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Comparison of some soils physicochemical properties in mixed and monocultures to non - cultivation in Zagros forests (case study: Zagros forest, Iran)

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Abstract

Forest dynamic is controlled by some factors and process such as habitat conditions, species composition, and regeneration and disturbance events. Given to role of Zagros forests in soil and water conservation, the present research was aimed to evaluate edaphic properties of lands under mixed- and monoculture (cereals) system to non-cultivation in forest. Then, a short reconnaissance was conducted using global positioning system (GPS) to determine mixed and monoculture lands. In order to remove edge effects, a control site (non - cultivated in forest) was selected in a suitable distance taking physiographical factors (slope, aspect, sea level - above elevation)into account so that it was homogenized in respect to vegetation type, geology and so on compared to mixed and mono - cultured lands. Some statistical grids (1250×800 m²) were landed on study area digital maps using GIS (geographical information system). The number of fifteen rectangular 25×30 m plots was distributed in field by GPS. For every study site, soils samples were taken from depths 0-10, 10-20 cm and were transported to laboratory for analysis soil acidity by EC-meter, electrical conductivity by pH-meter, total calcium, organic carbon and matter according to titration method, soil texture by hydrometric method, phosphor by Olsen method, K by photometric film, soil moisture by weighting method, bulk density by coagulation and total nitrogen by Kejeldal one. Results showed that non-cultivated and mixed-cultured lands were superior to mono-cultured one in forest respectively. In respect to great contribution of Zagros forests in soil and water conservation, results obtained from the present research showed that any anthropological interference(such as planting native species) in this system, interrupts these forest natural balance. To conserve soil and water balance within such systems, mixed-culture of orchard species is more superior to mono-culturing (cereals).

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Introduction

Forests serve as one of the vital renewable resources and infrastructure for countries survival so that rapid changes and revolutions in them, has motivated humans to get more knowledge and awareness on its structure (Shokuhi 1992, Ejtehadi *et al*, 2004). The main prerequisite to maintain and sustainability of forest ecosystem is to get comprehensive knowledge on its structure and components (Roodi, 2011). A deep understanding on forest characteristics and complexities assists us to present more suitable approach to optimum management. Forest is known to be a complicated ecosystem entailing for shedding light its components (Zanganehm, 2012). Getting knowledge on forest and as a whole forest ecosystem is very effective to making decision on ways of conservation and development. Forests, as a one of the richest natural landscapes, account for about 65% of terrestrial species (world commission of forest and sustainable development, 1999), providing the highest species diversity for different taxonomical groups including birds, invertebrates and microbes among others (lindenmayeret *et al.*, 2006). According to Bryant et.al investigations (1997), forty-six percent of world's forest has converted to other land uses, whereas only 22% of all forest has been remained intact. Under executional predicaments and facilities limitations, to protect such valuable repertoire entails for planning based on prioritization to conserve vegetation. Environments practitioners have consensus on that it is impossible and in part inefficient to conserve all species rage just using reserve systems and extending conservation beyond reserve area is important as much as reserves itself (Pilevar, 2007). Farming as the most important human feeding source, have been changed natural ecosystems performance and structure drastically. Human exploits natural resource in increasing trend without considering conservational aspects in short term to meeting their demands (Ataii Giglo *et al.*, 2010). Forest biodiversity involving species diversity, is found to be a heredity from several millions years ago which is handed over generations, providing a potential source for human welfare and serenity. Forest biodiversity refers to comprehensive abundance and diversity of life including plant, animal and microbes. This diversification occurs over ecological organization levels. The more biodiversity in a habitat, the more ecological sustainability and ferity will be result (Smith, 1996).given that ecosystem degradation, threatens life network on earth (Mohammadi Fazel *et al.,* 1999) and since forest is a complex and dynamic ecosystem, once it is subjected to some natural or anthropogenic destructive factors, dependent on factor severity, self-regulation state is degraded (Barnes *et al.*, 1998). In case of deforestation, wide varieties of animal and plant species will be extinct and biodiversity will be die out, in turns interrupts nature balance (Vatani *et al.,* 2009). As a qualitative index on biological state, biodiversity must be considered to prevent increasing trend of deforestation (Asadian *at al.,* 2011).unfortunately, natural resources specially forest and rangelands in Iran have been subjected to sever degradation so that it will have catastrophic outcomes. Hence, environment and biodiversity protection must be incorporated in countries development plans. Every region ecology serves as a common base of environmental factors and four factors of climate, topography, soil and living organisms are responsible for species autecology (Kervi and Khoshnevs, 2000). Forest habitats in arid and semiarid area are affected by species factors due to some local physical and environmental conditions. Therefore, to understand relationships between these factors is vital to their management and planning process (Jongman, 1987). Some factors like climate, bedrock, topography, and soil and biological condition establish a vegetation unit. Soil is a dynamic complex formed between atmosphere, water and soil crust as a result of common function of atmosphere, plants and animals, gradually evolves to reach balance state (Habibi Kaseb, 1992). Integrations among soils and forests in a given climate area are interrelated so that all components are indispensable and should be studied together (Zarin Kafsh, 2001, Mohammadi Samani *et al,* 2006). To understand soil properties is found to be one of the main principles to forest systemic management in turn determines many silviculture options including

