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Original Article

The Impact of Fire on the Forest and Plants Diversity in Iranian Oak Forest

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ABSTRACT

Fire, as a natural ecological disturbance factor in forest, this study located in the Marivan region, Northern Zagros forest, and western Iranian state of Kurdistan. In each burned and unburned area 30 circle sample plot (1000 m^2) were collected by randomized–systematic method in the 100×200 m net (in total 60 plots). In every sample plot the kind of species, number of tree, the height of coppice shoot, the diameter of coppice shoot at breast height, tree crown diameter, shrub and regeneration information (i.e. coppice and seed provenance) were recorded. In the sample plots the micro plots of 2 m by 2 m (i.e. area of 4 m^2) were designed and herb information was recorded then. Species diversity indexes including Shannon Wiener (H′), Simpson (1-D) and Margaleff (R_1) were used to evaluate plant diversity in each sample plot. Data analyzing was done by SPSS16 and Ecological Methodological software's. In this forest have 79 plant species, which consist of 6 trees, 4 shrubs and 69 herbaceous species. Results indicated that Compositae families have the highest number of species. Herbaceous layer in burned area has higher the unburned area, but shrub layers in the unburned area higher the burned area. T-test analysis indicated the differences between diversity indexes in the shrub and Herbaceous in the two areas were statistically significant, but differences between diversity indexes in the tree layer in the two areas not statistically significant. Herbaceous layer had the highest richness, evenness and diversity in the vegetation layer.

Key words: Burned area, Fire, Marivan region, Oak forest, Plant diversity, Zagros forest.

Introduction

With due attention to climate conditions of Iran that 65% area includes arid and semi-aired and degradation rapid of north and west, because of degradation of natural resources will cause to degradation agricultural lands and human environmental (Dastmalchi, 1998, Zabiholahii *et al*, 2012, Haidari *et al*, 2012, Haidari *et al*, 2013a and Askari *et al*, 2013a). Forests cover about 12 million ha in Iran (Forest and Rangeland Organization, 2002; Haidari *et al*, 2013b, Haidari *et al*, 2013c), including 5 million ha in the mountainous Zagros region. The major element of Zagros forest destruction include: fire, grazing, farm operation in forest, fuel wood and timber, mining, semi-parasite plant and non-wood forest production (Jazirei and Ebrahimi Rastaghi, 2003, Haidari *et al*, 2013d, Haidari *et al*, 2013e, Bazyar *et al*, 2013a, Parma and Shataei, 2013). Increasing population, low level of

development and high dependence of local communities on forests for their primary livelihood needs, are the main reasons of this destruction. The lack of regeneration in these forests is a major concern (Fattahi 1994, Jazirei and Ebrahimi Rastaghi, 2003, Bazyar *et al*, 2013b, Rezaei *et al*, 2013, Askari *et al*, 2013c, Haidari *et al*, 2012b, Haidari *et al*, 2012c). For centuries, these ecosystems have been subject to much human activity, such as cutting to obtain wood, and clearing and fire. Recurrent fires have seen an enormous increase in frequency over the recent decades and they are the main disturbances to this ecosystem (Luis-Calabuig *et al*., 2000). Disturbances such as fire, windstorms, floods, and grazing play a role in the maintenance of species diversity that has become well recognized in ecological theory (Mackey and Currie, 2000). Biodiversity has been an important objective of forest management because it provides a broader array of ecosystem services (Hooper *et al*., 2005).). Effects of Fire on vegetation are usually the most obvious impacts of burning. Fire affects natural ecosystems by consuming plants, altering successional patterns, and changing vegetative resources such as timber, forage and wildlife habitats (DeBano *et al*, 1978). Burning alone can result in increased forb abundance (Wienk *et al*, 2004) grained abundance and under story species richness (Laughlin et al, 2004). Many studies have been carried out on plant biodiversity indices in Iran and around the world. The zagros where fire occurs in 300-400 ha annually (Anonymous, 2002). Atrakchaiee, (2000) proclaimed that fire increased herbal species cover in burned area but did not effect on biodiversity indices in temperate forest of northeast of Iran. Banj Shafiei et al (2006) study effect of fire on herbal layer biodiversity in a temperate forest of northern Iran and results showed the biodiversity indices and coverage percent of shade tolerant species in unburned area were higher then burned area. Pourreza *et al* (2009) investigated on the preliminary results of post fire re sprouting of manna oak (*Quercus brantii* Lindl.) in the Zagros forests and results showed that post-fire re sprouting is positively related to the number of pre-fire sprouts and the fire intensity. In pine/oak forest USA, most post fire under story dominants were previously inconspicuous or absent from the wetter communities and these species increased significantly more than others (Plocher, 1999). The burned plots in ponderosa pine/Douglas-fire forest had reduced species richness and cover of the under story in early years after fire, however after three years, richness increased to the level of the unburned plots. Simpson evenness increased in subsequent years (Metlen and Fiedler, 2005). In another research that was conducted bay sanghoon *et al* (1997) cited that richness and evenness indices were higher in burned area than unburned area on year after burning in mixed broad leaves oak forest. Also richness index in burned pine/oak forest was higher compare with control (Mehta *et al*, 1997).These are mostly surface fire and effect mainly undergrowth and young trees. Despite such fires, there are unfortunately limited scientific studies or published papers about investigation of fire effects on temperate forests in Iran. Undergrowth biodiversity could help scientists determine if forest fire influences the presence or absence of certain plant species Biodiversity is useful to understand the distribution of new and native species in the study area. The present study was conducted to assess the status of plant biodiversity in both burned and unburned area using biodiversity indices. In this study we compared the effects of fire on plant diversity in Zagros vegetation, Marivan region, Kurdistan province, Northern Zagros forest.

