CATRINA (2021), 23(1):67-82

Distribution of *Pluchea dioscoridis* Plant Community Types in Relation to The Combined Effect of Soil and Climate

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ABSTRACT

Studying the factors affecting plants distribution is important for designing a sound management under both current and expected climate change. The present study aims to assess the distribution of *Pluchea dioscoridis* (L.) DC. and the main environmental factors affecting it along a gradient of aridity. Twenty-two stands distributed latitudinal were surveyed where vegetation was investigated and soil samples were collected and analyzed. A significant difference between soil characteristics at the studied stands was detected. Sixty-two species (34 perennials and 28 annuals) belong to thirty-one families were identified with Asteraceae, Chenopodiaceae and Poaceae as the most represented families. Therophytes followed by Chamaephytes are the highest recorded life forms. The highest represented chorotype elements are the Mediterranean (37.3%) followed by Saharo-Sindian (35.6%). TWINSPAN analysis identified three vegetation assemblages. Each one is connected with at least one main climate region and associated species. The Canonical Correspondence Analysis (CCA) showed that water content, chlorides, NaCl, potassium, sodium, calcium, clay and organic matter are the most effective edaphic factors, while precipitation, relative humidity, dew point, temperature, minimum and maximum temperature are the most effective climatic factors on *P. dioscoridis* distribution. In conclusion, the results revealed that *P. dioscoridis* able to survive under a wide range of edaphic and climatic conditions. Its distribution is mainly affected positively by water-related and negatively by salinity factors. So, it is expected that distribtution of *P. dioscoridis* would be affected by any increase in aridity under the anticipated climate change.
Keywords: Climate, *Conyza dioscoridis*, Multivariate analysis, Plant community, Soil, Weeds

INTRODUCTION

Environmental and climatic changes have the main tangible impact on the biological behavior in eco-systems. They affect species distribution and diversity in response to the ongoing changes (Mitchell *et al.*, 2003; Bonebrake *et al.*, 2018). At the same time, climate and vegetation affect the soil components of organic matter, water, temperature, erosion and nutrients (Miller *et al.*, 2004; Wang *et al.*, 2010; Lin *et al.*, 2018; Stefanidis & Stathis, 2018). Climate change promotes species invasion in many ecosystems, threatening biodiversity, fitness, and dynamics of native species and causing variable changes in ecosystem structure (Kamel *et al.*, 2008; Pyek *et al.*, 2012; Bradley *et al.*, 2016; Panetta & Gooden, 2017). Habitat disturbance through unmanaged growing human activities increase the susceptibility to invasion (Gritti *et al.*, 2006). On the other hand, climatic changes may reduce the invasion of other species due to the new unsuitable conditions which create a restoration and establishment opportunity of native species (Bradley *et al.*, 2009; Taylor & Kumar, 2013).

Pluchea dioscoridis is a perennial invasive weed belongs to family Asteraceae (Compositae) (Simposn, 1932; Shaltout & Slima, 2007) that has many ecological and medicinal importances. It has been recorded as a weed in desert reclaimed lands and abandoned fields in Egypt. It stabilizes heavy metals as Cu, Pb, Cd, and Zn and could be considered a bioindicator for Cr and Cd pollution (Eltaher *et al.*, 2019). Its allelopathic, herbicidal and larvicidal effects were recorded (Grace, 2002; Fahmy *et al.*, 2012; Balah, 2016). Medicinally, *P. dioscoridis* is widely used as a popular remedy to relieve rheumatic pains (Boulos & El-Hadidi 1984), treatment of epilepsy in children, colic, ulcer and cold, and as carminative (El Bitar, 1890). Its extract exhibited anti-diarrheal, anti-inflammatory, anti-microbial and anti-nociceptive activities effects (Atta & Mouneir, 2004; Awaad *et al.*, 2011; El-Ghorab *et al.*, 2015).

To quantify both of risks and opportunities of the expected environmental and climatic change for land management, the initial step is to collect monitoring data and information about the environment and species changes (Moustafa *et al.*, 2015). This allows the detection of invasion and understanding of its dynamics and generates quantitative expectations of the ecosystem performance (Crooks, 2005; Hulme *et al.*, 2008). Therefore, the present study aims to assess the distribution of *P. dioscoridis* and environmental and climatic factors that influence it. It also aims to figure out the potentiality of *P. dioscoridis* as an indicator species to specific habitats or environmental parameters.

MATERIALS AND METHODS

Study Area

The study area, of *Pluchea dioscoridis* investigated (Figure 1), covered the coastal region from Damietta at (31.378670 N, 31.786204 E) to Port Said at (31.266835 N, 32.315692 E) and extended inland latitudinally along the Suez Canal through Ismailia to Suez at (30.223762 N, 32.414534 E). The last inland point was on the Suez-Cairo highway at 29.97025N, 32.140694E (Figure 2). The soil of the area between the Suez Canal and El-Salam Canal shows high level of salinity (El-Kady *et al.*, 2017). Also, the soil of Abu khalifa region

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shows an incline land surface due to the nature of the soil and the increase of the underground water (Abou El Azim & CEO, 2007). The soil to the south is characterized by high permeability and low organic matter (Mohamed *et al*, 2020).

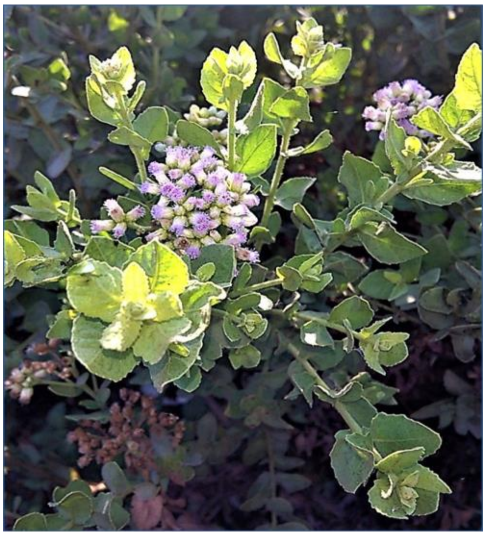

Figure (1): Photograph of *Pluchea dioscoridis* grown in the study area showing the morphology of the leaves and the flowers.

