Chelonian Conservation And Biology

Vol. 19 No. 1 (2024) | https://www.acgpublishing.com/ | ISSN - 1071-8443

DOI: doi.org/10.18011/2024.01(1).1450-1465

FIRE INTENSITY EFFECTS ON BIODIVERSITY PATTERNS OF PLANTS IN MEDITERRANEAN WOODLANDS IN NORTHERN ALGERIA

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ABSTRACT

Algeria, like several Mediterranean countries, was exposed to devastating wildfires. These fires are a key disturbance affecting plant biodiversity patterns and evolution, causing significant threats to lives, property and economic activity in the country. The Kabylia region, in particular, through the last few years, has undergone tragic consequences due to wildfires. In context, we assessed the recovery of floristic biodiversity and the soil-vegetation relationship, in order to evaluate the fire impact on this ecosystem. A qualitative inventory of plant species and a physico-chemical analyzes were carried out in the stations of Sidi Ali Bounab; considered as a reference site (A), since it was preserved from fires and the devastated Ikhelidjen site (B), with a big fire, in the Kabylia region (Northern Algeria). the survey was carriedout, during the spring (April- June) of the year 2022 and 2023, after 2021 big fires. The flora inventory, in Sidi Ali Bounab not burned site (A), revealed the presence of 55 species are belonging to 4 classes (Magnoliopsida, Equisetopsida, Liliopsida and Polypodiopsida) and to 50 genera, 31 botanical families, 25 orders, with the Asteraeae family dominance. At the same time, the flora survey in Ikhlidjen burned area revealed a total richness of 49 species belonging to 3 classes (Magnoliopsida, Liliopsida and Equisetopsida) spread over 43 genera, 20 families, and 19 orders. The flora regeneration was observed within the Asteraceae and Fabaceae families in a soil which presents a low alkaline and high organic matter content. The analyzes of the chemical properties, from both sites (A&B), showed that the quality of the soil favorized the installation and the diversification of the flora based on their loamy-sandy texture rich in organic, especially in the burned station and their pH as well as their electrical conductivity, which was confirmed by the ecological indices analyzes.

Keywords: Plants, flora, soil, forest, ecological analysis, Kabylia.

INTRODUCTION

Fire is one of the main disturbances influencing vegetation, plant biodiversity (Yang et al. 2015), by driving significant changes in species composition and species richness through a decrease in

the competitive impacts of some woody plants (Piston et al. 2016). In a short-term fire occurrence may increase the abundance and frequency of annual and perennial grasses (Keesstra et al. 2016). In addition, some evidence suggests that, functional traits such as life form, plant height, specific leaf area and leaf carbon and nitrogen content can impact the functioning of terrestrial ecosystems (Badano et al. 2016) and consequently change the fire occurrence (Bowd 2018). Such changes in species composition and functional traits following the fire may or may not result in significant variation in evolutionary diversity, depending on how functional traits are conserved across phylogenies (Ren et al. 2008; He et al. 2019). Plants regeneration becomes the main indictor of management and sustainable development of arid and semiarid shrublands (Bowman et al. 2016). However, restoration is highly dependent on disturbances (Ren et al. 2008; Pausas and Ribeiro 2013; Vallego et al. 2012) and the previous abundance of plant species (Bahalkeh et al. 2021).
Continuing climate change, droughts and extreme weather, coupled with associated changes in wildfire activity (Abatzoglou and Williams 2016) are resulting in landscape ecosystem changes and shifts in biodiversity composition (Stevens-Rumann et al. 2017). Climate change is altering the mountainous ecosystems of the Northern part of Algeria and affecting the people who depend on them for ecosystem services and livelihoods. Severe wildfires contribute to hundreds of hectares of mature forest loss in the North-Eastern region of Algeria (GDF 2022). Many ecosystems depend on the complex interactions between fire and vegetation (Bond et al. 2005) where variation in vegetation defined as live, dead and decomposing plant material drives wild land fire behavior across scales (Lentile et al. 2006) and multiple fires create legacy effects on ecosystems (Mitchell et al. 2009). These interactions create a tight feedback loop, since fire is a keystone biophysical process driving the structure, composition and function of vegetation, while vegetation determines the distribution of combustible material, air movement and moisture balances for the next fire. Finally, post-fire vegetation responses influence ecosystem trajectories between fires. These feedbacks are complex because of the strong influences of local and nonlocal drivers of both fire and vegetation dynamics, as well as interactions between the immediate conditions and historical legacies of fire (Bond et al. 2005). A deeper understanding of the evolution and function of fire-influenced ecosystems and identifying the causal links among feedback components requires a holistic approach in considering these complex interactions in space and time. While ecosystem shifts are concerning in any ecosystem type, the transition from forests to grasslands and shrublands is often particularly alarming due to the loss of carbon storage capacity in forests versus grasslands or shrublands (Chafai et al. 2023), habitat loss for many wildlife species and the potential economic loss in timber industries (Thomas et al. 2017). Effective action depends on understanding regional and local implications of climate change and ecological effects, which can directly affect fire extent, tree-vegetation mortality, and post-fire ecosystem recovery. The rôle of vegetation, beyond its function as a fuel or a short-term post-fire response, is considered to be the mechanisms responsible for the entire cycle of fire-vegetation-atmosphere feedbacks as an approach for a more comprehensive view of fire ecology (Bouzekri and Benmessaoud 2016). The vegetation is far from being the same in all regions, especially since its diversification impresses the appearance of the regions where it often presents a striking