species type, habitat fertility, mass growth rate and reserve required for seedling development (Daniel, 1979). Long term sustainability of forest ecosystem depends on soil quality conservation; hence it is so crucial to understand forest soils conditions and operation conducted on soil properties in forest management. Soils provide habitats fraught with high species richness on earth. For instance, one cubic meter soil in a sward can accommodate several millions organisms (10 million nematodes, 4500 insects, 4800 worms and several billions fine micro fauna) (Ielsen, 1995). To evaluate soil quality some soil health indices are used including biological traits(rooting depth and micro-fauna),physical and chemical properties(soil structure, bulk density, acidity electrical conductivity, cationic exchange capacity, soil carbon, nitrogen mineralization). So it is clear that any factor affecting soil, in turns may influence ecosystem function accordingly, so soil health determines soil sustainable management. One of the main long term outcomes is change in soils chemical and physical properties (Ca, K, Mn and so on) as a powerful environmental factor affecting habitat quality, soils micro-fauna and some other parts of forest ecosystem(Feller, 1982). Soil is one of the most important factor determining vegetation density and distribution (Haj Abasi, 2008).indeed, understanding soils ecosystem potentials and complexities by far entails for having deep knowledge on soil biology, physic and chemistry as well as interconnections among indices, disturbance events and ecological phenomena (Matini Zadeh et.al, 2001). Soil structure and texture are among most important physical factors having great deal of importance in plants nutrition and growth. Good soil structure and texture supplies moisture for plant through paving way for good microspores. So, soils physical properties affects plants rooting system directly (Zarin Kafsh, 1993; Amarlo, 2011). N, P, K and Mn are macronutrients or most essential elements for plants nutrition (Hanson 1968, Jeffry *et al.,* 2002). Factors influencing on presence of a species in a site are fall into two those physical and management. Physical ones included geographical (altitude, elevation, slope and aspect) and edaphic factors (soil type, soil structure, soil nutrients) (Karvai and Khoshnevis, 2000). Forest dynamic is affected by some factors and process such as habitat conditions, species composition, and regeneration and disturbance events. Given that nowadays Zagros forest are degrading increasingly and their regeneration have been limited(Akbari Nia *et al.,* 2007) and cultivation in forestlands has led to monoculture cropping, in turn caused forest destruction under Agroforestry words, the present research was aimed to evaluate some soils physicochemical properties in three monoculture(cereals), mixed-culture(grape, sumac and pomegranate) and non-cultivated lands in forest and subsequently to prioritize them in terms of their contribution in soil and water conservation in Zagros forest.

The aim of this study is comparison of some soils physicochemical properties in mixed and monocultures to non - cultivation in Kohgiluyeh and Buyerahmad in Zagros forests.

