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Investigation on Home-Field Advantage of *Prunus persica* L. Leaf Litter Decomposition in Monospecific and Multispecific Sites Based on Trees

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ABSTRACT: In terrestrial ecosystems C and nutrient cycling are performed by litter decomposition and this is very important for sustainability of ecosystems. Home-field advantage hypothesis suggests faster decomposition of litter in its home location from where it was derived. The aim of the current study was to examine home-field advantage of *Prunus persica* leaf litter decomposition in monospecific and multispecific sites based on trees, *Prunus persica* L., *Prunus persica* and *Prunus avium* L. mixture, and *Prunus avium*, *Ficus carica* L. and *Cydonia oblonga* Mill. mixture. Litter bag technique was used in order to examine decomposition. Decomposition was examined for three months (about 90 days). Decomposition parameters varied among months while they didn't significantly differed among study sites in all months. Similarly, when whole data was examined after three months, it was determined that decomposition parameters didn't significantly varied among study sites. But, the maximum decomposition rate was calculated in *Prunus avium*, *Ficus carica* and *Cydonia oblonga* litter mixture site. Any home-field advantage evidence didn't found. It was thought that home-field advantage is strongly related with litter quality and nutrient content in the study sites.

KEYWORDS: Decomposition, Home –field Advantage, Leaf, Litter, *Prunus persica*

I.INTRODUCTION

Litter decomposition is an important mechanism which performs C and nutrient cycling in terrestrial ecosystems. Because of its necessity for sustainability of ecosystems, various studies were carried out on litter decomposition. These studies mostly focused on effective ecological factors on litter decomposition process [1, 2, 3, 4], decomposition rate of plant species or ecosystems [5, 6, 7] and litter quality [8] etc.. However, some of the recent studies focused on home-field avantage hypothesis which suggests that due to presence of specialized decomposers, plant litter is decomposed faster in its own location or home than in a different location [9]. It is known that litter quality regulates decomposition and it determines function of decomposers [10]. Plant litter is used as food by soil organisms, so nutrient content of litter is important in formation of decomposer community. It is reported that N and P content in plant litter may determine the type of decomposers and thus decomposition rate because N and P requirements of bacteria and fungi are different [11]. For example, relative P requirement of fungi is less than that of bacteria. Fungi are generally dominant in difficultly decomposing organic material with low nutrient supply because of their less nutrient requirements and slower metabolism than bacteria [12]. Accordingly, litters of different species vary in physical and chemical features and this manage decomposer community and decomposition rate [13]. So, differences both in nutrient requirements of decomposers and nutrient content in plant litter may lead to home-field advantage. Rate of litter decomposition and effect of home-field advantage may vary according to litter diversity on the soil surface and stages of decomposition. Home-field advantage usually indicated in monospecific litters which transplanted the quite contrasting environments. But, studies that failed to detect a home-field advantage generally use more chemically similar litter species and diverse communities [14].

Although there are many studies about home-field advantage of litter decomposition, this hypothesis didn't understood and wasn't approved yet. Some of the studies indicated home-field advantage in litter decomposition [15, 16, 17] while others reported lack of home-field advantage [18, 19]. According to home-field advantage hyphotesis, decomposer community is specified to a specific plant litter and this provides fast decomposition in its home area. But, it is also

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strongly related with nutrient status of the litter layer [20]. In order to determine that the fast decomposition of plant litter in their home area whether resulted from specified decomposer community or nutrient supply of litter, more studies are required in different species and habitats.

The aim of the current study is to examine home-field advantage of decomposition in *Prunus persica* L. leaf litter by determining the differences in decomposition rate among pure *Prunus persica* litter, *Prunus persica* and *Prunus avium* L. litter mixture, and *Prunus avium*, *Ficus carica* L. and *Cydonia oblonga* Mill litter mixture.
Although there are numerous studies on litter decomposition in forests a few studies were carried out in orchards, where the nutrient supply and nutrient turnover have more importance because of agricultural activities and its economic significance such as fertilization or sustainability of orchards [21]. It was thought that results of the study may give important information about both decomposition of pure and mixture litters, and home-field effect. These results also provide fundamental data for ecological and agricultural studies.

