Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

June 2018, Volume 31, Issue 1, Page 214-219

Soil characteristics under the canopy of temperate forest tree species

Monika Rawat[1*] • Kusum Arunachalam[1] • Ayyanadar Arunachalam[2]

[1]School of Environment and Natural Resources, Doon University, Dehradun 248001

[2]Indian Council of Agricultural Research, Krishi Bhawan, New Delhi 110001

ARTICLE INFO

Article history:
Received 20 November 2017
Revision Received 12 February 2018
Accepted 13 April 2018

Key words:
carbon, nitrogen, soil, tree diversity, temperate forest

ABSTRACT

The present study was undertaken to understand the influence of tree species on soil properties in their rhizosphere zone. Ten tree species were selected based on their importance value indices from a temperate forest. Amongst all, the species that influenced the soil characteristics was mostly the evergreen broad-leaved angiospermic tree *Rhododenderon arboreum.* This species showed a greater influence on the soil properties such as moisture content, organic carbon, total nitrogen and microbial biomass carbon. Further, the leaf habitat differences between the angiosperms and gymnosperms did have difference influence on the soil nutrients properties in the temperate forest ecosystem.

1. Introduction

Forest growth and development is dependent on soil characteristics and therefore plant-soil have a complex inter-relationship (Bohlen Patrick J. *et al.,* 2001; Vivanco and Austin, 2008). The vegetation influences the soil characteristics *i.e.* consumption of nutrients by different tree species and their capacity to return back to the soil bring changes in soil properties (Augusto *et al.,* 2002). Concentration of nutrients in soil is a good indicator of plant growth and reproduction and the presence of nutrients give information about nutrient cycling in plant-soil interaction (Ordoñez *et al.,* 2009). At the same time, forest species have a great influence on soil properties due to its well-developed horizons (Lal, 2005). Each tree species differ in their way to influence and contribute soil properties as well as soil fertility (John *et al.,* 2007). Therefore it is important to determine the contribution of each species to understand plant-soil interaction in a forest ecosystem. Although a few studies report soil properties of a temperate forest ecosystem in the Indian Himalayan region (Sheikh *et al.,* 2009; Sharma *et al.,* 2011), it does not delineate the differential influence of tree species on soil properties. This study determined the soil properties under the canopy of dominant tree species in a temperate forest ecosystem in order to enhance our understanding on the role of dominant tree species in conserving soil nutrients and ecosystem functioning.

2. Material and Methods

The present study was conducted in Mussorie forest division (30° 28'02.6'' N latitude and 78° 05' 47.9'' E longitude) which comprises of high biological diversity of temperate forest species. The selected site is located at 2200 m asl. Soils of the region are leptosols, regosols and cambisols developed mostly on dolomite (Raina and Gupta, 2009). The composition of the forest was analyzed using nested quadrat method. Trees were analyzed by 10m x 10m quadrats as proposed by (Curtis and McIntosh, 1950).

---

*Corresponding author: monikapft@gmail.com

The dominant tree species selected for the study were evergreen - *Abies pindrow* Spach Ham (AP), *Cedrus deodara* Loud (CD), *Cupressus torulosa* D. Don (CT), *Pinus wallichiana* Jackson (PW), *Euonymus pendulous* Wall (EP) *Quercus leucotrichophora* A. Comm (QL) and *Rhododendron arboretum* Smith (RA), and deciduous ones were *Aesculus indica* Colebr (AI) *Pyrus pashia* Buch.Hemex D. Don (PP) and *Toona ciliata* R. (TC). Soil samples were collected from two different depths 0-15 cm and 15-30 cm for assessing the physico-chemical and biological properties of soil under the canopy of the chosen dominant tree species. The composite soil sample of each of the species was divided equally into two parts; one part was immediately (within 24 h) sieved (2 mm mesh screen) and analyzed for pH (digital pH meter), moisture content (gravimetric method), ammonium-N (Kjeldahl method) and available P (molybdenum blue method). The other part of the soil was sieved through 2 mm mesh screen, air dried under laboratory conditions, and were determined for texture (Boyoucous hydrometric method), water holding capacity (Keen's box method). The remaining air-dried soil samples were again sieved through 0.5 mm mesh screen and used for analysis of soil organic carbon and total nitrogen. All standard procedures were followed for soil analysis (Anderson and Ingram, 1994).