Materials and methods

Study area

Kohgiluyeh and Buyerahmad in area by 16249 km² are located at a mountainous and elevated land accounting for 1 percent of total countries' area. Warm and cold diverse climate among seven cities in this province have caused to it fall into four-seasonal provinces in Iran. in northwest of province and about 7 kilometre far away from Dogonbadan, protected habitat of Deil is located in coordinates 50 ° 46 ' E to 36 ° 45 W differed from Gachsaran formation in edaphic, physiographic and flora and fauna diversity. Whereas Gachsaran formation characterized by bedrock covered by almond, *pistachio atlantica* and *pistachio Khinjuk* species. Thanks to its 500 to 2020 m sea above elevation and diverse tree and shrub species such as almond, *pistacia atlantica, Acer monspessulanum*, *Ulmus minor, Crataegus aronia* and *Amygdalus Lycioides* and etc. among which *Quercus brantii* lindl is dominant species along with wide varieties of animal and medicinal plants this province have received large number of tourists. Since in some parts of protected area, native plants have been cultivated and role of Zagros forest in soil and

water conservation is substantial, so in the present research we dealt with soils physicochemical properties in three mixed culture (grape, fig, and sumac), monoculture (cereals) and non-cultivations in protected area of Deil.

Sampling methodology

A short reconnaissance was conducted using global positioning system (GPS) to determine mixed and monoculture lands. Since physiographical factors affect soils chemistry, moisture and others properties(Enright, 2005) as the most determinant factor to separate ecosystem units(Sohrabi *et al.,* 2007), ones must take these factors(slope, aspects and elevation) into account(Barnes *et al.,* 1998).In order to remove edge effects, a control site(non-cultivated in forest) was selected in a suitable distance taking physiographical factors(slope, aspect, sea level - above elevation)into account so that it was homogenized in respect to vegetation type, geology and so on compared to mixed and mono-cultured lands. Some statistical grids (1250*800 m2) were landed on study area digital maps using GIS (geographical information system). The number of fifteen rectangular 25*30 m plots was distributed in field by GPS. For every study site, soils samples were taken from depths 0 - 10, 10 - 20 cm and to minimize soil sampling error, there samples within each plot were prepared from depths 0-10 and 10-20 cm for chemical analysis (Salehi *et al.,* 2011, Borthes and Roose, 1999), then they were transported to laboratory. Soils samples were dried and sieved by 2 mm meshes sieve (Maranon *et al.,* 1999).results showed that non-cultivated and mixed-cultured lands were superior to mono-cultured one in forest respectively. In respect to great contribution of Zagros forests in soil and water conservation, results obtained from the present research showed that any anthropological interference(such as planting native species) in this system, interrupts these forest natural balance. To conserve soil and water balance within such systems, mixed-culture of orchard species is more superior to mono-culturing (cereals). soil acidity by EC-meter, electrical conductivity by pH-meter, total calcium, organic carbon and matter according to titration method, soil texture by hydrometric method, phosphor by Olsen method, K by photometric film, soil moisture by weighting method, bulk density by coagulation and total nitrogen by Kejeldal were measured. Data analysis was conducted by software Minitab using completely randomized design according to Tokay mean separation test.

Results

Results of variance analysis showed significant level of soil moisture(in probability level of 1%), bulk density (1%), total Ca (1%), carbon and organic matter (%5), total N (1%), P(1%), percent of clay, sand and silt (1%) and non-significance of electrical conductivity, C to N ratio and P (table 1). according to variance analysis table, edaphic characteristics except soil acidity was not significant (table1).

Table 1. varyance analysis of measured physic- chemical properties.