character with a fairly variable distribution on the surface of the globe (Piston et al. 2016). The Algerian the vegetation is diversified and rich in Mediterranean and Saharan botanical species belonging to the African flora families. The Kabylia region (Northern of Algeria), embrace an important specific richness in plant species, where some of them are endemic (Bouzekri and Benmessaoud 2016). The soil structure is an environment to be discovered in order to better build the future of the plant and allow its development, diversification and its renewal on the surface, especially since the plants are in strong interaction with their environment (Ruellan 2010; Ortiz 2016).

The present study aimed to evaluate the post-fire flora biodiversity regeneration and to understand the flora establishment. Also, the study was focused on the soil-vegetation relationship in order to characterize the distribution of plant species according to the physico-chemical qualities of the soil in before and post-fire areas.

MATERIAL AND METHODS

Study Area: The study areas are located in the Tizi-Ouzou district Northern part of Algeria, in Kabylia region and represent a part of the Djurdjura massif (Figure 1). This district covers an area of 3927 ha dominated by mountainous areas, with a Mediterranean climate, that represents a mild rainy winter and a hot summer. The study region is characterized by a high rugged topography, is renowned for its rural mountainous character. It shelters a diverse vegetation, classified in the stage of thermo-Mediterranean vegetation, predominantly the olive tree (*Olea europaea*), including various species and forest formations such as cork oak (*Quercus suber*), holm oak (*Quercus ilex*), zeen oak (*Quercus canariensis*) mixed with shrubs and herbaceous. The study sites selection was based on documented wildfire histories in the region. The study areas are represented by two sites, having close similarities in their geographic coordinates (Table 1). The first selected site, Sidi Ali Bounab (A) is unburned area with no previous fire disturbance. Hence this preserved not burned area is considered as a reference or control site (Figure 1). Therefore, the Ikhelidjen site (B) represents the post-fire area, was burned throughout the recent fire occurring during the summer of the year 2021 (Figure 1). The two study sites (A & B) situated on North-facing slopes and their geological formation was relatively the same based on the observations and the geological maps.