Material and Methods

Site description

This research was investigated in the Marivan region, Northern Zagros forest, and western Iranian state of Kurdistan (Fig. 2). Mean annual precipitation is 909.5 mm, ranging from 590.8 to

1422.2 mm, Mean annual temperature is 13.3º C, and the length of dry season is 4 month (based on embrothermic curve) from June to August. Type of climate is sub humid with cold winters in the basis of Emberger's formula (Pourbabaei and Navgran, 2011). For this study, the Fire event occurred in 2007 where 15 ha of forest were burned in 1 day, field data and sample collection was in 2008.

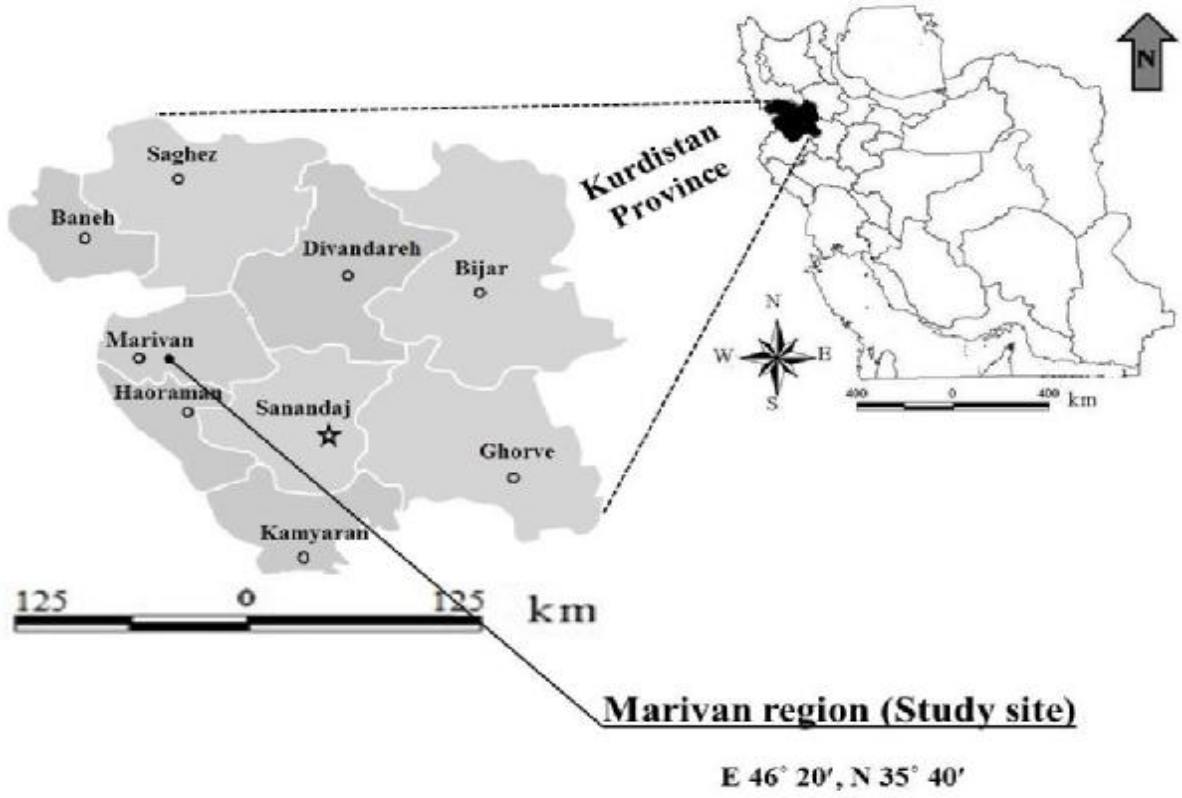

Figure 1. Study site location in the Kurdistan Province, Zagros region, Western Iranian state of Iran.

Analysis

In each burned and unburned area 30 circle sample plot (1000 m^2) were collected by randomized–systematic method in the 100×200 m net (in total 60 plots). In every sample plot the kind of species, number of tree, the height of coppice shoot, the diameter of coppice shoot at breast height, tree crown diameter, shrub and regeneration information (i.e. coppice and seed provenance) were recorded. In the sample plots the micro plots of 2 m by 2 m (i.e. area of 4 m^2) were designed and herb information was recorded then. Species diversity indexes including Shannon Wiener (H′) and Margaleff (R_1) were used to evaluate plant diversity in each sample plot (table 1). The means of different between diversity indexes in the two sites were estimated by t-test. Data analyzing was done by SPSS16 and Ecological Methodological software's.