Variables	df	Moisture (present)	Bulk density	pH	EC	Ca	C	om	N	C to N ratio	P	k	clay	silt	sand
Area (place)	1	68.75^{**}	0.16^{**}	5.62^{**}	0.06^{ns}	69.6^{**}	3.35^{**}	9.98^{**}	0.09^{**}	87.45^{*}	80.32^{**}	43767.6^{ns}	1587^{**}	1123^{**}	5366^{**}
a.s.l	2	3.71^{ns}	0.004^{ns}	3.54^{**}	0.003^{ns}	0.33^{ns}	0.52^{ns}	1.54^{ns}	0.008^{ns}	2.59^{ns}	3.01^{ns}	2116.8^{ns}	0.03^{ns}	4.03^{ns}	0.001^{ns}
Area*a.s.l	2	0.74^{ns}	0.02^{ns}	2.28^{**}	0.001^{ns}	0.086^{ns}	0.36^{ns}	1.05^{ns}	0.004^{ns}	9.19^{ns}	2.64^{ns}	24.7^{ns}	7.26^{ns}	13.63^{ns}	24.7^{ns}
Coefficient of variance		6.12	7.66	4.85	39.6	11.54	27	27	24.91	18.83	21.87	23.34	24.57	9.36	18.23
Significant level		0.002^{**}	0.001^{**}	0.001^{**}	0.7^{ns}	0.001^{**}	0.04^{*}	0.04^{*}	0.001^{**}	0.19^{ns}	0.002^{**}	0.4^{ns}	0.005^{**}	0.001^{**}	0.001^{**}

ns, *, ** show no significance and significance at 1% and 5% level, respectively.

Results showed that depth 10-20 cm has much acidity level than 0–10 cm (figure 6). There was significant relation between all three sites in terms of soil moisture and non-cultivated and mono-cultured lands indicated the least soil moisture (figure7). Mono-cultured and mixed-cultured lands showed significant relation in bulk density (figure 8). Non-cultivated area had high acidity compared to mono-cultured and mixed culture lands (figure 9). It can be attributed to high percent of lime in area. At the same time, organic matter and carbon showed significant relationship in control and mono-cultured lands (figures 11 and 12). similarly, both mixed-cultured and mono - cultured lands showed significant difference in total N and P so that control lands had the highest concentration (Figures 13 and 14). Mix-cultured, control and mono-cultured lands showed the lowest and highest clay percent respectively among others (figure 15). Results clearly demonstrated that mono-cultured land had much more silt and sand percent compared to mix-cultured and control ones in forest (Figures 16 and17). Soils moisture comparison showed that the depth 10-20 cm had much moisture than that 0-10 cm. mix-cultured and mono-cultured lands differed significantly in soil moisture in depth 0-10 and 10-20 cm (table 2).

Table 2. mean separation of measured physicochemical properties in different sites and depths.

site	Soil depth (cm)	Moisture (%)	Bulk density (g m^{-3})	pH	Total Ca (%)	OC (%)	OM (%)	Total N (%)	P (ppm)	Clay (%)	Sand (%)	Silt (%)
Mono-culture	0 - 10	28.3^{c}	1.54^{ab}	5^{b}	3.5^{c}	2.6^{ab}	4.5^{ab}	0.2^{b}	6.7^{abc}	26^{bc}	61.8^{a}	64^{a}
	10 - 20	29^{bc}	1.7^{a}	7.6^{a}	3.6^{c}	1.9^{b}	3.3^{b}	0.1^{b}	5.3^{c}	24.8^{c}	60.4^{a}	61.2^{a}
Mix-culture	0 - 10	33.7^{a}	1.51^{ab}	7.9^{a}	5.6^{b}	2.9^{ab}	5.1^{ab}	0.2^{b}	6.1^{bc}	49.4^{a}	28.6^{bc}	41^{b}
	10 - 20	33.9^{a}	1.52^{ab}	7.9^{a}	5.9^{b}	2.8^{ab}	4.8^{ab}	0.2^{b}	6.6^{bc}	49.6^{a}	32.2^{b}	42.8^{b}
Control	0 - 10	31.3^{ab}	1.3^{b}	8^{a}	8.6^{a}	3.4^{ab}	5.8^{ab}	0.4^{a}	11.6^{a}	43^{abc}	16.8^{cd}	56.8^{a}
	10 - 20	32.6^{abc}	1.4^{b}	8.2^{a}	8.9^{a}	3.42^{a}	5.9^{a}	0.3^{a}	10.6^{ab}	44.2^{ab}	14.6^{d}	55.6^{a}

Common letters represent non – significance.