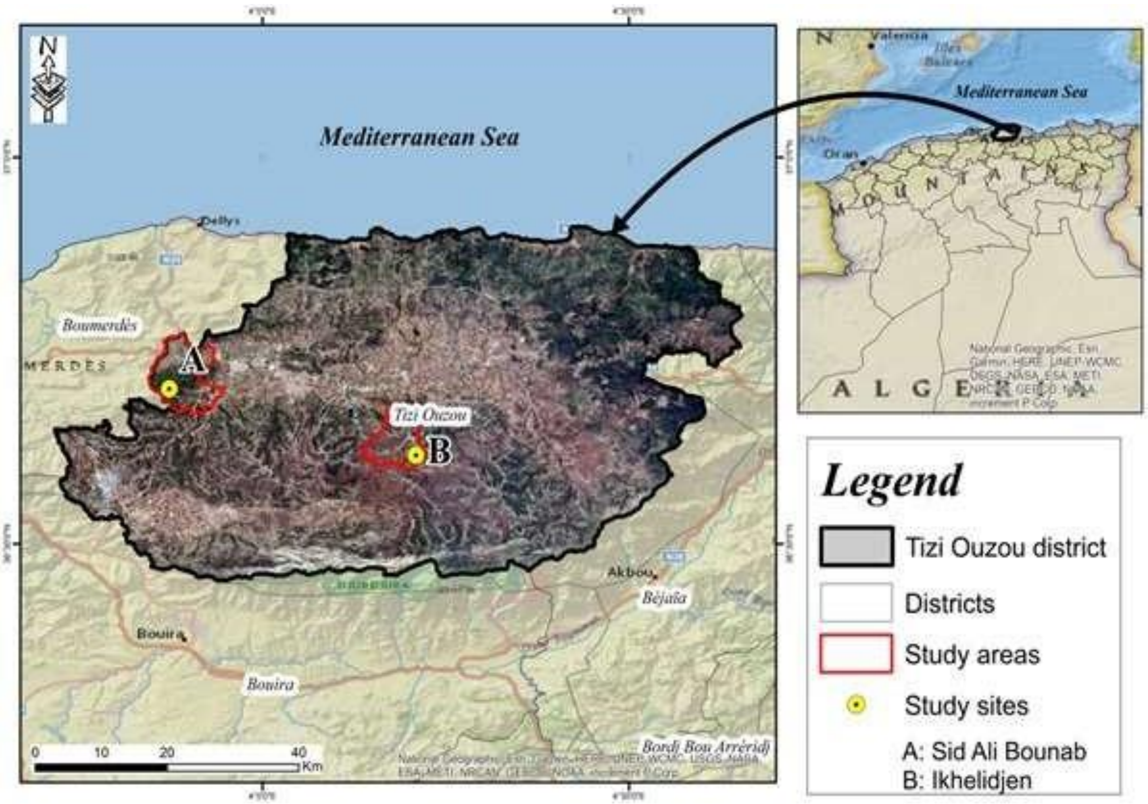

Figure 1: Geographical location of the study areas, Sidi Ali Bounab (Preserved area A) and Ikhelidjen (fired area B) (Google Earth, 2023).

Table 1: Geographical coordinates of the study sites, **Sidi** Ali Bounab (A) and Ikhlidjen (B).

Study area	Altitude	Latitude	Longitude	Slope
Preserved area: Sidi Ali Bounab (A)	201 m	36° 42' 13'' N	3° 57' 24''E	North-Easth
Fired area: Ikhlidjen (B)	168 m	36° 36' 41''N	4° 12' 31''E	North-Easth

Sampling Method: The survey was carried out in order to evaluate the fire effects, in less than 1-year on the vegetation scarring following the fires that ravaged Ikhelidjen (B) in the Larbaa Nath Irathen forest massif and to be compared to the preserved area Sidi Ali Bounab (A). The potential of the flora regeneration, the physico-chemical soil properties were studied during the post fire season, the spring 2022 and 2023 (April to June). During these periods systematic plant sampling with a measure of some physico-chemical parameters were done. The sampling was carried out randomly with a frequency of four times a month covering the all-study area. During the sampling all collected fresh (green) plants were put in plastic bags than broth to the laboratory for identification and a systematic study. Soil samples were taken from the same study areas at a depth of 20 Cm and the physico-chemical parameters were measured (particle size, pH, $CaCo_3$, electrical conductivity: EC and OM).

Plant identification and soil analysis: The flora samples were identified and classified, using criteria of Quezel and Santa (1963) and confirmed by the keys of Angiosperms Phylogeny Group IV (APG IV, 2016). Different Soil parameters of both study areas were analyzed, where the pH and EC (ds/m) for each plot were measured using a multi-parameter (Five Easy F20-Standard Kit-Mettler Toledo), respecting the soil/water ratio which is 1/5 respectively. For the granulometry, limestone and organic matter, soil samples were analyzed in the laboratory (Graffin et al. 2020). The granulometry is carried out using 10g of fine soil, in order to determine the percentage (%) of the different fractions of mineral particles constituting the aggregates, while allowing the evaluation of the structural stability of the soil. It consists firstly by destroying the organic matter using hydrogen peroxide (H_2O_2), then particles were dispersed using an energetic dispersant followed by a mechanical agitation and finally the samples were left for sedimentation. The results of the botanic biodiversity inventoried in the both study areas (A & B), were subjected to the classification of the strata, biological types and ecological indices treatment; represented by the assessments of species richness, relative abundance (F%) (Ramade, 2003) and Sorenson's similarity index.

RESULTS

Flora Biodiversity regeneration: The vegetation biodiversity is considered to be the main structure for forest ecosystem monitoring. Despite the biggest fires of the Ikhelidjen, have disrupted this forest ecosystem, fortunately a new healing survival begins in order to join its balance by initiating organization and emergence of some flora; in order to develop its initial state without human intervention (Figure 2). Plant Biodiversity changes across time after Wildfire. Since the last fire, it was found a significant and effective factor on variation in plant biodiversity facets at the burned studied site (Figure 2). These are translated with higher values of taxonomic, functional and phylogenetic diversity, in the burned area (B) in comparative to the reference not burned area (A) (Table 2). The floristic biodiversity inventoried from the sampling two sites (A & B), during the survey period, revealed the presence of a total of 79 species found to be under 70 generas, belonging to 4 classes; Magnoliopsida, Liliopsida, Pteridophyta and Equisetopsida, in both sites (Table 1). These species are distributed over 28 orders: Astrales, Myrtales, Apiales, Geraniales, Papaverales, Capparales, Brassicales, Lamiales, Scrophulariales, Rosales, Fagales, Caryophyllales, Fabaless, Ranunculales, Primulales, Rhamnales, Urticales, Arales, Malvales, Ericales, Campanulales,
Gentianales,Aspiales, Lamiales E, Poales, Liliales, Cyperales, and Polypodiales, which are represented by 32 families.