Microbial C and N were estimated by chloroform fumigation-extraction method (Anderson and Ingram, 1994) using two sets of treatment (chloroform fumigated and unfumigated) and extracted in 0.5 N K_2SO_4 and simultaneously digested and titrated against ferrous ammonium sulfate using 1,10 phenanthroline monohydrate as the indicator and N/140 HCl using boric acid indicator, respectively. While, microbial P was estimated by chloroform fumigation extraction technique (Anderson and Ingram, 1994) using 0.5 N $NaHCO_3$ (Brookes *et al.,* 1984). In all cases, the values of unfumigated samples were subtracted from fumigated one to get the values for microbial C, N and P.

3. Results

The soil pH varied from acidic to neutral (5.87–7.68) and the values ranged 1.01-1.51g/cm^{-3} for the bulk density, 40.11-65.44 % for water holding capacity and soil moisture (20.46-32.23 %). Soil moisture was greater under the evergreen angiospermic species *i.e. Rhodenderon arboreum* and lowest under the canopy of gymnosperm - *Cedrus deodara* (Table 1). Soil organic carbon was highest for *Rhodenderon arboreum* and lowest for decidous *Pyrus pashia* whereas, the total carbon in the soil was highest for the gymnospermic species *Cupressus torulosa*. The available nitrogen was high for gymnospermic species *Cupressus torulosa,* whereas the total nitrogen was high for angiospermic *Rhodenderon arboreum*. Similarly, available P level in the soil was highest (247.96 µg g^{-1}) in evergreen, gymnospermic *Abies pindrow*, while the minimum value was recorded in deciduous, angiopsermic *Pyrus Pashia*. C/N ratio was high for angiospermic, deciduous species *i.e.* for *Aesculus indica.* The soil microbial biomass C and N was greater in the soils under gymnosperms *Cedrus deodara* and *Pinus wallichiana,* while microbial P were greater for angiospermic *Toona ciliata* species (75.80 µg g^{-1} and 23.78 µg g^{-1}). The MBC/MBN and MBN/MBP were also higher for the gymnosperms *Cedrus deodara* and *Cupressus torulosa*. The contribution of microbial C to soil organic carbon (SOC) and microbial N to total soil nitrogen (TN) was greater under evergreen tree species *Rhodenderon arboreum* and *Quercus leucotricophora*, while the contribution of microbial P to total P in the soil was maximum under the canopy of deciduous *Toona ciliata* (Table 2).

4. Discussion

Temperate forest of Himalaya characterized mainly of *Abies pindrow*, *Aesculus indica, Cedrus deodara*, *Cupressus torulosa*, *Pyrus pashia, Pinus wallichiana*, *Quercus leucotrichophora,* and *Rhododendron arboretum* tree species. These species can be categorized under two groups either evergreen or deciduous or angiosperms and gymnosperms. Soils under the canopy of these tree species were influencing the nutrient cycling and contributing towards forest ecosystem and processes (Sharma *et al.,* 2010). The soil moisture and organic carbon was high under the canopy of evergreen angiospermic species *Rhododenderon arboretum*, whereas the available nitrogen and total nitrogen was higher under *Cupressus torulosa* and *Rhododenderon arboreum*. Available phosphorous and total phosphorous were high *Abies pindrow* and *Rhododenderon arboreum*. Thus, it could be predicted that the evergreen angiospermic and gymnospermic species influencing the soil nutrients more and the species which was influencing the most was *Rhododenderon arboreum* due mainly to its morphological and physiological features (Bai *et al.*, 2015), as it has high ability to store water and nutrient content (Augusto *et al.,* 2015; Chauhan *et al.,* 2017). The C/N ratio was higher in case of the deciduous species *Aesculus indica* and this indicates greater accumulation of biomass in deciduous species that has been reported to grow in limiting nitrogen condition. Therefore from these results, it was identified that the soil organic carbon, total nitrogen and available phosphorous was greater under the canopy of evergreen trees as compared to deciduous species and this may be due to high moisture retention under the canopy of evergreen species.