Table 1. Biodiversity Indices used in this paper

Indices	References	Equation*
Shannon (H)	(Peet, 1974)	$H = \sum_{i=1}^{S} pi \ln(pi)$
Simpson (1-D)	(Peet, 1974)	$1 - D = (\sum (pi)^2$
Margaleff (R)	(Ejtehadi, 2009)	$R = (s-1)/\ln(n)$

*S and pi refer to total number of species in the sample and proportion of individuals in the species, respectively

Results

Biodiversity measurement is recognized as guidance for conservation plans in local scale. Species biodiversity is used greatly in vegetation studies, and environmental evaluation is one of the main criteria to determine ecosystems condition (Mirdavoodi and Zahedi Pour 2005).

Table 2. List of Scientific and Family name of plant species in the burned and unburned areas.

Unburned area	Burned area	Tree/Shrub/Herb	Family name	Scientific name	NO
*	*	Tree	Fagaceae	*Quercus libani* Oliv	1
*	*	Tree	Fagaceae	*Quercus infectoria* Oliv.	2
*	*	Tree	Fagaceae	*Quercus Brantii Lindl.*	3
*	*	Shrub	Rosaceae	*Cerasus microcarpa*	4
*	*	Tree	Rosaceae	*Crataegus meyeri*	5
*	*	Shrub	Caprifoliaceae	*Lonicera nummularifolia* Jaub & spach.	6
*	*	Tree	Aceraceae	*Acer Monspessulanum* L. Subsp . cinerascens (Boiss)	7
*	*	Shrub	Rosaceae	*Cotoneaster nummularius* Fisch & Mey.	8
*	*	Shrub	Rosaceae	*Rosa canina*	9
	*	Tree	Rosaceae	*Pyrus communis* L.	10
*	*	Herb	Compositae	*Achillea millefolium* L.	11
	*	Herb	Gramineae	*Aegilops triuncilis* L.	12
*	*	Herb	Gramineae	*Aegilops cylindrica* Host.	13
*	*	Herb	Aristolochiaceae	*Aristolochia bottae* Jaub & spach.	14
*	*	Herb	Crucifereae	*Alyssum* sp.	15
*	*	Herb	Compositae	*Anthemis hauss knechtii* Boiss &	16