Control and mono - cultured lands differed significantly in various depth bulk densities. Soil acidity was significant only in depth 0-10 in mono-cultured lands compared to others. All three lands differed significantly in terms of total lime, whereas control area exhibited much more total lime compared to mix and mono-cultured lands. Both control and mono-cultured lands differed significantly in organic matter and carbon in soils depth 10-20 cm. Total N was measured in highest level in control area, significantly varied compared to others. Both mix-culture and monoculture lands did not varied significantly in total N. clay percent between depth 0-10 and 10-20 cm in mix-cultured condition was varied significantly compared to mono-cultured one. Sand percent in mono-cultured and control area showed the highest and lowest level respectively. Mono-cultured lands varied significantly in sands percent to both control and mix - cultured lands in depths 0-10 and 10-20 cm. Mix-cultured lands showed the highest silt percent so that it was significantly varied in comparison to control and mono-cultured lands (table2). At is illustrated in table 3, there was negative correlation between bulk density to soil moisture, acidity, total Ca, total N, total P and clay percent , while it was correlated to sand percent positively. Soils moisture correlated to acidity, total clay percent and sand percent positively and to silt percent and bulk density negatively. Sail acidity was positively correlated to lime, N and clay percent and negatively correlated to sand and silt percent. Also, results indicated that Total Ca is correlated to organic matter and C, N, P and clay percent positively and to silt and sand percent negatively. Organic matter and C had positive correlation to N and P, while it was negative for sand

percent and organic matter correlated positively. N, P and clay percent showed negative correlation to sand percent, while, there was positive Correlation between total N to P, clay and silt percent.

Table 3. correlation between physiochemical properties.

properties	Moisture (%)	Bulk density	pH	Total Ca (%)	OC (%)	OM (%)	Total N (%)	P (ppm)	Clay (%)	Sand (%)	Silt (%)
Moisture	1										
Bulk density	- 0.31*	1									
pH	0.48**	0.51**	1								
Total Ca	0.42*	- 0.6**	0.61**	1							
OC	0.28ns	0.08ns	.28ns	0.56**	1						
OM	0.29ns	- 0.1ns	.28ns	0.56**	0.001ns	1					
Total N	0.1ns	0.53**	.37*	0.65**	0.01ns	0.47*	1				
p	0.21ns	0.35ns	.22ns	0.62**	0.2ns	0.39*	0.5**	1			
Clay percent	0.52**	0.36*	0.52**	0.44*	0.29ns	0.29ns	0.21ns	0.37*	1		
Sand percent	.58**	0.64**	- 0.66**	- 0.86**	- 0.55**	- 0.55**	- 0.6**	- 0.51**	- 0.64**	1	
Silt percent	- 0.62**	0.02ns	- 0.42ns	- 0.15ns	- 0.1ns	- 0.1ns	0.03ns	0.09ns	0.6**	0.38ns	1

Discussion and conclusion

According to (table 3) it can be concluded that in mono-cultured lands, because of low vegetation, erosion is accelerated and as soil is leached, basic cations are re moved, in turn reduces soils acidity. As sand percent increase, soil bulk density is increased accordingly. Given that both mono and mix-culture operations are conducted in study area, interrupting soil structure and reducing bulk density, but results showed higher bulk density. This might be attributed to prescribed fire in autumn and no vegetation cover in winter. results showed that moisture and sand percent correlated positively, as a results, as participation occurs in area, both mix and mono-couture soil is eroded due to bareness, in turn increasing sand percent and bulk density as well as reducing basic cations and pH, organic matter and carbon, total N and P (Table 3). Soil is the upper horizon of crust providing a good habitat for plants provided that some conditions like temperature, moisture, nutrients are in optimized levels (Navab Zadeh, 2007). Human interference may impose adverse effect on soils organic matter, affecting soil structure and texture directly (figure 6). As a result of low organic matter, soils particles are dispersed and subsequently number of pores decreases.by the way, due to low organic matter and less soil microspore, bulk density is increased(figure 9).plant growth is affected by this process(figure 8), in that soils aeration and gaseous exchanges become less (figire 10). Soil depth 0-10 had less acidity compared to 10-120cm (figure 11), it can be attributed to much more humus. Since humus contains Humic and Folic acid, it lessens soil acidity (Zarin Kafsh, 1997, Mohammadi Samani, 2006). Soils minerals and elements are affected by acidity to large extent so that in acidic soil, Al and Mn concentration tends to be high, causing toxicity (Navab zadeh, 2007). As it can be seen in figure 4-6, since clays are of the most active part of mineral fraction, and are negatively charged, they are able to absorb basic cations and subsequently improve soil fertility (figures 11, 12). These cation absorbed by clays are variable depending on clay type. Some species roots are able to utilize such cations as nutrients. Laboratory synthesis of clays showed that type of clay is controlled by solution ions (Navab zadeh 2007). As a result, anthropogenic activities in nature have led to much more leaching of basic cations from soils and as a result clay type and texture change (figures 7). It is worthy to note that somehow, much manipulation in forest ecosystem may change soil texture and much more sand percent in long term (figure 8). Sand particles are not active chemically, however they can soil physical properties appreciably