Figure 2: Aspect of regeneration of the flora biodiversity after the big- fire of Ikhelidjen (A) (originals, 2023).

Table 2: Identified plant Species collected from study sites, the unburned area, Sidi Ali Bounab (**A)** and burned area Ikhelidjen (A), during the study period. (+ = Presence of the species **-** = Absence of the species common species = 25)

Class	Order	Family	Genera	Species	A	B
Magnoliopsida	**Astrales**	**Asteraceae**	*Galactites*	*Galactites tomentosa*	+	+
			Chcysanthemum	*Chrysanthemum myconis*	+	+
			Sonchus	*Sonchus oleraceus*	+	+
			Picris	*Picris comosa*	-	+
			Bellis	*Bellis annua*	+	+
			Pallenis	*Pallenis spinosa*	-	+
			Andryala	*Andryala integrifolia*	+	+
			Crypsis	*Crypsis alopecuroides*	-	+
			Chicorium	*Chicorium intybus*	-	+
			Xanthium	*Xanthium strumarium*	-	+
			Eryngium	*Eryngium tricuspidatum*	+	-
			Echinops	*Echinops sphaerocephalus*	+	-
				Echinops spinosus	+	-
			Taraxacum	*Taraxacum dens leonis*	+	-
			Centaurea	*Centaurea pullata*	+	-
	Myrtales	**Thymlaceae**	*Daphne*	*Daphne gnidium*	-	+
		Myrtaceae	*Myrtus*	*Myrtus communis*	+	-

	Apiales	**Apiaceae**	*Ferula*	*Ferula communis*	+	-
	Geraniales	**Oxalidaceae**	*Oxalis*	*Oxalis pes-caprae*	+	+
		Rubiaceae	*Rubia*	*Rubia perigrina*	+	-
		Geraniaceae	*Blackstonia*	*Blackstonia perfoliata*	+	-
			Geranium	*Geranium robertianum*	+	-
	Papaverales	**Papaveraceae**	*Fumaria*	*Fumaria capreolata*	+	+
				Fumaria officinalis	+	+
			Papaver	*Papaver rhoeas*	-	+
	Capparales	**Brassicaceae**	*Capsella*	*Capsella bursa-pastoris*	-	+
			Sinapis	*Sinapis arvensis*	+	+
	Brassicales		*Biscutella*	*Biscutella didyma*	-	+
			Raphanus	*Raphanus raphanistrum*	-	+
	Lamiales	**Boraginaceae**	*Echium*	*Echium vulgare*	+	+
				Echium australe	+	-
		Lamiaceae	*Lamium*	*Lamium garganicum subsp longiflorum*	-	+
				Lamium album	-	+
				Lamium purpureum	-	+
			Mentha	*Mentha pulegium*	+	-
	Scrophulariales	**Oleaceae**	*Olea*	*Olea europaea*	+	+
	Rosales	**Rosaceae**	*Rubus*	*Rubus ulmifolius*	+	+
			Prunus	*Prunus avium*	-	+
			Crataegus	*Crataegus monogyna*	+	-
			Rosa	*Rosa sempervirens*	+	-
	Fagales	**Fagaceae**	*Quercus*	*Quercus suber*	+	+
				Quercus ilex	-	+
	Caryophyllales	**Caryophyllaceae**	*Silene*	*Silene fuscata*	+	+
			Cerastium	*Cerastium semidecandrum*	+	-
	Fabaless	**Fabaceae**	*Calicutome*	*Calicotome spinosa*	+	+
			Cytisus	*Citysus triflorus*	+	+
				Cytisus spinosus	-	+
			Lupinus	*Lupinus angustifolius*	-	+
			Vicia	*Vicia monantha*	+	+
			Melilotus	*Melilotus sulcata subsps brachystachys*	+	+
			Trifolium	*Trifolium repens*	+	-
				Trifolium campestre	+	-