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*	*	Herb	Compositae	*Anthemis tinctoria* L.	17
	*	Herb	Pappilionaceae	*Astragalus* sp.	18
*	*	Herb	Liliaceae	*Bellevalia pycantha*.	19
*		Herb	Gramineae	*Bromus Danthoniae* Trin.	20
	*	Herb	Gramineae	*Bromus sterilis* L.	21
*	*	Herb	Campanulaceae	*Campanula cecilii* Rech. F.	22
*	*	Herb	Crucifereae	*Capsela bursa-pastoris* (L.) Medicus.	23
*		Herb	Compositae	*Centaurea iberica* Trev.	24
*	*	Herb	Rosaceae	*Cerasus* sp.	25
	*	Herb	Umbelliferae	*Chaerophyllum sp. macropodum*	26
*	*	Herb	Umbelliferae	*Chaerophyllum tuberosum*.	27
*	*	Herb	Umbelliferae	*Conium maculatum* L.	28
*		Herb	Pappilionaceae	*Coronilla varia* L.	29
*	*	Herb	Compositae	*Crataegus meyeri*	30
*	*	Herb	Compositae	*Crepis sanctus*	31
*	*	Herb	Gramineae	*Dactylis glomerata* L.	32
*	*	Herb	Euphorbiaceae	*Euphorbia orientalis* L.	33
	*	Herb	Umbelliferae	*Eryngium billardieri* F.	34
*	*	Herb	Umbelliferae	*Eryngium bungei* Boiss.	35
*		Herb	Euphorbiaceae	*Euphorbia szovitsii*.	36
	*	Herb	Gramineae	*Ferula macrocolea* Bioss.	37
*		Herb	Gramineae	*Festuca* sp.	38
	*	Herb	Fumariaceae	*Fumaria asepala* Boiss.	39
*		Herb	Graninaceae	*Geranium tuberosum* L.	40
	*	Herb	Compositae	*Gundelia tournefortii* L.	41
*		Herb	Cistaceae	*Heilanthemum ledifolium* Miller.	42
	*	Herb	Gramineae	*Hordeom violaceum*.	43
*	*	Herb	Gramineae	*Hordeum* sp.	44
	*	Herb	Hypericaceae	*Hyoscyamus arachnoides*.	45
*	*	Herb	Umbelliferae	*Jorinea macrocephala*.	46
*	*	Herb	Compositae	*Lactuca serriola*.	47
	*	Herb	Pappilionaceae	*Lathyrus sphaericus*.	48
	*	Herb	Pappilionaceae	*Lens cyanea*.	49
*		Herb	Gramineae	*Lolium rigidum Gaudin*.	50
*	*	Herb	Pappilionaceae	*Lotus corniculatus* L.	51
	*	Herb	Malvaceae	*Malva neglecta* Wallr.	52
*	*	Herb	Caryophyllacea e	*Minurtia* sp.	53
*	*	Herb	Boragiaceae	*Onosma microcarpum* DC.	54
	*	Herb	Papaveraceae	*Papaver orientalis*.	55
*	*	Herb	Papaveraceae	*Papaver* sp.	56
	*	Herb	Labiateae	*Phlomis persica*.	57

*	*	Herb	Compositae	*Picnomon Acarna* Cass.	58
*	*	Herb	Umbelliferae	*Pimpinella olivieri* Vill.	59
	*	Herb	Gramineae	*Poa bulbosa* L.	60
	*	Herb	Gramineae	*Poa* sp.	61
		Herb	Ranunculaceae	*Ranunculus oxypermus.*	62
*	*	Herb	Boragiaceae	*Rochelia disperma.*	63
	*	Herb	Rosaceae	*Rosa canina.*	64
*		Herb	Polygonaceae	*Rumex* sp.	65
*	*	Herb	Labiateae	*Salvia indica* L.	66
	*	Herb	Umbelliferae	*Scandix iberica.*	67
*	*	Herb	Compositae	*Scariola orientalis* (Boiss). Stojak.	68
*	*	Herb	Compositae	*Scrozonera calyculata* Boiss.	69
*	*	Herb	Compositae	*Senecio vernalis* L.	70
*	*	Herb	Caryophyllacea e	*Silene conoidea* L.	71
*		Herb	Umbelliferae	*Smyrniopsis aucheri.*	72
	*	Herb	Gramineae	*Taeniatherum crinitum.*	73
	*	Herb	Umbelliferae	*Torilis leptophylla.*	74
*		Herb	Compositae	*Tragopogon buphthalmoides.*	75
*	*	Herb	Pappilionaceae	*Trifolium pretense* L.	76
*	*	Herb	Pappilionaceae	*Trifolium repens* L.	77
*	*	Herb	Pappilionaceae	*Vicia variabilis* Freyn & Sint.	78
*	*	Herb	Labiatea	*Ziziphora capitata* L.	79

The Tree species identified in the region studied belonged to six tree species in the three Families. In this forest have 79 plant species, which consist of 6 trees, 4 shrubs and 69 herbaceous species. (Table 2).