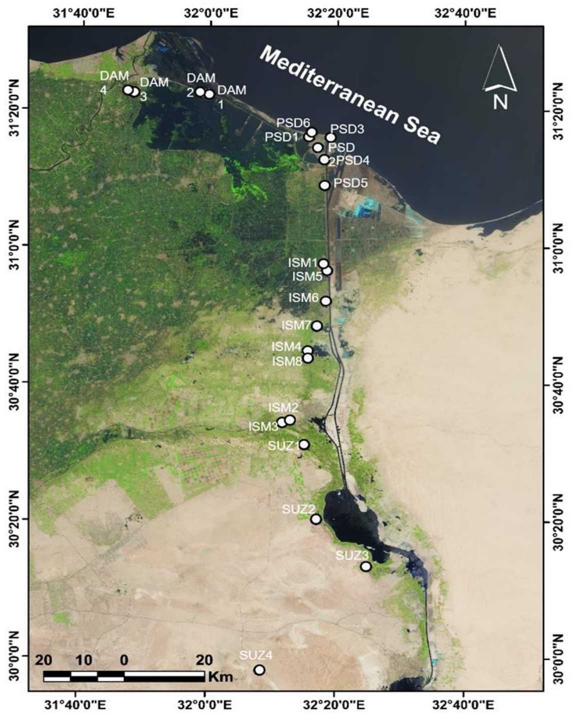

Figure (2). Location map of the studied stands

Climate data collection

The climate data of the studied period, between 2000 and 2018, for Damietta, Port Said, Ismailia, Suez, Suez-Cairo railway were obtained from the NASA Langley Research Center (LaRC) POWER Project funded through the NASA Earth Science/Applied Science Program.

The annual mean of precipitation during the period from the year 2000 to 2018 ranged from 46.11 mm/year at Suez-Cairo railway to 103.35 mm/year at Port Said. Also, the relative humidity ranged from 49.6% at Suez-Cairo railway to 64.5% at Port Said. The annual dew/frost point at 2 Meters ranged from 9.02 ^{o}C at Suez-Cairo railway to 26.92 ^{o}C at Damietta. Although the mean annual temperature did not differ greatly between different governorates (from 20.91^{o}C at Suez-Cairo railway to 21.85^{o}C at Damietta), the annual temperature range differed significantly between them; it ranged from 6.50 ^{o}C at Port Said and 9.01^{o}C at Damietta to 13.91^{o}C at Suez and 12.78^{o}C at Suez-Cairo railway (Table 1).

Selection of stands and collecting phytosociological data

Twenty-two stands were selected from April 2017 to September 2017 (Table 1). The area of each stand was 5m X 5m except at site no. 15 (3m X 5m) as it was a narrow roadside strip. The main criterion to select stands was the distribution over latitudinal Mediterranean and semi-arid and arid inland areas to assess the effect of climate differences and the clear representation of the studied species in the stand. Diversity of habitat types was sampled as roadsides, wastelands, demolition residue, seashore, valley and industrial areas.

In each stand, plant species were identified according to Tackholm (1974) and Boulos (1999, 2000, 2002, 2005). Nomenclature was revised according to Boulos (2009). Plant life forms were identified according to Raunkiaer (1934) in to the categories: Phanerophyte, Chamaephyte, Hemicryptophyte, Cryptophytes (Geophyte and Helophyte), and Therophyte. Chorological classification was done following Zohary (1972); Mashaly *et al.* (2013) and Abd El-Ghani *et al.* (2015). Plant cover of each species was determined as the canopy cover, and plant frequency was calculated as the proportion of the stands at which the species was represented once at least (Kuchler *et al.*, 1974).

Soil sampling and analysis

Three samples were collected from each site near the root (15 cm depth), mixed well, air-dried, sieved through a 2 mm sieve and stored for physical and chemical analyses. For determination of soil moisture content, the ratio of water mass to sample mass in oven-dried fine earth soil samples (105 °C to constant weight) was calculated (Piper, 1966), while hygroscopic moisture content was expressed as a percentage of the oven-dry weight. Soil texture has been detected by pipette method in 20 g using soil texture triangle and following Piper (1966).

A soil extract (1:5) was used as described by Slavich & Petterson (1993) in chemical analyses. pH-meter (Hanna Instruments™ HI2210-02) and EC-meter (Milwaukee Mi306) were used. Organic matter percentage was determined by loss on ignition method at 550^{o}C (Dean, 1974; Heiri *et al*., 2001). Carbonate and Bicarbonate were determined following the rapid titration method described by Allen *et al*., (1974). The concentrations of soluble calcium and magnesium were quantified by titration with EDTA (Allen *et al*., 1976). Chloride concentration by titration with 0.02N silver nitrate solution and 5% Potassium Chromate was used as an indicator (Allen *et al*., 1976). To determine the soil total nitrogen, 0.5 g of 3 leaves' powder was digested by sulfuric acid and hydrogen peroxide according to Piper (1966). The total nitrogen was determined using modified Kjeldahl method according to Piper (1966) and AOAC (1995). Available phosphorus in soils has been extracted by using sodium bicarbonate method (Olsen *et al*., 1954) in five grams of air-dried fine earth soil. Vanadate molybdate method was used for estimation of phosphorus concentration (Koenig & Johnson, 1942). Total potassium and sod-ium concentrations were determined in the digested soil by sulfuric acid and hydrogen peroxide according to Piper (1966) by (JENWAY PFP 7) flame photometer.