II. MATERIAL AND METHODS

The study was conducted in Amasya in Middle Blacksea Region of Turkey. Senescent *P. persica* leaves were study materials and collected from a *P. persica* orchard in October 2015. Litter bag technique was used to examine the litter decomposition [22]. Collected senescent *P. persica* leaves were firstly air dried and then dried into drying oven at 75 °C until constant weight was reached. Litter bags were made from fibreglass net with 2 mm mesh as 20×20 cm in size [6]. Each litter bag enclosed 2.5 g of *P. persica* leaf litter. In order to determine the differences in decomposition rate between pure and mixture litter, litter bags were fastened two different sites. In first site, there were only *P. persica* trees (home site where *P. persica* leaf samples collected) and in the second site, there were both *P. persica* and *P. avium* trees. In order to examine the home-field advantage litter bags also fastened to another site in where there are *P. avium*, *F. carica* and *C. oblonga* trees. Three litter bags as repetition were done for each month and each treatment. All the litter bags were fastened by iron nails to the soil surface in October 2015. The decomposed litter bags were collected monthly for three months, November and December 2015, and January 2016. The collected litter bags were air-dried and then foreign materials were removed by washing with distilled water. Litter samples were dried at 75 °C until constant weight was reached. Remaining dry weights of leaf litter were determined monthly.

Remaining dry weights, % Mass loss, daily decomposition rate, litter decay coefficient (k, decomposition rate), litter decomposition half-life and time to decompose 95% dry weight were calculated as below [23].

$$\text{Mass Loss }(\%)=\frac{\text{Initial mass }-\text{Mass in t time}}{\text{Initial mass}}\times 100 \qquad (1)$$

$$Daily\ decomposition\ rate\ = Mass\ loss\ (\%)/Incubation\ time\ (in\ days) \qquad (2)$$

$$\frac{W}{W0}(\%) = e^{-kt} \qquad (3)$$

where W is the weight of litter at an elapsed t time, W_0 is the initial mass, t is the elapsed time (day) and k constant is the decomposition rate (day $^{-1}$).
Decomposition half-life was calculated as T_{50}=In(0.5)/k=0.693/k and time to decompose 95% dry weight calculated as T_{95}=3/k.

Variation in decomposition parameters among study sites and months were analyzed with one-way ANOVA. All the statistical analyses were done in SPSS version 20.

III. RESULTS AND DISCUSSION

Mean remaining dry weights, % mass loss, daily decomposition rate and k values were given according to months and study sites in Table 1.

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Table 1. Mean values of decomposition parameters and their differences among study sites and months. Small letters indicates differences in decomposition parameters among months

First Month	Trees in Study Site	Mean ± Std. Dev.	P
Remaining Mass (g)	*P. persica*	1.796 ± 0.055 a	0.792
	P. persica+P. avium	1.849 ± 0.312 a	
	P. avium+ F. carica + C. oblonga	1.740 ± 0.098 a	
Mass Loss (%)	*P. persica*	28.133 ± 2.275 a	0.777
	P. persica+P. avium	26.000 ± 12.477 a	
	P. avium+ F. carica + C. oblonga	30.533 ± 3.885 a	
Daily Decomposition Rate (g day^{-1})	*P. persica*	0.938 ± 0.076 a	0.777
	P. persica+P. avium	0.867 ± 0.416 a	
	P. avium+ F. carica + C. oblonga	1.018 ± 0.130 a	
k ($gg^{-1}day^{-1}$)	*P. persica*	0.011 ± 0.001 a	0.813
	P. persica+P. avium	0.010 ± 0.006 a	
	P. avium+ F. carica + C. oblonga	0.012 ± 0.002 a	
Second Month			
Remaining Mass (g)	*P. persica*	1.499 ± 0.033 b	0.670
	P. persica+P. avium	1.435 ± 0.098 ab	
	P. avium+ F. carica + C. oblonga	1.461 ± 0.108 b	
Mass Loss (%)	*P. persica*	16.428 ± 4.231 ab	0.855
	P. persica+P. avium	19.043 ± 11.994 a	
	P. avium+ F. carica + C. oblonga	15.773 ± 2.502 b	
Daily Decomposition Rate (g day^{-1})	*P. persica*	0.548 ± 0.141 ab	0.855
	P. persica+P. avium	0.635 ± 0.400 a	
	P. avium+ F. carica + C. oblonga	0.526 ± 0.083 b	
k ($gg^{-1}day^{-1}$)	*P. persica*	0.006 ± 0.002 b	0.808
	P. persica+P. avium	0.007 ± 0.005 a	
	P. avium+ F. carica + C. oblonga	0.006 ± 0.001 b	
Third month			
Remaining Mass (g)	*P. persica*	1.330 ± 0.131 b	0.291
	P. persica+P. avium	1.302 ± 0.043 b	
	P. avium+ F. carica + C. oblonga	1.221 ± 0.013 c	
Mass Loss (%)	*P. persica*	11.633 ± 7.128 b	0.568
	P. persica+P. avium	11.684 ± 4.907 a	
	P. avium+ F. carica + C. oblonga	16.358 ± 5.611 b	
Daily Decomposition Rate (g day^{-1})	*P. persica*	0.388 ± 0.238 b	0.568
	P. persica+P. avium	0.390 ± 0.164 a	
	P. avium+ F. carica + C. oblonga	0.545 ± 0.187 b	
k ($gg^{-1}day^{-1}$)	*P. persica*	0.004 ± 0.003 b	0.568
	P. persica+P. avium	0.004 ± 0.002 a	
	P. avium+ F. carica + C. oblonga	0.006 ± 0.002 b	