			Coronilla	*Coronilla scorpioides*	-	+
			Psophocarpus	*Psophocarpus tetragonolobus*	+	-
	Ranunculales	**Ranunculaceae**	*Clematis*	*Clematis flammula*	+	-
			Ranunculus	*Ranunculus macrophyllus*	+	-
	Primulales	**Primulaceae**	*Anagalis*	*Anagalis arvensis*	+	-
	Rhamnales	**Rhamnaceae**	*Rhamnus*	*Rhamnus alaternus*	+	-
	Urticales	**Ulmaceae**	*Ulmus*	*Ulmus pumila*	+	-
	Arales	**Araceae**	*Arisarum*	*Arisarum vulgare*	+	-
	Malvales	**Cistaceae**	*Cistus*	*Cistus monspeliensis*	+	+
	Ericales	**Ericaceae**	*Erica*	*Erica arborea*	+	+
			Arbutus	*Arbutus unedo*	-	+
	Campanulales	**Campanulaceae**	*Campanula*	*Campanula rapunculus*	+	-
Equisetopsida	**Brassicales**	**Brassicaceae**	*Brassica*	*Brassica rapa*	-	+
	Aspiales	**Aspiaceae**	*Daucus*	*Daucus carota*	+	+
			Thapsia	*Thapsia garganica*	-	+
	Lamiales	**Lamiaceae**	*Stachys*	*Stachys ocymastrum*	+	+
	Poales	**Poaceae**	*Polypogon*	*Polypogon monspelinesis*	-	+
			Brachypodium	*Brachypodium distachyon*	+	-
			Avena	*Avena sterilis*	+	-
Liliopsida	**Liliales**	**Liliaceae**	*Allium*	*Allium triquetrum*	+	+
				Allium roseum	+	+
			Muscari	*Muscari comosum*	-	+
			Asparagus	*Asparagus acutifolius*	+	+
		Dioscoreaceae	*Dioscorea*	*Dioscorea communis*	+	-
	Cyperales	**Poaceae**	*Ampelodesmos*	*Ampelodesmos mauritanicus*	-	+
Polypodiopsida	**Polypodiales**	**Aspleniaceae**	*Asplenium*	*Asplenium adiantum*	+	-
		Dryopteridaceae	*Dryopteris*	*Dryopteris filix-mas*	+	-
4	**28**	**33**	**70**	**79**	**55**	**49**

Ecological indices study: The results of the different collected plant strata, during the flora sampling at the study areas, are presented in Figure 3. The results illustrate the dominance of the annual plant stratum in the studied areas, with a percentage ranging from 46% at the unburned site (A) to 47% at the burned one (B). This is followed by the perennial plant stratum with 35% and 36% respectively for the two sites (A & B), and finaly with the presence of the woody shrub layer, with 18% for both sites; reflecting the floristic latter regeneration.

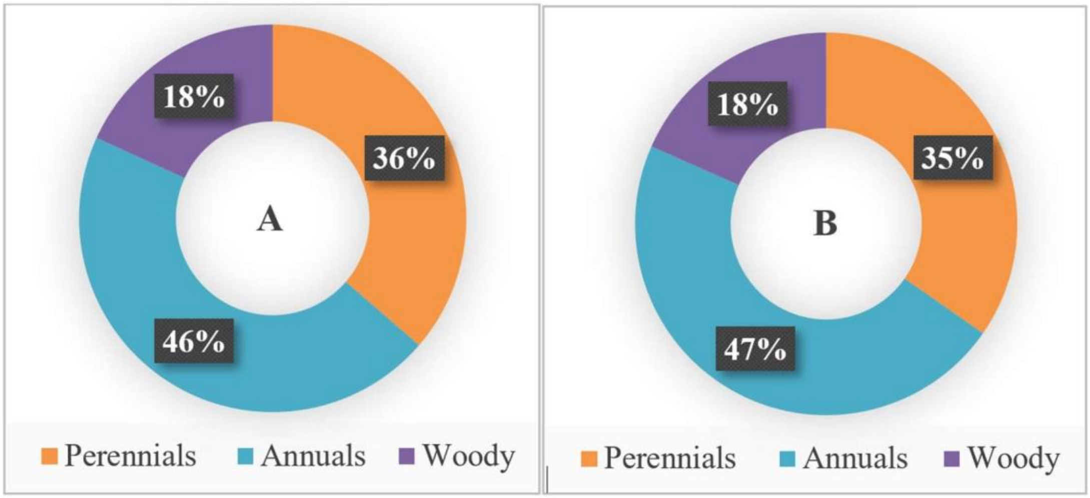

Figure 3: Classification and rate of harvested plant species in the study areas (A& B).

Classification by biological types: The classification of plants, according to their organization with the environment and the persistence of their vegetative development during the bad season, divides them into a different biological type represented by: Phanerophytes, Hemicryptophytes, Geophytes and Therophytes (Figure 4B) and Chamaephytes which was found only in the preserved sit (Figure 4A). The biological types analysis of the collected flora highlights the dominance of Therophytes in the stations studied followed consecutively by Hemicryptophytes, Phanerophyte, Geophytes and Chamephytes.