The contribution of microbial biomass C and N to soil nutrient pool was governed by evergreen species while, microbial P was influenced by deciduous species (Arunachalam and Pandey, 2003). The species contribution of microbial biomass to soil nutrient pool was in the following order: Microbial C to SOC: *Rhododenderon arboreum* > *Pyrus pashia* > *Cedrus deodara*; Microbial N to TN: *Quercus leucotricophora* > *Toona ciliata* > *Aesculus indica*; and Microbial to P: *Toona Cilata* > *Cedrus deodara* > *Aesculus indica.* These trends indicated that the contribution of microbial biomass to the soil nutrient pool (C, N and P) was mutually contributing in the soils by both evergreen and deciduous species (Kharkwal *et al.,* 2005) that would help conservation of these elements vis-a`-vis support the growth of these plants (Vivanco and Austin, 2008; Walthert and Meier, 2017; Zheng Xiaofeng *et al.,* 2017). The microbial biomass C and N was high for gymnosperms, whereas microbial P was high for angiospermic species *Toona ciliata*. Greater microbial ratios *i.e.* MBC/MBN and MBN/MBP in the rhizosphere soils of gymnosperms (Barbhuiya *et al.,* 2004) may be attributed to their morphological and physiological functioning (Lusk *et al.,* 2012)

It could be concluded that the species, its leaf habit (evergreen /deciduous) and its flowering and non-flowering features *i.e.* angiosperms and gymnosperms composition influence the soil nutrients and microbial biomass properties in the temperate forest. The species which influences these properties the most is *Rhododenderon arboreum* which is an evergreen broad-leaved angiospermic plant. This species influencing the more due to its greater storage of soil moisture, organic carbon, total nitrogen and microbial biomass carbon in the soil of temperate forest. Further, *Rhododendron arboreum* is known for its ecological indication of a tree line in a mountain landscape. Hence, it is important that the tree influence on the soil properties, both physio-chemical and biological, are determined to elucidate their differential role in ecosystem functioning.

Acknowledgement

The author thank the Uttrakhand Forest Department for research permission. The Department of Science and Technology (DST), Government of India awarded INSPIRE Fellowship to the first author.

References

Arunachalam A., and H.N. Pandey (2003). Ecosystem restoration of Jhum fallows in Northeast India: microbial C and N along altitudinal and successional gradients. *Restoration Ecology* 11, 168–173.

Augusto L., Ranger J, Binkley D, and A. Rothe (2002). Impact of several common tree species of European temperate forests on soil fertility. *Annals of Forest Science* 59: 233–253. https://doi.org/10.1051/ forest:2002020

Augusto L., Schrijver A.D, Vesterdal L, Smolander A, Prescott C, and J. Ranger (2015). Influences of evergreen gymnosperm and deciduous angiosperm tree species on the functioning of temperate and boreal forests. *Biological Reviews* 90: 444–466. https://doi.org/10.1111/brv.12119

Bai K., He C, Wan X, and D. Jiang (2015). Leaf economics of evergreen and deciduous tree species along an elevational gradient in a subtropical mountain. AoB Plants 7. https://doi.org/10. 1093/aobpla /plv064

Barbhuiya A.R., Arunachalam A, Pandey H.N, Arunachalam K, Khan M.L, and P.C. Nath (2004). Dynamics of soil microbial biomass C, N and P in disturbed and undisturbed stands of a tropical wet-evergreen forest. *European J Soil Biol* 40: 113–121. https://doi.org/10.1016/j. ejsobi. 2005.02.003

Bohlen Patrick J., Groffman Peter M, Driscoll Charles T, Fahey Timothy J, and G. Siccama Thomas (2001). Plant–soil–microbial interactions in a northern hardwood forest. *Ecology* 82: 965–978. https://doi.org/10.1890/0012-9658(2001)082[0965 :PSMIIA]2.0.CO;2

Brookes P.C., Powlson D.S, and D.S. Jenkinson (1984). Phosphorus in the soil microbial biomass. S*oil Biology and Biochemistry* 16: 169–175. https://doi.org/10.1016/0038-0717(84)90108-1

Chauhan D.S., Lal P, and D. Singh (2017). Composition, Population Structure and Regeneration of Rhododendron arboreum Sm. Temperate Broad-Leaved Evergreen Forest in Garhwal Himalaya, Uttarakhand, India. *J Earth Sci & Clim Change* 8. https://doi.org/10.4172/2157-7617.1000430

Curtis J.T., and R.P. McIntosh (1950). The Interrelations of Certain Analytic and Synthetic Ph*ytosociological Characters. Ecology* 31: 434–455. https://doi.org /10.2307/1931497

John R., Dalling J.W, Harms K.E, Yavitt J.B, Stallard R.F, Mirabello M, Hubbell S.P, Valencia R, Navarrete H, Vallejo M, and R.B. Foster (2007). Soil nutrients influence spatial distributions of tropical tree species. *Proceedings if National Academy of Sciences* 104: 864–869. https://doi. org/10.1073/pnas.0604666104

Kharkwal G., Mehrotra P, Rawat Y.S, and Y.P.S. Pangtey (2005). Phytodiversity and growth form in relation to altitudinal gradient in the Central Himalayan (Kumaun) region of India. *Current Science* 89: 873–878.