Vegetation analysis

The phytosociological data of twenty-two populations and sixty-two species were classified using TWINSPAN (Two-way Indicator Species Analysis) technique (Hill, 1979) using PC-ORD ver.5 (McCune & Mefford, 1999).The relation between both of species and populations and the environment were interpreted using CCA technique (ter Braak, 1986) in PC-ORD. The species whose over all stand cover were less than 0.05 were excluded (40=64.6%) to reduce noise (Gauch, 1982). The environmental factors widely explain the variance in species composition was chosen.

Statistical analysis

Statistical analyses of different soil parameters were performed using IBM SPSS 25 and significant differences between populations were tested. The variation in the environmental factors between the three assemblages produced from TWINSPAN was tested for significance by using one-way analysis of variance (ANOVA). Fishers Least Significant Difference (LSD) pairwise comparison between TWINSPAN groups were used to assess the differences between groups.

RESULTS

Species and vegetation composition

Fifty-nine species (out of sixty-two) were identified belong to thirty-one families. Two species were identified to the genus level only in addition to one unknown Asteraceae species. The highest represented family was Asteraceae with thirteen species. Chenopodiaceae and Gramineae were represented by seven species and Zygophyllaceae by three species. Six families (Leguminosae, Asclepiadaceae, Boraginaceae, Convolvulaceae, Cruciferae and Cyperaceae) were represented by two species. The other families (21, 67.7%) were represented by a single species. The life span for each species was determined; annual plants represented 40.3 % (25 species) and perennial plants represented 59.7 % (37 species). Six life forms were identified in the study area; Therophytes (21, 33.9 %), Chamaephytes (17, 27.4 %), Phanerophytes (11, 17.7 %), Geophytes (6, 9.7 %), Hemicryptophytes (6, 9.7%), and Helophytes which was represented by only one species (1.6 %) (Figure 3, Table 2).

The chorological analysis revealed that the bio-regional species were the higher recorded chorotype

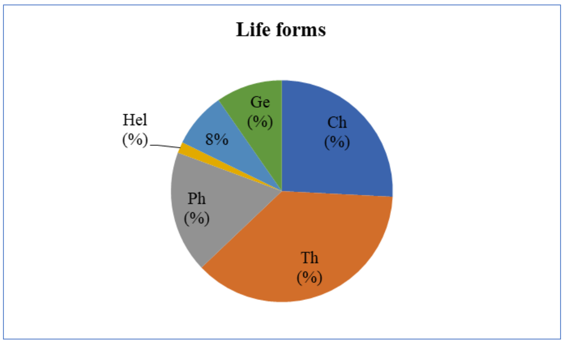

Figure (3): The life form spectrum of the *Pluchea dioscoridis* associated species over the studied area. Th, Therophyte; Ph, Phanerophyte; H, Hemicryptophyte; Ch, Chamaephyte; Hel, Helophyte; Ge, Geophyte.

(23 species represented 39% of the identified species), followed by the mono-regional species with ninteen (32.2 %) and pluri-regional species with ten (17%) of the identified species. While cosmopolitans were seven species with 11.8% of the identified ones. Over mono-regional, bi-regional and pluri-regional species, the highest represented chorotype was the Mediterranean by twenty two (37.3%), followed by Saharo-Sindian by twenty one (35.6), Irano-Turanian by sixteen (27.1%) and Euro-Siberian by nine species (15.3%). The dominant choro-type element in the studied area was Saharo-Sindian with eight species followed by both of Mediterranian/Irano-Turanian/Euro-Siberian and Saharo-Sindian/Sudano-Zambezian with six species for each.

Classification of stands

The stands were classified by TWINSPAN at the second level into four assemblages. The fourth one comprises one stand with low variations from the third assemblage in annuals. Accordingly, it was combined with very close one to get three main assemblages based on species cover of sixty-two species growing in twenty-two stands (Figure 3): Assemblage I: *Pluchea dioscoridis-Tamarix nilitica*; Assemblage II: *Pluchea dioscoridis-Phragmites australis*; Assemblage III: *Pluchea dioscoridis-Cynodon dactylon*.

Pluchea dioscoridis was dominant in all three assemblages with 100% presence and 5% average cover. The dominance of this species is attributed to the selective choice of *Pluchea dioscoridis* dominated stands as it is the target of the study. Assemblage (I) has two species (*Pluchea dioscoridis* and *Tamarix nilitica*) with 100% presence and with average cover of 5% and 3.83%, respectively. In the second assemblage, *Pluchea dioscoridis* has 100% presence with average cover 5% and *Phragmites australis* is a co-dominant with 86% presence and 2.7% average cover. In third assemblage, *Pluchea dioscoridis* and *Cynodon dactylon* are species that have 100 % presence with 5% and 4.44% average cover values, respectively (Table 3).

To give a general idea about the variation in the environmental factors among the three assemblages, means and standard error of environmental variables for each assemblage stands were calculated (Table 4). Soil water content was the only edaphic factor which

Table 1. List of populations locations, latitude, longitude and abbreviation, the annual record of precipitation (mm day^{-1}), relative humidity at 2 meters%, dew/frost point at 2 meters (^{o} c), temperature (^{o} c), temperature range (^{o} c), minimum and maximum temperature (^{o} c), wind speed (m/s), all sky insolation incident on a horizontal surface (kW-hr/m2/day) from 2000 to 2018 At Damietta, Port Said, Ismailia, Suez and Suez-Cairo railway meteorological stations.