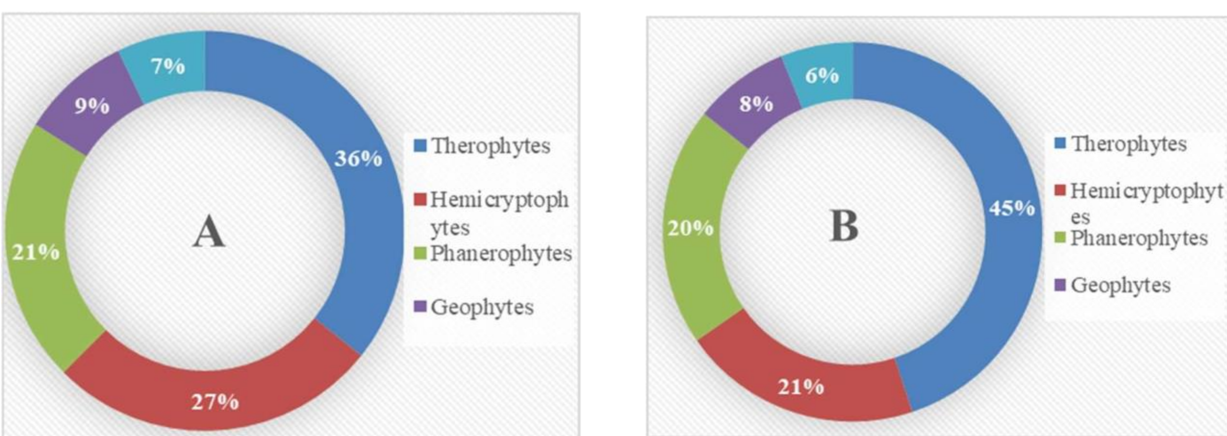

Figure 4: Classification spectra of the recorded plants according to their biological types.

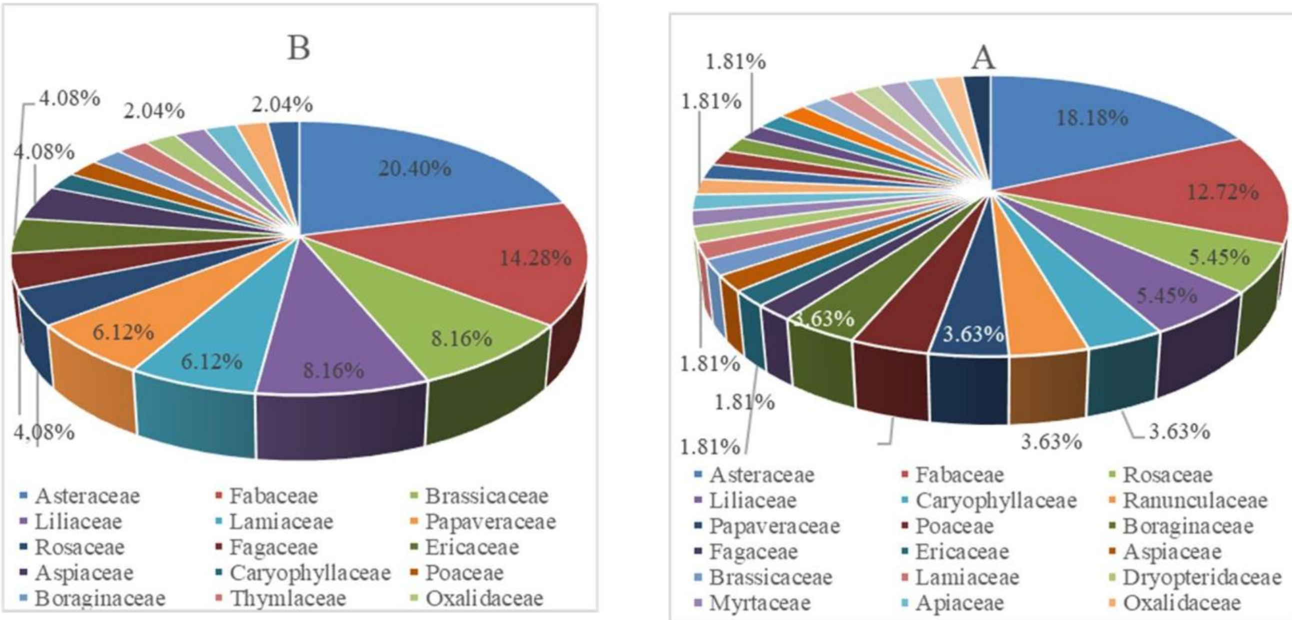

Figure 5: Relative abundance of the families of plant species recorded in the study stations.

Relative abundance: Floristic diversity is noteworthy, in the post-fire site, Ikhelidjen (B:) during the following two years post-fire, where a total richness of 49 species across 3 classes only (Magnoliopsida, Liliopsida and Equisetopsida) were found. Therefore, the preserved area, Sidi Ali Bounab (A) presents a richness of 55 species across 4 found classes (Magnoliopsida, Liliopsida, Equisetopsida and Polypodiopsida). Following the systematic organization, the Asteraceae family was noticed to be the most dominant in the two study sites (A & B), with 20.40% in Ikhelidjen (B) and 18.18% in Sidi Ali Bounab (A). For this family it was recorded that the Asterale was the most dominant order, comprising 10 species for each station, with only 5 similar species (Table 2). Therefore, the second dominant family, for the unburned site, was followed by the Fabaceae family with 12.72%, whereas in the burned post-fire site is the same family it was higher with 14.28 %. This same increase was found for all the following existent families (Figure 5).