Analysis indicated that there were significant variations in all decomposition parameters for study sites of *P. persica* trees (1) and *P. persica* and *P. avium* trees (2), and only in remaining dry weight for study sites of *P. persica* and *P. avium* (2) among months. It is known that decomposition consists of several biological, chemical and physical processes [3, 24]. These are varied according to, litter type, ecological factors and decomposition stages. There are three basic processes in litter decomposition (1) leaching of litter by water, (2) fragmentation of litter into smaller sizes (3) chemical alteration [25, 26]. These processes strongly related with decomposition stages. These processes are also required decomposer activity and sufficient climatic factors such as precipitation. So, variation in decomposition

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parameters among months may be strongly related with different processes in decomposition stages. In early stage of decomposition, litter decay rate is very high and then it usually decreases proportionally according to decay processes.

In the current study, the fastest decomposition was determined in the first month and it supports above mentioned expression. Rates of decomposition also related with litter quality. Decomposition of lignin is very slow. So, litters with high lignin content generally decompose more slowly. Similar with results of the current study, Ventura et al. [21] reported greater decomposition rate for *P. persica* leaf litter in early phase. This attributed to leaching of soluble substances in litter.

There wasn't any statistically significant difference in decomposition parameters among study sites in all months (Table 1). However, the minimum and the maximum litter decay occurred in the study sites of *P. persica* and *P. avium* (Site 2), and *P. avium, F. carica* and *C. oblonga* trees (Site 3), in the first month, respectively. Additionally, the decomposition rates of litters were classified as "fast" [27, 28] However, Graça et al. [28] reported that when applied uncritically, classification of decomposition rate by Petersen & Cummins (1974, in streams) has limitations. The minimum and the maximum decomposition rates was determine in the study sites of *P. avium, F. carica* and *C. oblonga* trees (Site 3) and *P. persica* and *P. avium* trees (Site 2) in the second month, respectively.

The decomposition rates of litters in the second month were classified as "medium". In third month, while decomposition rates were similar in in the study sites of *P. persica* trees (Site 1), and *P. persica* and *P. avium* trees (Site 2), the maximum decomposition rate was in in the study site of *P. avium, F. carica* and *C. oblonga* trees (Site 3). Except Site 3 (medium), decomposition rates of litters were "slow".

Easy soluble substances especially in water rapidly leave from litter and move into the soil. This may explains fast litter decay in early phase of decomposition. In later phases, difficultly-degrade substances such as lignin remain in litter and thus decomposition rate get slower. The results of the study confirmed this process ones again.

When whole data were analyzed after 90 days, it was determined that there wasn't significant variation in decomposition parameters among study sites (Table 2). However, the fastest litter decay was determined in the study site of *P. avium, F. carica* and *C. oblonga* trees (3) and it was followed by the study sites of *P. persica* and *P. avium* trees (2) and *P. persica* trees (1) (Figure 1). k values calculated with whole data after 90 days indicated that *P. persica* leaf litter decompose slowly in all study sites according to Petersen & Cummins 1974.