Region	Population location	Code	Latitude	Longitude	Prec†.	R h‡	Dew point	Temperature	Temp range	Maximum temperature	Minimum temperature	Wind speed
Mediterranean	PortSaid - Damietta highway	DAM1	31.371907N	31.996846E	83.05	59.84	26.92	21.85	9.01	17.91	13.26	3.9
	PortSaid - Damietta highway	DAM2	31.375809N	31.976391E								
	Damietta - Gamasa highway	DAM3	31.374509N	31.800645E								
	Damietta - Gamasa highway	DAM4	31.378670N	31.786204E								
	PortSaid governorate	PSD1	31.271595N	32.262543E	103.35	64.5	14.29	21.58	6.5	25.24	18.73	3
	PortSaid governorate	PSD2	31.241879N	32.283491E								
	PortSaid governorate	PSD3	31.266835N	32.315692E								
	PortSaid governorate	PSD4	31.150359N	32.301104E								
	PortSaid - Ismailia highway	PSD5	31.213343 N	32.299730E								
	PortSaid - Damietta highway	PSD6	31.277608N	32.26637E								
Semi-arid	PortSaid -Ismailia highway	ISM1	30.943481N	32.308532E	62.11	53.89	11.25	21.67	12.56	28.69	16.13	3.51
	Ismailia governorate	ISM2	30.573066N	32.194053E								
	Ismailia - Suez highway	ISM3	30.519506N	32.252150E								
	PortSaid - Ismailia highway	ISM4	30.744072N	32.258967E								
	PortSaid - Ismailia highway	ISM5	30.942279N	32.308759E								
	PortSaid - Ismailia highway	ISM6	30.868206N	32.307095E								
	PortSaid - Ismailia highway	ISM7	30.808075N	32.282624E								
	PortSaid - Ismailia highway	ISM8	30.730653N	32.260171E								
Arid	Ismailia - Suez highway	SUZ1	30.337588N	32.284131E	50.77	49.82	9.57	21.35	13.91	28.97	15.07	3.37
	Ismailia - Suez highway	SUZ2	30.519754N	32.251938E								
	Ismailia - Suez highway	SUZ3	30.223762N	32.414534E								
	Suez - Cairo highway	SUZ4	29.97025N	32.140694E	46.11	49.6	9.02	20.91	12.78	27.79	15.01	2.92

†Precipitation , Prec.; ‡Rh, Relative humidity

Table 2. List of species, family, life-form, chorotype, designation code used in quantitative analysis, presence (%) and plant cover (%). Life forms: CH Chamaephyte; H Hemicryptophyte; G Geophyte; PH Phanerophyte; and TH Therophyte. Chorotype: ME Mediterranean, IR-TR Irano-Turanian, SZ Sudano-Zambezian, ER-SR Euro-Siberian, SA Saharo-Sindian, COSM: Cosmopolitan, AM American, PAL Palaeotropical, PAN Pantropical, TRO Tropical and BO boreal.

Family	Species	Life form	life span	Chorotype	Code	Presence (%)	Cover (%)
Aizoacea	*Mesembryanthemum crystallinum* L.	Th	Annual	ME+ER-SR	*Mes-cry*	9.091	0.068
Amaranthaceae	*Amaranthus viridis* L.	Th	Annual	COSM	*Ama-vir*	4.545	0.015
Apocynaceae	*Cascabela thevetia*	Ph	Perennial	TRO+AM	*Cas-the*	4.545	0.303
Asclepiadaceae	*Calotropis procera* (Aiton) W.T. Aiton	Ph	Perennial	SZ+SA	*Cal-pro*	4.545	0.064
	Cynanchum acutum L.	Ch	Perennial	ME+IR-TR	*Cyn-acu*	68.182	1.011
Boraginaceae	*Tecoma stans* (L.) Juss. ex Kunth	Ph	Perennial	Cult.	*Tec-sta*	4.545	0.091
	Echium sp.	Ch	Perennial		*Echium*	4.545	0.284
	Heliotropium curassavicum L.	Ch	Perennial	ME+IR-TR+ER-SR	*Hel-cur*	4.545	0.023
Chenopodiaceae	*Arthrocnemum macrostachyum* (MORIC.) K. Koch	Ch	Perennial	ME+SA	*Art-mac*	4.545	0.303
	Bassia indica (Wight) A. J. Scott	Th	annual	SZ+IR-TR	*Bas-ind*	27.273	0.356
	Beta vulgares L.	Ge	Annual	ME+ IR-TR+ ER-SR	*Bet-Vul*	4.545	0.023
	Chenopodium album L.	Th	Annual	COSM	*Che-alb*	4.545	0.030
	Chenopodium murale L.	Th	Annual	COSM	*Che-mur*	4.545	0.023
	Halocnemum strobilaceum (Pall) M. Bieb.	Ch	Perennial	ME+IR-TR+SA	*Hal-str*	4.545	0.136
	Salsola kali L.	Th	Annual	COSM	*Sal-kal*	4.545	0.091
Asteraceae (Compositae)	*Conyza bonariensis* (L.) Cronquist	Th	Annual	ME	*Con-bon*	27.273	0.524
	Cotula cinerea Delile	Th	Annual	SA	*Cot-cin*	4.545	0.009
	Glebionis coronaria (L.) Tzvelev	Th	Annual	ME	*Gle-cor*	4.545	0.061
	Limbarda crithmoides (L.) Dumort.	Ch	Perennial	ME+ ER-SR +SA	*Lim-cri*	4.545	0.011
	Iphiona mucronata (Forssk.) Asch. & Schweinf.	Ch	Perennial	SA	*Iph-muc*	4.545	0.018
	Lactuca serriola L.	Th	Annual	ME+IR-TR+ ER-SR	*Lac-ser*	4.545	0.091
	Launaea mucronata (Forssk.) Muschl.	Ch	Perennial	SA	*Lau-muc*	9.091	0.348
	Pluchea dioscoridis (L.) DC.	PH	Perennial	SZ+SA	*Plu-dio*	100.000	47.992
	Reichardia tingitana L. Roth	Th	Annual	SA+IR-TR	*Rei-tin*	4.545	0.015
	Senecio glaucus L.	Th	Annual	SA+IR-TR	*Sen-gla*	4.545	0.023
	Sonchus oleraceus L.	Th	Annual	ME+IR-TR+ER-SR	*Son-ole*	13.636	0.098
	Compositae (unknown)	Ch	Annual		*comp*	4.545	0.045
	Xanthium strumarium L.	Th	Annual	BO-TRO	*Xan-str*	4.545	0.258
Convolvulaceae	*Convolvulus arvensis* L.	H	Perennial	PAL	*Con-arv*	4.545	0.045
	Ipomoea pes-caprae (L.) R. Br. Subsp. *brasiliensis* (L.) Ooststr.	H	Perennial	TRO	*Ipo-pes*	4.545	0.455