Species richness: The results of the specific richness of the plant species harvested in the study areas are illustrated in Figure 6. This specific richness was cover 55 species in the preserved site (A) (Sid Ali bounab) while 49 species presented the post-fire site (B) in Ikhelidjen area. In general, the biodiversity evenness increases with the number of species, i.e., low evenness is only the consequence of a low number of taxa and/or the dominance of a few species which is explained by Figure 7. The estimated value of the Sorenson index, was $ISørense = 0.48$ and which represents the close similarity of the flora between the two study sites. This is confirming a biodiversity plant regeneration at 50% in burned, the Ikhlidjen site (A). This index tends to 0, is indicating that the different habitat conditions determine a renewal of important species.

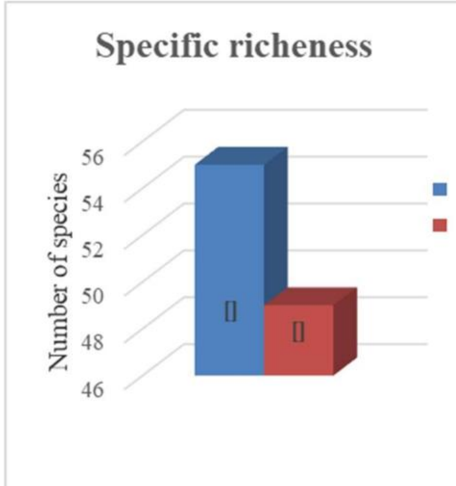

Figure 6: the specific richness of the plant species harvested in the study stations, the preserved site (A) (Sid Ali bounab) and the post-fire site (B) (Ikhelidjen area).

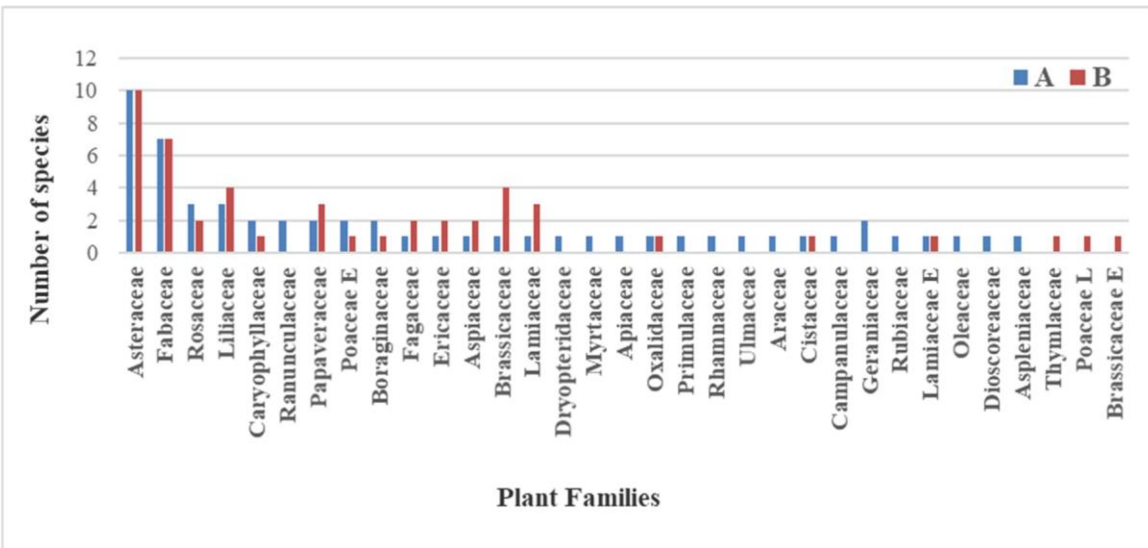

Figure 7: The specific richness of the families collected in the study stations.

Substrate analysis: The obtained results of the physico-chemical analyze are illustrated in Table 2, which is interpreted according to international standard parameters. The physico-chemical characterization of the soils of the study stations allowed to distinguish a sandy-loamy texture, a neutral pH, a high electrical conductivity, an increase in organic matter levels and moderate calcareous in the burned area

Table 2: Results of the physico-chemical analyzes of the soils of the study sites (A & B).
(C= Clay, FS= Fine Silt, Coarse Silt=CS, Fine Sand =FS, Coarse Sand =CS, Eletric condictivity, Organic Matter).