Dissimilar with the current study, studies that determined positive interactions between litter and the environment of origin usually carried out with litters of one single species, highly contrasting litter qualities, in multi-species litter layer and environments dominated by single plant species [29]. Conversely, studies that reported lack of home-field advantage conducted with litters of similar quality and environments dominated by multi-species [29, 30]. These expressions fully support and explain the results of current study.

In order to distinguish differences that resulted from litter diversity, decomposition experiment were conducted in three different area with single tree species, two tree species and three tree species. Additionally, in the second area there were litters of two species belonging to same genus. So, litter qualities of these two species were approximately similar. According to results, decomposition rates of study sites of *P. persica* trees (Site 1) and *P. persica* and *P. avium* trees (Site 2) were similar. However, existence of *P. avium* in Site 2 a bit increased decomposition rate.

Again, it was found that increase in litter diversity based on number of species in the ecosystem may increase decomposition rate. It is strongly related with nutrient supply as food for decomposers. Litters with rich nutrient content attract decomposers and are suitable for both bacteria and fungi. The more decomposer activity, the faster litter decay.

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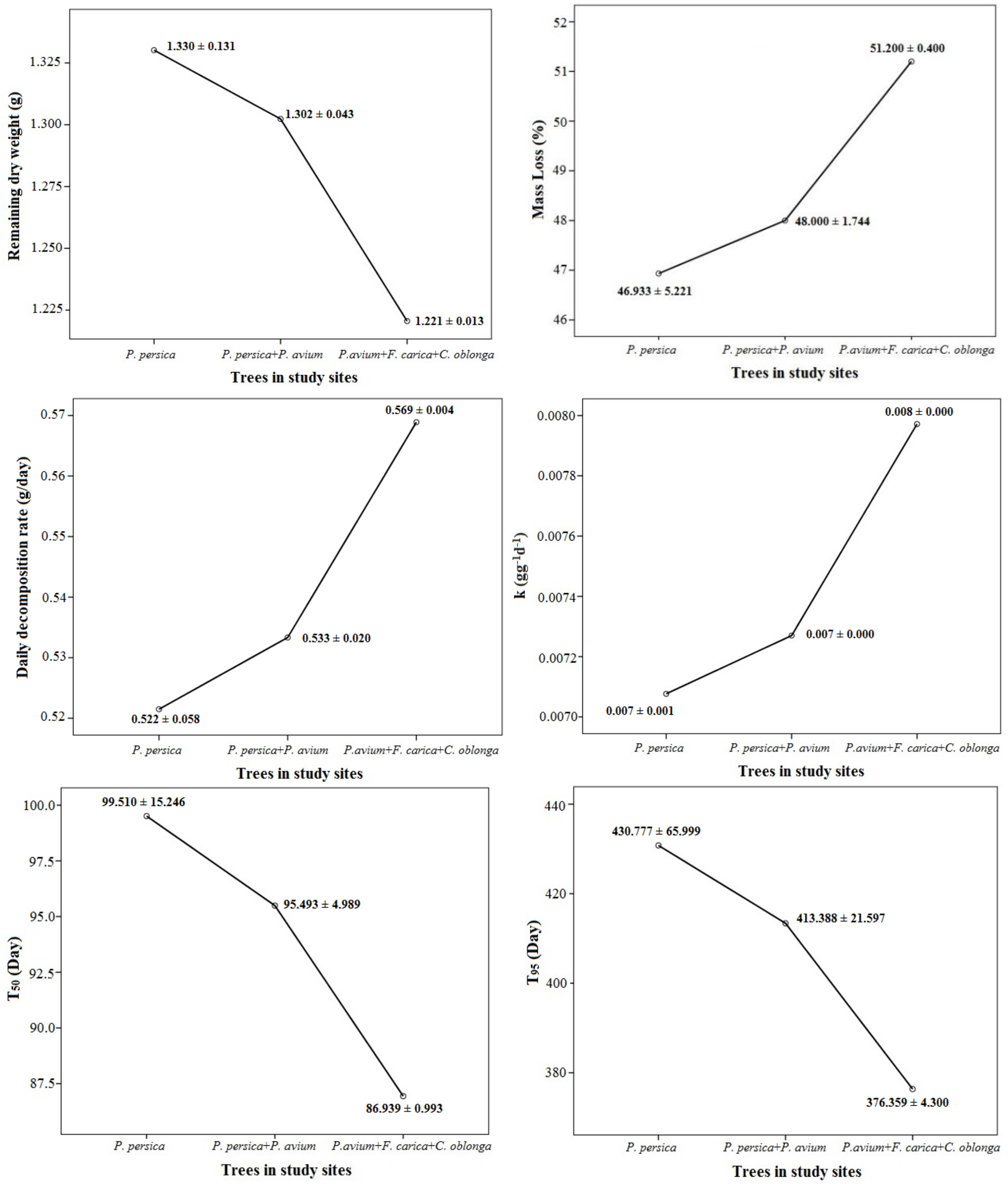