Table 2: Continued

Cruciferae	*Cakile maritima* subsp. *aegyptiaca* (willd.) Nyman	Th	Annual	ME+ER-SR	*Cak-mar*	9.091	0.091
	Zilla spinosa (L.) Prantl	Ch	Perennial	SA	*zil-spi*	4.545	0.500
Cucurbitaceae	*Cucumis melo var. cantalupensis Naudin*	Ch	Annual	COSM	*cucumis*	4.545	0.034
Cyperaceae	*Cyperus laevigatus* L. var. *laevigatus*	Ge	Perennial	PAL	*Cyp-lae*	18.182	0.386
	Cyperus rotundus L.	Ge	Perennial	PAN	*Cyp-rot*	4.545	0.379
Euphorbiaceae	*Euphorbia peplus* L.	Th	Annual	ME+IR-TR+ER-SR	*Eup-pep*	4.545	0.009
Gramineae (Poaceae)	*Phragmites australis (Cav.) Trin. ex Steud.*	Ge	Perennial	COSM	*Phr-aus*	63.636	3.996
	Stipa sp.	Ch	Annual	-	*stipa*	4.545	0.136
	Cenchrus biflorus Roxb.	Th.	Annual	SZ+SA	*Cen-bif*	4.545	0.015
	Panicum repens L.	H	Perennial	ME-TR	*Pan-rep*	4.545	0.015
	Panicum turgidum Forssk .	H	Perennial	SA	*Pan-tur*	4.545	0.045
	Imprata cylendrica (L.) Raeusch	H	Perennial	ME+SZ	*Imp-cyl*	40.909	0.879
	Cynodon dactylon (L.) Pers.	Ge	Perennial	COSM	*Cyn-dac*	54.545	8.860
Juncaceae	*Juncus rigidus* Desf.	Ge	Perennial	ME+IR-TR +SA	*Jun-rig*	31.818	1.174
Lamiaceae	*Vitex agnus-castus*	Ph	Perennial	ME+IR-TR	*vit-agn*	4.545	0.114
Leguminosae	*Alhagi graecorum* Boiss.	Ch	Perennial	ME+IR-TR	*Alh-gra*	27.273	1.773
	Melilotus indicus (L.) All	Th	Annual	ME+IR-TR	*Mel-ind*	9.091	0.045
Moraceae	*Ficus benjamina* L.	Ph	Perennial	ME+IR-TR	*Fic-ben*	4.545	0.303
Onagraceae	*Oenothera drummondii* Hook.	Ch	Perennial	AM	*Oen-dru*	4.545	0.023
Palmae (Areaceae)	*Phoenix dactylifera* L.	Ph	Perennial	SA+SZ	*Pho-dac*	27.273	0.742
Plantaginaceae	*Plantago major* L.	H	Perennial	ME+IR-TR+ER-SR	*Pla-maj*	4.545	0.182
Resedaceae	*Ochradinus baccatus* Delile	Ph	Perennial	SA	*Och-bac*	4.545	0.036
Sapindaceae	*Dodonaea viscosa* (L.) Jacq.	Ph	Perennial	PAN	*Dod-vis*	4.545	0.076
Solanaceae	*Solanum lycopersicum*	Th	Annual	COSM	*Sol-lyc*	4.545	0.015
Tamaricaceae	*Tamarix nilotica* (Ehrenb.) Bunge	Ph	Perennial	SA+SZ	*Tam-nil*	72.727	6.883
Tiliaceae	*Corchorus olitorius* L.	Th	Annual	PAN	*Cor-oli*	4.545	0.015
Typhaceae	*Typha domingensis domingensi*s (Pers.) Poir. ex Steud.	Hel	Perennial	PAN	*Typ-dom*	9.091	0.258
Umbelliferae	*Deverra tortusa* (Desf.) DC.	Ch	Perennial	SA	*Dev-tor*	4.545	0.009
Verbenaceae	*Lantana camara* L.	Ph	Perennial	TRO+AM	*Lan-cam*	4.545	0.152
Zygophyllaceae	*Zygophyllum coccineum* L.	Ch	Perennial	SA	*Zygo-coc*	13.636	0.200
	Zygophyllum album L. F.	Ch	Perennial	MED+SA+SZ	*Zygo-alb*	9.091	0.068
	Zygophyllum simplex L.	Th	Annual	SA+SZ	*Zyg-sim*	9.091	0.082

-, The plant couldn't be identified due to absence of fruits. therefore, choroloy of it couldn't be determined.

Table 3. Phytosociological table showing presence percentage and average for the main assemblages resulted from TWINSPAN classification technique.