(Elias Azar, 1995). Soils chemical properties are controlled by colloid components to some extent. Clays and humus are among the most important colloids in soil. Humus is an organic composition mainly created as a result of biological processes, activity of soil micro fauna on plants and animals residues. It can be said that agroforestry interrupts soils physiochemical properties and adsorption of basic cations by plants (figure 12). Soil type is a factor leading to high acidity as a result of salts accumulations including Ca and Mn (Navab zadeh, 2007). According to results from the present research, plants improve soil structure and aggregates stability (figures 12), preventing run off. On the other hand vegetation degradation leads to less litter turn over as a soil organic matter, in turns weakens soil structure. Given that soil fertility represent soil quality by which soil can provide balanced nutrients for plant, it can be concluded that anthropogenic activities interrupts environmental homeostasis. Hence, much more investment on farming and huge revolution in farming operations will destructed natural habitat and contaminated environment, imposing some drastic issues like soil structure losses, environmental pollution and nutrient toxicities. Results of research suggested mix-culture operations (orchards tree) more preferably than monoculture (cereals) for providing nutrients. However, in long term, it will lead to fewer yields in monoculture compared to control area. So it is recommended that to undertake some operation to convert these area into orchards or mix-cultured species in non-forested areas at least to minimize damages to Zagros forest. Agroforestry or mix-culture is defined as integration of some operation like tree planting, farming, forage production, ranching and etc. in a given area (Akbari nia, 2007). It is more compatible to most parts of world in particular in natural forestlands. It is more appropriate for planting annual and perennial herbs and at the same time is integrated to ranching. In agroforestry, soil erosion is minimized, cropping system aeration will be desirable and maximum productivity on light, water and nutrients will be reached. According to studies conducted by researchers in Walse College (2000), to use integrated cropping system is found to be one of promising solutions to prevent deforestation, tree association's degradation and related flora and fauna and eventually greenhouse gases emissions. Yakheshki 1964 while studying on mix-culture in forestlands reported that low-productive and steep lands in Gilan province it is not cost-effective to wheat and barley dry-farming for rural people, leading to much more soil erosion. Land use change and integrated cropping system may improve soil conservation and yield simultaneously. Integrated cropping also included farming management and tree planting and mainly it is conducted in northern forests in Iran. As a whole, integrated cropping is not recommended for northern forests except degraded forest lands in steep slope prone to erosion. Since anthropogenic activities interrupts ecosystems natural balance, affecting forest flora and fauna negatively, mix-culture only is recommended for area with farming and forestry operations respectively. Unfortunately, nowadays Zagros forest is dominated by monoculture specially by annual species(cereals) and mix-culture (orchard species), depleting soils nutrients and breaking out pests and diseases, firing and etc. so it is worthy to say that human consistently is evolving, hence he must respect all others organism life and habitat during this process and take actions to support them. Although human is much more evolved than others, but it does not mean that he has right or empower to destruct others animals or plants species. There is urgent need to change altitude forward to protected habitats and the major approach to conserve forest is to eradicate anthropogenic interference on them.

Fig. 1. Mix- culture in Zagros forests.