Figure 1. Variation in decomposition parameters among study sites by analysing whole data (after 90 days)

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Table 2. Differences in decomposition parameters among study sites after 90 days

	Sum of Squares	df	Mean Square	F	P
Remaining Mass (g)	0.019	2	0.010	1.528	0.291
Mass Loss (%)	29.582	2	14.791	1.457	0.305
Daily Decomposition Rate (g day^{-1})	0.004	2	0.002	1.457	0.305
k ($gg^{-1}day^{-1}$)	0.000	2	0.000	1.462	0.304
T_{95}	4634.871	2	2317.436	1.436	0.309
T_{50}	247.321	2	123.661	1.436	0.309

IV. CONCLUSION

According to results and literature home-field advantage hypothesis is still questionable and strongly context-dependent to litter quality and diversity. In order to determine and distinguish factors that affect home-field advantage of litter decomposition more studies in different environments with different plant species are required. For sustainability of ecosystems especially agricultural ecosystems, studies should focus these areas.

REFERENCES

[1]. Berg, B., "Decomposition of root litter and some factors regulating the process: long-term root litter decomposition in a Scots pine forest", Soil Biology and Biochemistry, Vol. 16(6), pp. 609-617, 1984.
[2]. Keiser, A.D., and Bradford, M.A., "Climate masks decomposer influence in a cross-site litter decomposition study", Soil Biology and Biochemistry, Vol. 107, pp. 180-187, 2017.
[3]. Karavin, N., Yalman, E., Kizir, Z., Kocamaz, A., and Kartal, B., "Variation in leaf litter decomposition rate according to salinity and water regime in *Juglans regia* L." International Journal of Advanced Research in Biological Sciences, Vol.3(2), pp.158-162, 2016.
[4]. Ma, Z., Yang, W., Wu, F., and Tan, B., "Effects of light intensity on litter decomposition in a subtropical region", Ecosphere, Vol. 8(4), pp. 1-13, 2017.
[5]. Austin, A.T., and Vivanco, L., "Plant litter decomposition in a semi-arid ecosystem controlled by photodegradation", Nature, Vol. 442(7102), 555-558, 2006.
[6]. Karavin, N., and Ural, Z., "Impact and Extent of Traffic-Based Pollution on N and P Use Proficiency and Litter Decomposition in *Malus domestica* Borkh", Water, Air, & Soil Pollution, Vol. 227(6), pp. 195, 2016.
[7]. Ge, J., Xie, Z., Xu, W., and Zhao, C., "Controls over leaf litter decomposition in a mixed evergreen and deciduous broad-leaved forest, Central China", Plant and Soil, Vol. 412(1-2), pp. 345-355, 2017.
[8]. Cornelissen, J.H., Pérez-Harguindeguy, N., Díaz, S., Grime, J.P., Marzano, B., Cabido, M., ... and Cerabolini, B., "Leaf structure and defence control litter decomposition rate across species and life forms in regional floras on two continents", The New Phytologist, Vol. 143(1), pp. 191-200, 1999.
[9]. Veen, G.F., Freschet, G.T., Ordonez, A. and Wardle, D.A., "Litter quality and environmental controls of home-field advantage effects on litter decomposition", Oikos, Vol. 124, pp. 187-195, 2015.
[10]. Austin, A.T., Vivanco, L., González-Arzac, A. and Pérez, L.I., "There's no place like home? An exploration of the mechanisms behind plant litter-decomposer affinity in terrestrial ecosystems" New Phytologist, Vol. 204(2), pp. 307-314, 2014.
[11]. Güsewell, S. and Gessner, M., "N:P rations influence litter decomposition and colonization by fungi and bacteria in microcosms", Functional Ecology, Vol. 23: pp. 211-219, 2009.
[12]. Cross, W.F., Benstead, J.P., Frost, P.C. and Thomas, S.A., "Ecological stoichiometry in freshwater benthic systems: recent progress and perspectives", Freshwater Biology, Vol. 50(11), pp. 1895-1912, 2005.
[13]. Wardle, D.A., Bonner, K.I. and Barker, G.M., "Linkages between plant litter decomposition, litter quality and vegetation responses to herbivores", Functional Ecology, Vol. 16: pp. 585-595, 2002.
[14]. Jewell, M.D., Shipley, B., Paquette, A., Messier, C. and Reich, P.B., "A traits-based test of the home-field advantage in mixed-species tree litter decomposition" Annals of Botany, Vol. 116(5), pp. 781-788, 2015.
[15]. Vivanco, L. and Austin, A.T., "Tree species identity alters forest litter decomposition through long-term plant and soil interactions in Patagonia, Argentina" Journal of Ecology, Vol. 96(4), pp. 727-736, 2008.
[16]. Ayres, E., Steltzer, H., Berg, S. and Wall, D.H., "Soil biota accelerates decomposition in high-elevation forests by specializing in the breakdown of litter produced by the plant species above them" Journal of Ecology, Vol. 97(5), pp. 901-912, 2009.
[17]. Wallenstein, M.D., Hess, A.M., Lewis, M.R., Steltzer, H. and Ayres, E., "Decomposition of aspen leaf litter results in unique metabolomes when decomposed under different tree species", Soil Biology and Biochemistry, Vol. 42(3), pp. 484-490, 2010.
[18]. John, M., Orwin., K. and Dickie, I., "No 'home' versus 'away' effects of decomposition found in a grassland-forest reciprocal litter transplant