Group	**I**		**II**		**III**	
No. of Populations	6		7		9	
Number of species	28		29		28	
Species code	Presence	Cover†	Presence	Cover†	Presence	cover†
Alh-gra	16.67	0.50	14.29	0.71	44.44	0.67
Ama-vir	16.67	0.17	0.00	0.00	0.00	0.00
Art-mac	16.67	0.50	0.00	0.00	0.00	0.00
Bas-ind	0.00	0.00	71.43	1.14	11.11	0.11
Bet-Vul	0.00	0.00	14.29	0.14	0.00	0.00
Cak-mar	0.00	0.00	28.57	0.29	0.00	0.00
Cal-pro	16.67	0.17	0.00	0.00	0.00	0.00
Cas-the	0.00	0.00	0.00	0.00	11.11	0.33
Cen-bif	0.00	0.00	0.00	0.00	11.11	0.11
Che-alb	0.00	0.00	0.00	0.00	11.11	0.11
Che-mur	0.00	0.00	14.29	0.14	0.00	0.00
Comp	16.67	0.17	0.00	0.00	0.00	0.00
Con-arv	0.00	0.00	0.00	0.00	11.11	0.11
Con-bon	50.00	0.83	0.00	0.00	33.33	0.44
Cor-oli	0.00	0.00	0.00	0.00	11.11	0.11
Cot-cin	16.67	0.17	0.00	0.00	0.00	0.00
Cucumis	0.00	0.00	14.29	0.14	0.00	0.00
Cyn-acu	66.67	1.17	85.71	1.14	55.56	0.56
Cyn-dac	16.67	0.50	28.57	0.57	100.00	4.44
Cyp-lae	0.00	0.00	28.57	0.29	22.22	0.50
Cyp-rot	0.00	0.00	0.00	0.00	11.11	0.33
Dev-tor	16.67	0.17	0.00	0.00	0.00	0.00
Dod-vis	0.00	0.00	14.29	0.14	0.00	0.00
Echium	0.00	0.00	14.29	0.43	0.00	0.00
Eup-pep	16.67	0.17	0.00	0.00	0.00	0.00
Fic-ben	0.00	0.00	0.00	0.00	11.11	0.33
Gle-cor	0.00	0.00	0.00	0.00	11.11	0.11
Hal-str	16.67	0.33	0.00	0.00	0.00	0.00
Hel-cur	0.00	0.00	14.29	0.14	0.00	0.00
Imp-cyl	83.33	1.00	0.00	0.00	44.44	0.89
Iph-muc	16.67	0.17	0.00	0.00	0.00	0.00
Ipo-pes	0.00	0.00	14.29	0.57	0.00	0.00
Jun-rig	33.33	0.33	42.86	1.00	22.22	0.44
Lac-ser	16.67	0.33	0.00	0.00	0.00	0.00
Lan-cam	0.00	0.00	0.00	0.00	11.11	0.22
Lau-muc	16.67	0.17	14.29	0.43	0.00	0.00
Lim-cri	0.00	0.00	14.29	0.14	0.00	0.00
Mel-ind	0.00	0.00	0.00	0.00	22.22	0.22
Mes-cry	0.00	0.00	28.57	0.29	0.00	0.00
Och-bac	16.67	0.17	0.00	0.00	0.00	0.00
Oen-dru	0.00	0.00	14.29	0.14	0.00	0.00
Pan-rep	0.00	0.00	0.00	0.00	11.11	0.11
Pan-tur	16.67	0.17	0.00	0.00	0.00	0.00
Pho-dac	33.33	0.67	0.00	0.00	44.44	0.67
Phr-aus	83.33	2.00	85.71	2.71	33.33	0.56
Pla-maj	0.00	0.00	14.29	0.29	0.00	0.00
Plu-dio	100.00	5.00	100.00	5.00	100.00	5.00
Rei-tin	0.00	0.00	0.00	0.00	11.11	0.11
Sal-kal	0.00	0.00	14.29	0.29	0.00	0.00
Sen-gla	0.00	0.00	14.29	0.14	0.00	0.00
Sol-lyc	16.67	0.17	0.00	0.00	0.00	0.00
Son-ole	0.00	0.00	28.57	0.29	11.11	0.11
Stipa	16.67	0.33	0.00	0.00	0.00	0.00
Tam-nil	100.00	3.83	71.43	1.14	55.56	1.67
Tec-sta	0.00	0.00	0.00	0.00	11.11	0.22
Typ-dom	0.00	0.00	28.57	0.57	0.00	0.00
vit-agn	0.00	0.00	14.29	0.29	0.00	0.00
Xan-str	0.00	0.00	0.00	0.00	11.11	0.33
Zil-spi	16.67	0.67	0.00	0.00	0.00	0.00
Zygo-alb	0.00	0.00	28.57	0.29	0.00	0.00
Zygo-coc	33.33	0.33	0.00	0.00	11.11	0.22
Zyg-sim	16.67	0.17	14.29	0.14	0.00	0.00

† Plant Cover is in average

was found to have significant difference between the groups. While at the climatic factors, dew point, maximum temperature, minimum temperature and wind speed differs significantly between groups ($p \leq 0.05$).

Fisher's Least Significant Difference (LSD) pairwise comparison was applied to find differences between TWINSPAN groups. Three pairwise comparisons were performed. At the edaphic factors, soil water content had a significant difference between assemblages I-II and II-III. Also, chloride, TDS and NaCl had a significant difference between assemblages I-II ($p \leq 0.05$). At the climatic factors, dew point, maximum temperature, and minimum temperature had a significant differ-rence between assemblages I-II and II-III, while wind speed had a significant difference between assemblages I-II only (Table 4).