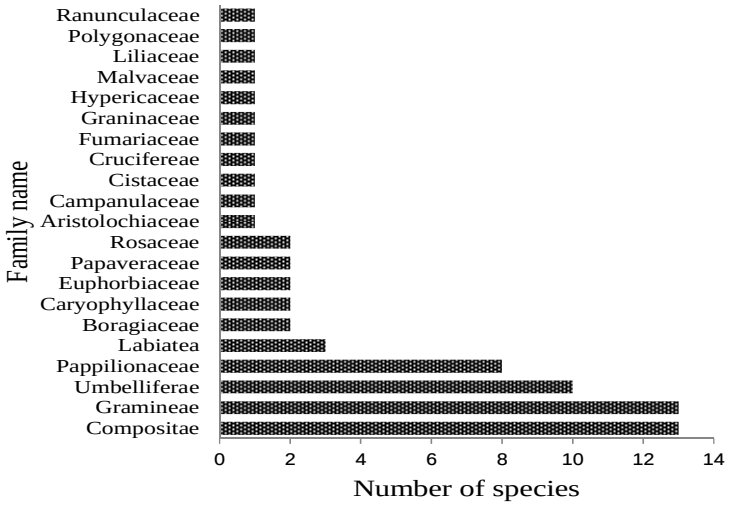

Figure 2. The number of plant species in the plant family in the study area

The tree, shrub and herbaceous species belonged to 21 families and 79 species were identified in the study area (Table 2). thus for the classes of Compositae, Gramineae, Umbelliferae, Pappilionaceae, Labiateae, twelve, twelve, ten, eight and three species were existed and have larger number of species, respectively (Figure 2).

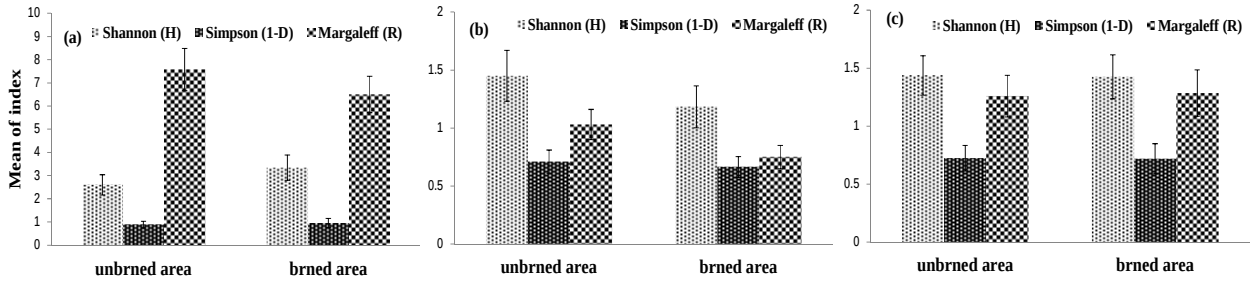

Figure 3. Mean diversity index in the: (a) Herbaceous (b) Shrub and (c) tree layer in the burned and unburned area.

A result showed in the herbaceous layer in burned area has higher the unburned area, but shrub layers in the unburned area higher the burned area (Figure 3). Tree layer mean diversity index in burned area as well as than unburned area. T-test analysis indicated the differences between diversity indexes in the shrub and Herbaceous in the two areas were statistically significant, but differences between diversity indexes in the tree layer in the two areas not statistically significant (Table 3).

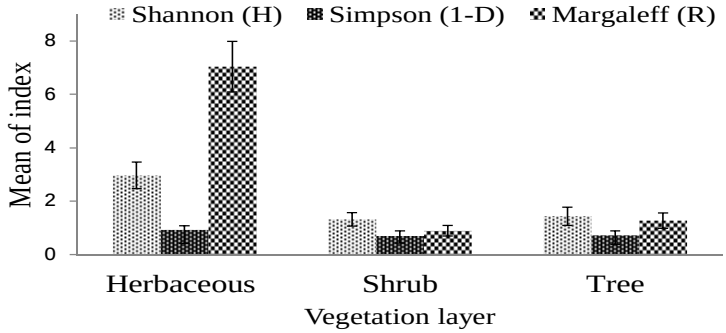

Figure 4. The means of diversity indices in the vegetation layer.

Results Figure 4 showed Herbaceous layer had the highest richness, evenness and diversity in the vegetation layer.