study", Soil Biology and Biochemistry, Vol. 43, pp. 1482-1489 2011.
[19]. Perez, G., Aubert, M., Decaens, T., Trap, J. and Chauvat, M., "Home-field advantage: A matter of interaction between litter biochemistry and decomposer biota", Soil Biology & Biochemistry, Vol. 67, 245-254, 2013.
[20]. Wang, Q., Zhong, M. and He, T., "Home-field advantage of litter decomposition and nitrogen release in forest ecosystem" Biology and Fertility of Soils, Vol. 49, pp. 427-434, 2013.
[21]. Ventura, M., Scandellari, F., Bonora, E. Tagliavini, M., "Nutrient release during decomposition of leaf litter in a peach (*P. persica* L.) orchard", Nutrient Cycling In Agroecosystems, Vol. 87(1), pp. 115-125, 2010.
[22]. Weerakkody, J., Parkinson, D., "Leaf litter decomposition in an upper montane rainforest in Sri Lanka" Pedobiologia, Vol. 50(5), pp. 387-395, 2006.
[23]. Olson, J.S., "Energy stores and the balance of producer and decomposers in ecological system", Ecology, Vol. 44, pp. 322-331, 1963.
[24]. Berg, B. and McClaugherty, C., "Plant litter: decomposition, humus formation, carbon sequestration", SpringerVerlag, New York, 2008.
[25]. Chapin, F.S., Matson, P.A. and Mooney, H.A., "Principles of ecosystem ecology", Springer-Verlag, New York, 2002.
[26]. Kutsch, W.L., Bahn, M., Heinemeyer, A., "Soil carbon dynamics: an integrated methodology", Cambridge University Press, Cambridge, 2009.
[27]. Petersen, R.C. and Cummins, K.W., "Leaf processing in a woodland stream" Freshwater Biology, Vol. 4, pp. 343-368, 1974.
[28]. Graça, M.A., Bärlocher, F. and Gessner, M.O., (Eds.). "Methods to study litter decomposition: a practical guide" Springer Science & Business Media, 2005.
[29]. Freschet, G.T., Aerts, R. & Cornelissen, J.H., "Multiple mechanisms for trait effects on litter decomposition: moving beyond home-field advantage with a new hypothesis" Journal of Ecology, Vol. 100(3), pp. 619-630, 2012.
[30]. Chapman, S. and Koch, G., "What type of diversity yields synergy during mixed litter decomposition in a natural forest ecosystem?" Plant and Soil, Vol. 299, pp.153-162, 2007.