Assemblage I: *Pluchea dioscoridis-Tamarix nilitica*

Pluchea dioscoridis and *Tamarix nilotica* are the codominant species. *Imprata cylendrica* (83.33 % presence) and *Phragmites australis* (83.33 % presence) are the most prominent important species. This assemblage is distributed over six populations in different localities: Mediterranean, semi-arid and arid. The highest species richness was recorded in this assemblage. The soil of this assemblage is characterized by having the highest mean of pH (7.87 ±0.24), conductivity (24763.5 µS ±20266.93), TDS (2934.5 mg/l ±809.28), NaCl (11.3% ±3.18), organic matter (5.14% ± 1.53), clay (14.93% ±3.02), silt (15.64% ±8.21), Cl^- (975.92 mg/100g ±367.35), bicarbonate (60.17 mg/100g ±39.41), Mg^{++} (24.04 mg/100g ±5.09), Na^+ (689.26 mg/100g ±132.95), K^+ (440.44 mg/100 g ±74.62), phosphorus (19.63 mg/100 g ±132.95) concentrations and the climate of it has the highest precipitation (80.06 mm day^{-1} ±10.68), relative humidity (58.48% ±2.77) and minimum temperature (17.24 ^{o}C ± 0.69). It also has the lowest mean of nitrogen (283.11 mg/100g ± 49.84), sand (69.43% ±11), moisture content (4.14% ±1.6), temperature range (9.57^{o}C ±1.37) and wind speed (3.16m/s ± 0.11) (Table 4).

Assemblage II: Pluchea dioscoridis-Phragmites australis

In this assemblage, *Pluchea dioscoridis* is the dominant species. *Cynanchum acutum* and *Phragmites australis* are the codominant species with 85.71% presence for both. The associated species include *Bassia indica* (71.43% presence) and *Tamarix nilotica* (71.43% presence). This assemblage is distributed mainly at five populations of Mediterranean region, and two populations in the arid region. The soil of this assemblage is characterized by having the highest mean of moisture content (21.835%) and the climate of it has the highest mean of dew point (20.16 ±3.24), temperature range (10.05 ^{o}C ±1.05) and wind speed (3.62 m/s±0.14) and the lowest mean of pH (7.49±0.08), conductivity (1549.49 µS±619.42), TDS (778.76 mg/l ±309.34), NaCl (3 % ±1.18), bicarbonate (22.86 mg/100g ± 2.11), Cl^- (235.56 mg/100g ±85.53), Ca^{++} (11.28 mg/100g ±2.41), phosphorus (8.78 mg/100g ±0.76), Na^+ (482.93 mg/100g ±50.3), clay (7.89% ±1.9) and maximum temperature (22.12^{o}C ± 2.04) (Table 4).

Assemblage III: *Pluchea dioscoridis-Cynodon dactylon*

This assemblage is dominated by *Pluchea dioscoridis* (100% presence) and codominated by *Cynodon dactylon* (100% presence). *Tamarix nilotica* (55.56% presence), *Cynanchum acutum* (55.56% presence) and *Imprata cylendrica* (44.44% presence) represent the highest common species in populations of the assemblage. Most semi-arid populations (six populations from eight) are classified in this assemblage, in addition to two populations located in Mediterranean and one in arid region. The soil is characterized by the highest mean content of sand (82.74% ± 1.81) and nitrogen (424.67 mg/100g ±45.04) and the lowest mean content of organic matter (3.69% ± 0.78), hygroscopic water (2.22% ± 0.47), potassium (415.65 mg/100g ± 28.57) and silt (5.16% ±1.13). The climate of this assemblage is featured with the highest temperature mean (21.61^{o}C ±0.11) and maximum temperature (27.95^{o}C ±0.51) and the lowest precipitation (70.01mm day^{-1} ±6.42), relative humidity (55.80% ±1.70) and dew point (11.74 ±0.52). The low precipitation and relative humidity recorded are caused by the non-concentration of arid region populations in certain assemblages (Table 4).

Ordination

In Canonical Correspondence Analysis (CCA) ordination diagrams, rare species are located at the edge of diagrams. When all species were included in ordination analysis, majority of species were clumped at the centre of the diagram and the rare species were located at the edge. So, the rare species were eliminated to reduce that noise and to get a successful summarization of community composition and gradients (Gauch, 1982). To apply that, the species whose overall stand covers were less than 0.05 were excluded (40 = 64.6%). The CCA diagrams showed that first and second assemblages were separated along the axis1 and axis 2, while the third assemblage overlapped with both (Figure 5). It was also revealed that conductivity, NaCl, chloride, sodium, precip-itation, relative humidity, dew point, temperature range and maximum temperature are the most correlated factors with axis 1. While organic matter, clay, soil water content, annual mean temperature, minimum temperature and wind speed, are the most correlated environmental variables with axis 2. Clay is the most correlated variables with axis3.

Species - Environment relationship

From the studied edaphic factors, eight factors (conductivity, NaCl, Cl^-, Ca^{++}, Na^+, K^+, and clay and organic matter percentages) were represented as vectors (lines) and twenty-two species as cross symbol (+) in ordination diagrams. According to TWINSPAN classification, the first group of species which includes *Cynanchum acutum*, *Phragmites australis*, *Bassia indica*, *Ipomoea pes-caprae*, *Launaea mucronata*, *Typha domingensis*, *Zilla spinosa*, *Arthrocnemum macrostachyum and Echium* sp. occupies the right half of the diagrams of both axis1-axes2 plane for both

Table 4. Mean, standard error, ANOVA values of soil variables for the three vegetation assemblages resulted from TWINSPAN and LSD pairwise comparisons among assemblages.