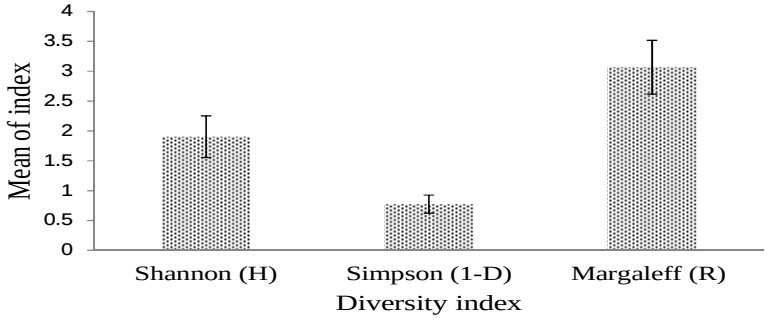

Figure 5. The means of diversity indices in the study area

The results of Figure 5 showed that the computed plant species diversity index is as follows as: mean species Shannon index: 1.90, Simpson index: 0.77 and Margaleff index: 3.06.

Table 3. The results of t-test to compered the means diversity index in the vegetation layer in the burned and unburned areas

Vegetation Layers	Diversity index	DF	F	Sig.
Tree	Shannon(H)	29	1492.34	0.065 ^{ns}
	Simpson (1-D)	29	87.12	0.07 ^{ns}
	Margaleff (R)	29	1904.39	0.056^{ns}
Shrub	Shannon(H)	29	984.31	0.005**
	Simpson (1-D)	29	106.63	0.045*
	Margaleff (R)	29	1173.51	0.000**
Herbaceous	Shannon(H)	29	3095.49	0.000**
	Simpson (1-D)	29	298.34	0.003*
	Margaleff (R)	29	4934.86	0.000**

* Different letters indicate significant differences in 5% level, ** Different letters indicate significant differences in 1% level.

Result Table 3 indicated the differences between diversity indexes in the shrub and Herbaceous in the two areas were statistically significant, but differences between diversity indexes in the tree layer in the two areas not statistically significant.

Discussion

Disturbances such as fire, windstorms, floods, and grazing play a role in the maintenance of species diversity that has become well recognized in ecological theory (Huston 1994, Mackey and Currie 2000). Fires have negative impacts on native plant diversity, with varying effects on species and ecosystems, including the potential for localized extinction (Franklin *et al*., 2005). Fire was historically a major influence on landscape patterns and species diversity in the forests (Delcourt and Delcourt, 1997). One of the serious threats to most of the Iranian ecosystems is drought, because much of Iran lies in the arid or semi-arid regions. The other threats for plants are: fire, overgrazing, fuel wood extraction, conversion of forest and other wild lands for agriculture, road construction, overexploitation, and unscientific extraction of plant resources for medicine and food. A total of 79 plant species were found in the studied area, of which 10 woody species (6 trees, 4 shrubs) and 69 herbaceous species existed (Table 2). Also, it can be deduced from Table 2 that Rosaceae and Fagaceae families play an important role in among woody species. Moreover, Compositae and Gramineae families were most abundant amongst herbaceous species**.** Results showed in this study area Compositae family have higher number of species in the study area (Fig. 2). Results showed herbaceous layer in burned area has higher the unburned area, but shrub layers in the unburned area higher the burned area. Tree layer mean diversity index in burned area as well as than unburned area. T-test analysis indicated the differences between diversity indexes in the shrub and Herbaceous in the two areas were statistically significant, but differences between

diversity indexes in the tree layer in the two areas not statistically significant (table 3). Fire has negative effect on the shrub species diversity and reduce diversity but have positive effect on the Herbaceous diversity. In this study area herbaceous layer had the highest richness, evenness and diversity in the vegetation layer (fig.4). This study showed that the computed plant species diversity index is as follows as: mean species Shannon index: 1.90, Simpson index: 0.77 and Margaleff index: 3.06. Therefore, Margaleff index has highest average in this study area. Sanghoon *et al* (1997) and Mehta *et al* (1997) showed that plant diversity in the burned higher the unburned area and in our study emphasis this research. Banj Shafiei *et al* (2006) showed the biodiversity indices and coverage percent of shade tolerant species in unburned area were higher then burned area but our study showed plant diversity in the burned higher the unburned area.

Conclusion

Fire, as natural ecological disturbance factors in forest, in this study plant diversity (herb and shrub layer) were higher in the burned area and fire has positive effect on the plant diversity in the Oak forest.

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