Fig. 2. Zagros forests in Iran.

Fig. 3. Mono - culture in Zagros forests.

Fig. 4. The map of altitude sea level of case study.

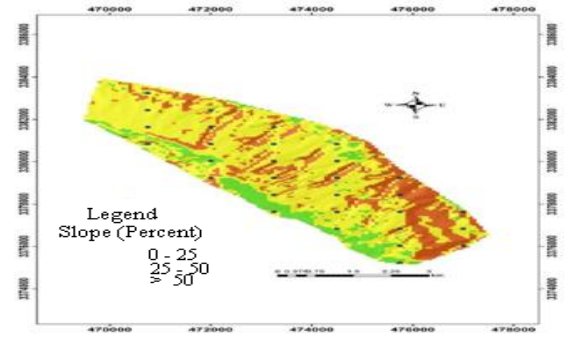

Fig. 5. The map of slope of case study.

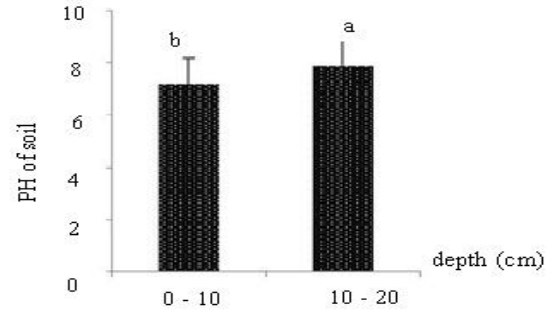

Fig. 6. pH of soils in depth.

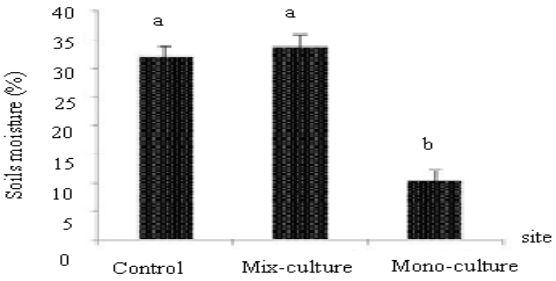

Fig. 7. comparison of soils moisture in three sites.

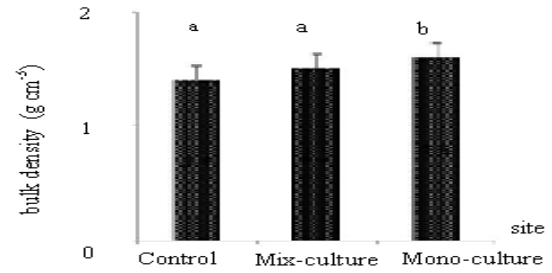

Fig. 8. comparison of bulk density in three sites.

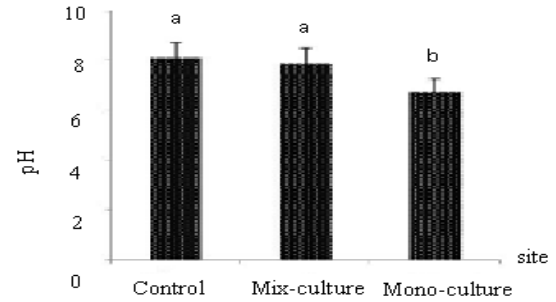

Fig. 9. comparison of soil PH in three sites.

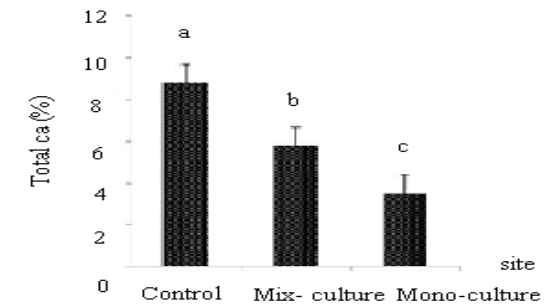

Fig. 10. comparison of total ca in three sites.

