	
Sand (%)	underbush	53.8	ns	23.43	ns	46.8	ns
	control area	54.1		23.05		46.3	
Clay (%)	underbush	26.2	ns	44.83	ns	34.7	ns
	control area	25.7		46.45		37.2	
Silt (%)	underbush	15.5	ns	32	**	18.5	ns
	control area	18.75		31		25.6	

The results of the current study show that the presence of *A. tauri* and *P. fragilis* causes to improve soil productivity of underbush soil rather than control area. This improvement can be considered because of adding of their aerial organs and as a result of intensifying activities of microorganisms. The results of current study correspond with the findings of khalkhali (1997), Halvarson (1997), Rumbark *et al.* (1982) and Chalak Haghighi (2000).

C/N ratio is the important factor that influences soil productivity. By measuring this index in litter and soil, it can be elicited good results. Azar (1977) stated when C/N ratio is low; plants have better litter quality for soil productivity. Results indicated that *A. tauri* has less C/N ratio than other species and also this species has high amount of nitrogen in its litter.

Totally it can be concluded that *A. tauri* species is a suitable plant for influence on soil quality indices and it can be used for reclamation and development projects in the area.

References

Alexander, M. (1977) Soil Microbiology, 2nd ed. John Wiley and Sons. New York. pp. 467.

Azar, A. (1977). Investigation on plant sociology of Sefid koh protected area. J. Natural, Res; VOL54, No. p: 423-440, (In Persian).

Chalak Haghighi, S.M (2000). Investigation on some effects of *Atriplex lentiformis* on soil and plant cover (case study: Phars province). MSc thesis in range management, Natural Resources Faculty, University of Tehran.

Couteaux MM, Bottner P, Berg B (1995) Litter decomposition, climate and litter quality. *Trends in Ecology and Evolution* 10, 63–66.

Franck M, Bruce A, Stuart F, Chistopher B (1997) Decomposition of litter produced under elevated co_2 dependence on plant species and nutrient supply. *J. Biogeochemistry* 36: 223-237.

Hajibagloo N (2006) Litter quality of some plants in Taleghan rangelands. MSc thesis in range management, Natural Resources Faculty, University of Tehran.

Halvarson, B., (1997). Plant as soil indicators along the Saudi coast of the Arabian Gulf, Journal of Arid Environment, 199: 261-266.

Hanteh A (2002) Investigation of *Atriplex canasens* cultivation effects on native vegetation and soil. Ph.D. thesis in range management, Natural Resources Faculty, University of Tehran.

Heal OW, Anderson JM, Swift MJ (1997) Plant litter quality and decomposition: an historical overview. In: Cadisch, G., Giller, K.E. (Eds.), Driven by Nature: Plant Litter Quality and Decomposition, CAB International, Wallingford, pp. 3–45.

Jafari M, Rahim Zadeh N (2004) The project report of C/N ratio in some rangeland species, Natural Resources Faculty, University of Tehran.

Khalkhali, A., Minaei,P. 1997. Decomposition of dominant plant species litter in semi arid grassland. J. Soil Ecology. 23: 13- 23.

Lupwayi NZ, Haque I (1998) Mineralization of N, P, K, Ca, and Mg from *Sesbania* and *Leucaena* leaves varying in chemical composition. *J. Soil Biol. Biochem.* 30: 337-343.

Madritch MD, Mark DH (2004) Phentypic diversity and litter chemistry affect nutrient dynamics during litter. Decomposition in a two species mix. OIKOS 105: 125 – 131.

Melillo, J.M. Naiman, R.J. Aber, J.D. and Linkins, A.E. (1984). Factors conrolling mass loss and nitrogen dynamics of plant litter decaying in northern streams. Bull. Marine Sci. 35:341-356.

Paustina S.B., J.E. Herrick, Wander M.M. & S.F. Wright. (1977). Spatial heterogeneity of aggregate stability and soil carbon in semi-arid rangelands. Environmental Pollution, 116:445-455.

Raeisi F, Mohammadi J, Assadi A (2003) The relationship between litter quality of range species with carbon dynamic in Sabzkuh rangelands, 2nd national conference of Iranian Range and Range Management, pp. 280-291.

Rowland, J.L. and Plam, S.W. (1997). Changes in soil nutrient status resulting from over grazing and their consequences in plant communities of semi-arid areas. Ecol.Soc. Aust. Proc. 3:38-49.

Rumbark, K. Agren, G.I. and Bosatta, E. (1982). Modelling litter quality effects on decomposation and soil organic matter dynamics. In: Cadish G. and Giller, K.E.(eds.) Driven by Nature: Plant Litter Quality for Decomposition . pp.313-335.

Throop L, Holland A, Parton J (2004) Effect Of nitrogen deposition and insert herbivory on pattern of ecosystem – level carbon and nitrogen ynamics: results from the CENTURYmodel.*Global Change Biology*. 10: 1092 –1105.

Wedin DA (1995) Species, nitrogen, and grassland dynamics: the constraint of stuff. In: Jones, C.G., Lawton, L.H. (Eds.), Linking Species and Ecosystems. Chapman & Hall, New York, pp. 253–262.

Wedin DA, (1999) Nitrogen availability, plant–soil feedbacks and grassland stability. In: Eldridge, D., Freudenberger, D. (Eds.), Proceedings of the VI International Rangeland Congress on People and Rangelands Building the Future. Townsville, Australia, pp. 193–197.