Lal R., (2005). Forest soils and carbon sequestration. Forest Ecology and Management, Forest Soils Research: Theory, *Reality and its Role in Technology* 220: 242–258. https://doi.org/10. 1016/j.foreco.2005.08.015

Lusk C.H., Pérez-Millaqueo M.M, Saldaña A, Burns B.R, Laughlin D.C, and D.S. Falster (2012). Seedlings of temperate rainforest conifer and angiosperm trees differ in leaf area display. *Annals of Botany* 110: 177–188. https://doi. org/10.1093 /aob /mcs095

M. Anderson J., and J. Ingram (1994). Tropical Soil Biology and Fertility: A Handbook of Methods. *Soil Science* 157: 265. https://doi.org/10.2307 /2261129

Ordoñez J.C., Bodegom P.M.V, Witte J.-P.M, Wright I.J, Reich P.B, and R. Aerts (2009). A global study of relationships between leaf traits, climate and soil measures of nutrient fertility. *Global Ecology and Biogeography* 18: 137–149. https://doi. org/10.1111/j.1466-8238.2008.00 441x

Raina A.K., and M.K. Gupta (2009). Soil characteristics in relation to vegetation and parent material under different forest covers in Kempty forest range, Uttarakhand. *Indian Forester* 135: 331–341.

Sharma C.M., Baduni N.P, Gairola S, Ghildiyal S.K, and S. Suyal (2010). Effects of slope aspects on forest compositions, community structures and soil properties in natural temperate forests of Garhwal Himalaya. *J For Res* 21: 331–337. https://doi.org/10.1007/s11676-010-0079-y

Sharma C.M., Gairola S, Baduni N.P, Ghildiyal S.K, and S. Suyal (2011). Variation in carbon stocks on different slope aspects in seven major forest types of temperate region of Garhwal Himalaya*,* India. *J Biosci* 36: 701–708. https://doi. org/ 10.1007/s 12038-011-9103-4

Sheikh M.A., Kumar M, and R.W. Bussmann (2009). Altitudinal variation in soil organic carbon stock in coniferous subtropical and broadleaf temperate forests in Garhwal Himalaya. *Carbon Balance and Management* 4: 6. https://doi.org/10.1186/1750-0680-4-6

Vivanco L., and A.T. Austin (2008). Tree species identity alters forest litter decomposition through long-term plant and soil interactions in Patagonia, *Argentina. J Ecol* 96: 727–736. https://doi.org /10.1111/j.1365-2745.2008. 0139 3.x

Walthert L., and E.S. Meier (2017). Tree species distribution in temperate forests is more influenced by soil than by climate. *Ecology and Evolutions* 7: 9473–9484. https://doi.org/10.1002/ece3.3436

Zheng Xiaofeng, Wei Xin, and Zhang Shuoxin, (2017). Tree species diversity and identity effects on soil properties in the Huoditang area of the Qinling Mountains, China. *Ecosphere* 8: e01732. https://doi. org/10.1002/ecs2.1732

Table 1. Physical and chemical properties of soil under tree canopy of temperate species