Ground Quality of the Site	Physical analyzes					Chemical analyzes				Texture
	C%	FS %	CS%	FS %	CS %	pH	Total $CACO_3$	EC ds/cm	OM %	
Sidi Ali Bounab (A)	17.37	40.06	1.53	18.04	23	6.3	5.63	111.1	8	Sandy-loamy
Ikhlidjen (B)	18	39.95	1.7	20	25	7.6	12.5	538	45.6	

DISCUSSION

In Algeria, the fire use in agricultural work was the main cause of fires, as well as vegetation management activities (i.e. the creation or renewal of pastures, forestry work and wild honey hunting) as well as illegal dumping and burning of waste (Meddour-Sahar et al. 2013), cigarette butts and deliberate fires, intentionally set by humans according to the harmonized fire classification system (Camia et al. 2013), were also causes of negligence, mainly related to interests in land use change. The resurrection also appears important in Algeria, where it is caused by firefighters who do not always ensure the cleaning of controlled fires, but also by so-called "security" fires (Meddour-Sahar et al. 2013). The flora of a geographical area is the most important biotic component (Ortíz 2016) which expresses the ecological conditions (climatic, geological, historical, geomorphological and edaphic) (Loisel 1978) especially since it is far from be the same in all countries (Piston et al. 2016). The Mediterranean region is considered among regions in the world that contains plant diversity which corresponds to various heterogeneous groups linked to the region's paleo-history (Myers et al. 2000; Quezel and Medail 2003). Algeria, is one of the rare biogeographical countries, having an exceptional ecological entity in the biosphere, due to its extended area which represents various ecosystems. The flora biodiversity recorded during the survey in the non-burned area (Sidi Ali Bounab = A) represents 55 identified species to 50 genera, wherase the flora survey in Ikhelidjen burned area results revealed the presence of a total richness of 49 species belonging to 43 genera, 20 families, and 19 orders. The rapid flora regeneration was observed with the Asteraceae and Fabaceae families, in a soil presented a low alkaline and high organic matter content. These results show a 50% similarity between the study area. These inventoried species were closely similar to those identified by Rebbas et al. (2010) in the Gouraya massif, which is the massif extension of the studied burned area. Also, comparing the present results with those of the national flora, the Asteraceae family is the most important botanical family in Algeria and particularly one of the plant biodiversity hotspots in the Kabylia region (Lembrouk and Sadoudi 2022), since it contains 408 species distributed in 109 genera (Quezel and Santa 1963). The analysis of the floristic richness of the different groups, according to their biological and chronological characteristics would make it possible to highlight their floristic originality, its state of conservation and consequently their heritage value. This is visible through the different plant strata collected during flora sampling at the study stations where dominate the annual's plant stratum with 46% at the unburned station to 47% at the burned station, followed by the perennial plant stratum with 35% and 36% respectively for the two stations, to finish with the woody shrub layer with 18% for each station. This flora classification according to its biological type, revealed the dominance of Therophytes type followed by Hemicryptophytes < Phanerophyte <Geophytes < Chamephytes. Verlaque et al. (2001) and Benabadji et al. (2007) emphasized that the preponderance of therophytes indicates strong anthropogenic pressure linked to human action, especially the fires which characterize the Mediterranean area as well as seasonal rainfall, which leave them resistant to dry periods and high temperatures as is the case in Ikhelidjen after fire, during the summer 2021. Plant communities are in direct interaction with their soil throughout their existence (Keesstra et al. 2016), they are involved in the genesis, spatial organization and functioning of soils (Freshet et al. 2018). This is evidenced by the presence of the species: *Echium vulgare*, *Andryala integrifolia*, *Rubus ulmifolius*, *Ampelodesmos mauritanicus*, indicating a limestone relief (Bayer and Starr 1998). In addition, Chapin et al. (2011) specify that many edaphic factors influence vegetation, these may be physical and chemical factors or the availability of nutrient resources.

The biodiversity of Ikhelidjen's flora after the big-fire was characterized by the massive installation of herbaceous, perennial and annual species from the Asteraceae, Poaceae and Fabaceae families. This could be due to the fertility of the soil, particularly as the vegetation retains the same dynamics and structure without any profound floristic changes. In addition, It was also noticed bounce and a stable plant community adapted after the fire. The estimated species represent a close similarity of the flora between the two study sites; since the different habitat conditions determine a renewal of important species. Therefore, it temporarily eliminates all the epigeous vegetation, but it is also defined by the appearance of a new equilibrium that is established during the healing process of the forest ecosystem and the disturbed communities are recovered and reconstituted in the same way a according to the preserved area.

Acknowledgement

The research project was supported by the National Fund for Scientific Research, Ministry of High Education and Scientific Research (PRFU Project, N° D01N01UN150120220003). Laboratory of Production, Threatened Species and Crops Safeguarding. Influence of Climatic Variations, Mouloud Mammeri University, Tizi-Ouzou, Algeria.

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