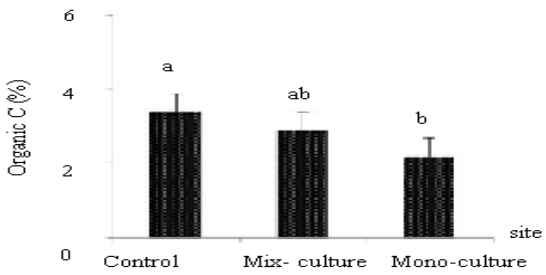

Fig. 11. comparison of organic C in three sites.

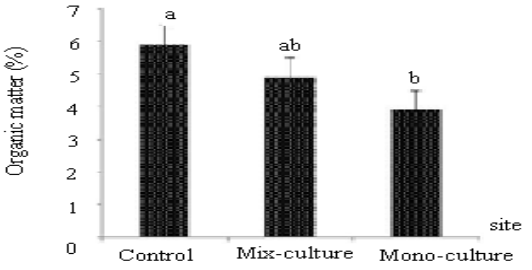

Fig. 12. comparison of soils organic matter in three.

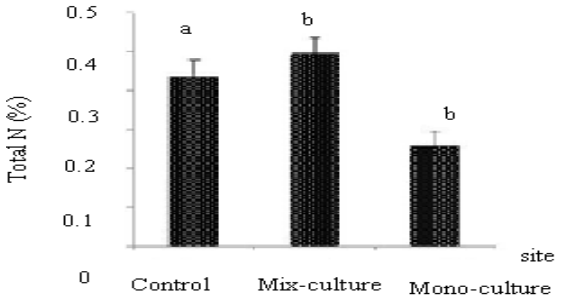

Fig. 13. comparison of total N in three sites.

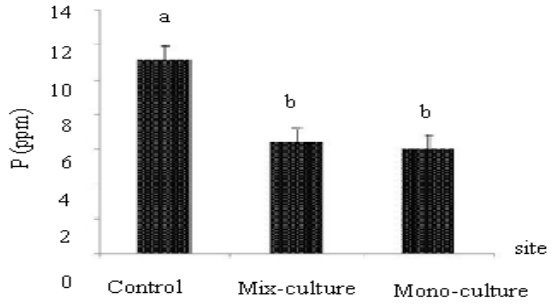

Fig. 14. comparison of P in three sites.

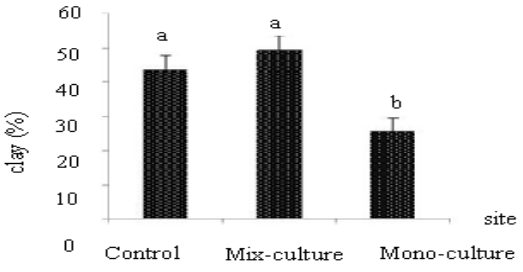

Fig. 15. comparison of soil clay percent in three sites

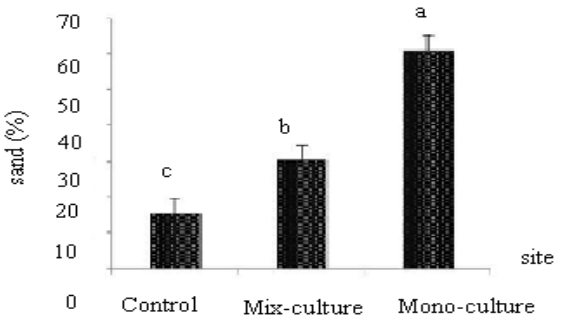

Fig. 16. comparison of soil sand percent in three.

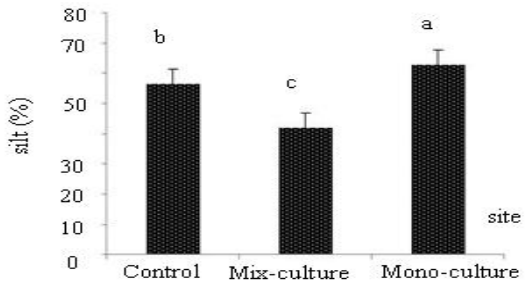

Fig. 17. comparison of soil silt percent in three sites.

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