Soil properties	**Depth (cm)**	**AP**	**AI**	**CD**	**CT**	**EP**	**PW**	**PP**	**QL**	**RA**	**TC**
Soil Texture		Sandy loam	Sandy clay loam	Sandy loam	Sandy loam	Sandy clay loam	Sandy loam	Sandy clay loam	Sandy clay loam	Sandy clay loam	Sandy clay loam
pH	**0-15**	7.26 ± 0.04	6.97 ± 0.06	6.08± 0.09	7.15± 0.06	6.92 ± 0.08	6.17 ± 0.08	6.13 ± 0.07	6.26± 0.07	5.87 ± 0.13	6.70 ± 0.22
	15 - 30	7.31 ± 0.04	6.66 ± 0.11	6.47± 0.10	7.30 ± 0.11	6.93± 0.10	6.12 ± 0.05	6.18± 0.09	6.05± 0.04	6.24 ± 0.05	7.68± 0.06
Bulk Density (g/cm^{-3})	**0-15**	1.31± 0.00	1.21± 0.02	1.33± 0.10	1.33± 0.00	1.23± 0.33	1.22± 0.12	1.11± 0.00	1.11± 0.02	1.32± 0.01	1.51± 0.22
	15 - 30	1.32± 0.01	1.2± 0.02	1.11± 0.09	1.29± 0.00	1.33± 0.10	1.52± 0.11	1.23± 0.00	1.01± 0.01	1.33± 0.00	1.5± 0.00
Water Holding Capacity (%)	**0-15**	54.23± 0.11	44.32± 0.00	52.12± 0.10	53.45± 1.22	54.56± 0.10	43.22± 0.23	52.11± 0.99	64.55± 1.33	65.44± 1.23	40.11± 0.11
	15 - 30	52.11± 0.00	40.11± 0.01	50.23± 0.12	54.11± 1.11	52.11± 0.22	41.22± 0.11	52.11± 1.22	60.22± 1.45	62.21± 1.00	38.00± 0.99
Soil Moisture (%)	**0-15**	27.86± 2.17	28.70± 2.20	23.23±3.35	29.67± 2.14	31.14± 1.89	27.66± 2.15	24.57± 2.13	30.13±1.91	32.23± 2.42	27.93± 2.07
	15 - 30	30.76±18.05	24.60±13.72	20.46± 8.26	27.24±15.73	29.95 ±13.42	24.62 ± 9.03	24.86 ± 11.44	28.42 ±11.35	31.65 ±15.11	30.35 ±10.75
Soil Organic Carbon (%)	**0-15**	2.76± 0.08	2.32± 0.01	2.59± 0.07	2.83± 0.07	2.56± 0.06	2.43± 0.06	2.49± 0.05	3.10± 0.08	2.25± 0.03	2.05± 0.07
	15 - 30	2.33 ± 0.11	2.35± 0.09	2.07± 0.05	2.67± 0.09	2.45± 0.04	2.24± 0.04	1.57± 0.05	2.69± 0.10	2.06± 0.05	2.61± 0.08
Total Carbon (%)	**0-15**	9.10± 0.75	12.29± 1.49	11.44± 0.83	21.04± 1.63	10.02± 0.56	5.54± 0.29	10.28± 0.13	9.19± 0.82	9.44± 0.65	9.83± 1.35
	15 - 30	11.28± 1.21	12.53± 0.99	7.88± 0.20	20.11± 2.16	10.53± 0.68	8.21± 0.52	6.87± 0.17	10.16± 0.27	21.02± 2.54	11.44± 1.40
Available Nitrogen (µg g^{-1})	**0-15**	49.12± 8.07	52.72± 8.80	50.23± 6.51	65.65± 8.25	64.06± 6.56	44.73± 7.38	55.50± 5.60	54.88± 7.67	54.13± 4.82	40.73± 8.90
	15 - 30	46.70± 8.13	56.12± 8.85	40.19±7.47	64.01± 8.02	57.53± 7.47	59.38±7.36	56.10±9.48	59.91±7.06	57.24± 6.28	50.26± 6.39
Total Nitrogen (%)	**0-15**	0.81± 0.05	0.71± 0.06	0.86± 0.05	2.02± 0.33	0.82± 0.06	0.74± 0.06	0.85± 0.08	0.71± 0.07	0.80± 0.05	0.66± 0.04
	15 - 30	0.79± 0.07	0.84± 0.06	0.84± 0.06	1.82± 0.30	0.86± 0.07	0.91± 0.11	0.64± 0.05	0.82± 0.06	2.64± 0.50	0.81± 0.06
Available Phosphorous (µg g^{-1})	**0-15**	247.96± 49.17	159.97± 26.43	193.72 ± 42.98	156.99 ± 25.64	162.03 ± 30.57	229.65 ± 45.48	179.67 ± 37.05	216.33 ± 51.54	124.49 ± 29.27	187.61 ± 33.75
	15 - 30	190.80± 42.27	173.53± 30.35	219.92 ± 55.60	172.34 ± 30.25	177.25 ± 40.27	243.10 ± 50.59	120.51 ± 23.10	163.37 ± 34.00	141.16 ± 29.13	193.61 ± 34.77
Total Phosphorous (%)	**0-15**	0.15± 0.02	0.19± 0.03	0.23± 0.02	0.14± 0.02	0.19± 0.04	0.16± 0.02	0.49± 0.13	5.28± 2.10	4.20± 1.63	0.23± 0.03
	15 - 30	0.24± 0.03	0.20± 0.03	0.23± 0.02	0.13± 0.02	0.19± 0.04	0.17± 0.02	0.50± 0.14	3.97±1.54	4.13±1.60	0.25 ± 0.03
C/N	**0-15**	11.30	17.26	13.35	10.42	12.27	7.53	12.02	13.02	11.86	14.80
	15 - 30	14.36	14.90	9.42	11.05	12.20	9.00	10.70	12.32	7.9	14.09
C/P	**0-15**	61.39	66.06	50.78	150.56	53.94	33.80	21.14	1.74	2.25	42.10
	15 - 30	46.48	61.25	34.66	154.70	55.13	48.68	13.76	2.56	5.10	46.20

± SE (n = 5)

Table 2. Microbial biomass under the tree canopy of temperate species

	Depth (cm)	**AP**	**AI**	**CD**	**CT**	**EP**	**PW**	**PP**	**QL**	**RA**	**TC**
Microbial Biomass C (μg g^{-1})	**0-15**	1893.27 ± 292.61	1347.28 ± 47.50	2242.16 ±307.84	1719.22 ±205.25	1814.50 ±146.11	1833.90 ±371.24	1323.89 ± 21.32	2038.20 ±210.96	1578.83 ±220.62	1153.28 ± 79.28
	15 - 30	1813.22 ± 127.51	1704.00 ±162.91	1505.56 ±125.47	1643.22 ±160.71	1149.40 ±90.88	1347.96 ±240.65	1428.00 ±138.10	2002.56 ±343.04	2037.97 ±260.49	1598.67 ±298.11
Microbial Biomass N (μg g^{-1})	**0-15**	48.04 ± 5.53	63.03 ± 6.39	28.94 ± 2.10	62.11 ± 6.37	58.27 ± 8.84	50.05 ± 6.61	65.28 ±7.98	71.40 ± 11.94	42.84 ± 5.96	63.17 ± 7.47
	15 - 30	53.50 ± 8.86	36.96 ± 3.26	51.15 ± 8.00	65.03 ± 7.56	30.47 ± 3.70	75.81 ± 9.65	47.14 ± 7.56	44.02 ± 5.98	51.83 ± 7.18	66.26 ± 7.75
Microbial Biomass P (μg g^{-1})	**0-15**	4.61 ± 0.91	6.09 ± 1.20	7.86 ± 1.00	2.90 ± 0.32	2.84 ± 0.35	4.96 ± 0.89	4.85 ± 0.82	17.72 ± 2.39	3.34 ± 0.42	23.78 ± 4.99
	15 - 30	15.67 ± 1.97	9.43 ± 1.31	8.90 ± 1.79	2.18 ± 0.28	6.34 ± 1.24	3.28 ± 0.68	9.78 ± 1.28	14.51 ± 2.27	6.36 ± 0.85	5.65 ± 0.74
MBC/MBN	**0-15**	39.41	21.38	77.48	27.68	31.14	36.64	20.28	28.54	36.85	18.26
	15 - 30	33.89	46.11	29.43	25.27	37.72	17.78	30.29	45.49	39.32	24.13
MBN/MBP	**0-15**	10.41	10.34	3.68	21.45	20.50	10.09	13.45	4.03	12.82	2.66
	15 - 30	3.42	3.92	5.75	29.85	4.81	23.09	4.82	3.03	8.15	11.73
MBC to SOC (%)	**0-15**	6.85	5.81	8.67	6.07	7.09	7.53	5.32	6.57	7.03	5.64
	15 - 30	7.80	7.26	7.29	6.16	4.69	6.02	9.08	7.44	9.89	6.13
MBN to TN (%)	**0-15**	0.60	0.89	0.34	0.31	0.71	0.68	0.76	1.01	0.54	0.95
	15 - 30	0.68	0.44	0.61	0.36	0.35	0.83	0.73	0.53	0.20	0.82
MBP to P (%)	**0-15**	0.31	0.33	0.35	0.21	0.15	0.30	0.10	0.03	0.01	1.02
	15 - 30	0.65	0.46	0.39	0.17	0.33	0.19	0.20	0.04	0.02	0.23

± SE (n = 5)