Assemblage No.	I		II		III		ANOVA		LSD pairwise comparisons between TWINSPAN assemblages		
Number of stands	6		7		9						
	Mean	S.E	Mean	S.E	Mean	S.E	F	Sig.	I-II	I-III	II_III
pH	7.87	±0.24	7.49	±0.08	7.79	±0.17	1.32	0.29	0.15	0.75	0.21
Conductivity (µ S)	24763.5	±20266.9	1549.49	±619.42	3140.56	±1176.49	1.67	0.22	0.12	0.13	0.90
TDS (mg/l)	2934.5	±809.28	778.76	±309.34	1570.89	±588.39	2.98	0.07	0.03	0.12	0.34
NaCl%	11.3	±3.18	3.00	±1.18	6.06	±2.29	2.90	0.08	0.03	0.13	0.34
Organic matter%	5.14	±1.53	4.90	±1.79	3.69	±0.78	0.36	0.70	0.99	0.73	0.79
Carbonate (Mg/100g)	16.67	±16.67	0.00	±0.00	0.00	±0.00	1.38	0.28	0.17	0.15	1.00
Bicarb. (Mg/100g)	60.17	±39.41	22.86	±2.11	30.5	±6.15	0.96	0.40	0.20	0.28	0.77
Cl (mg/100g)	975.92	±367.35	235.56	±85.53	445.44	±208.7	2.36	0.12	0.05	0.13	0.52
Ca (mg/100g)	34.13	±16.50	11.28	±2.41	33.67	±14.29	1.00	0.39	0.25	0.98	0.22
Mg (mg/100g)	24.04	±5.09	14.25	±4.18	21.41	±8.21	0.52	0.60	0.35	0.79	0.45
N (mg/100g)	283.11	±49.84	385.33	±110.47	402.37	±45.04	0.72	0.50	0.36	0.26	0.87
P (mg/100g)	19.36	±9.64	8.78	±0.76	9.00	±1.42	1.53	0.24	0.14	0.13	0.97
Na (mg/100g)	689.26	±132.95	482.93	±50.3	539.59	±53.51	1.64	0.22	0.21	0.39	0.86
K (mg/100g)	440.44	±74.62	435.13	±39.93	415.65	±28.57	0.09	0.92	0.94	0.71	0.76
Moisture content%	4.14	±1.60	21.83	±9.36	5.33	±1.09	3.41	0.05	0.04	0.88	0.03
Hygroscopic water%	3.09	±1.33	3.04	±1.50	2.22	±0.47	0.22	0.81	0.98	0.58	0.59
Clay%	14.93	±3.02	7.89	±1.90	12.1	±1.66	2.52	0.11	0.04	0.36	0.16
silt%	15.64	±8.21	11.77	±5.44	5.16	±1.13	1.20	0.32	0.61	0.15	0.34
sand%	69.43	±11.00	80.34	±6.1	82.74	±1.81	1.19	0.33	0.26	0.15	0.78
Precipitation	80.06	±10.68	76.73	±7.26	70.01	±6.42	0.44	0.65	0.78	0.38	0.54
Relative humidity%	58.48	±2.77	57.64	±2.12	55.80	±1.70	0.44	0.65	0.80	0.39	0.53
Dew point	12.40	±0.91	20.16	±3.24	11.74	±0.52	6.24	0.01	0.01	0.81	0.00
Temperature	21.50	±0.29	21.67	±0.24	21.61	±0.11	1.07	0.36	0.17	0.31	0.62
Temperature range	9.57	±1.37	10.05	±1.05	11.36	±0.93	0.76	0.48	0.77	0.26	0.39
Maximum temperature	26.82	±0.72	22.12	±2.04	27.95	±0.51	6.50	0.01	0.02	0.52	0.00
Minimum temperature	17.24	±0.69	14.56	±0.77	16.59	±0.42	4.91	0.02	0.01	0.46	0.02
Wind speed	3.16	±0.11	3.62	±0.14	3.38	±0.07	4.16	0.03	0.01	0.16	0.12

edaphic and climate ordination diagrams. It is mostly affected positively with potassium, precipitation, relative humidity, dew point and negatively with conductivity, Na^+, organic matter, clay, temperature range and maximum temperature.

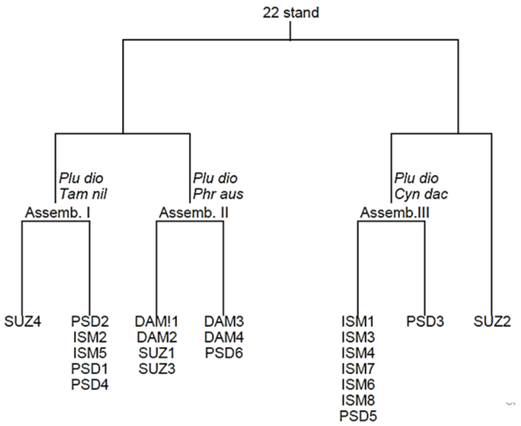

Figure (4). TWINSPAN classification of 22 stands along study area. Three assemblages are separated and the number of stands belongs to each assemblage are denoted. Abbreviations of the indicator species: *Plu dio, Pluchea dioscoridis*; *Tam nil, Tamarix nilotica*; *Phr aus*, *Phragmites australis* and *Cyn dac, Cynodon dactylon*.

The second group which includes *Pluchea dioscoridis, Alhagi graecorum, Juncus rigidus* and Tamarix nilotica is located at a central position of axis1-axes2 plane. At the climate diagrams, the group was located at the upper half of axis1-axes2 plane. This group is most affected positively with organic matter, clay, maximum temperature and negatively with conductivity, K^+, Na^+ and annual temperature (Figures 6, 7).

The third group comprises *Conyza bonariensis, Imprata cylendrica and Phoenix dactylifera* and occupies a central position of axis1-axes2 plane. For climate parameters ordination graph, this group is located at the lower half near axes2. This group is most affected positively with organic matter, clay, minimum temperature and negatively with conductivity, potassium, sodium, temperature range and wind speed. The fourth group which is represented by *Cynodon dactylon, Cyperus laevigatus, Cyperus rotundus, Xanthium strumarium, Ficus benjamina* and *Cascabela thevetia* is mostly concentrated at the right lower corner of axis1-axes2 plane. At climate ordination diagrams, the group mainly distributed at the left half of axis1-axes2 plane. This group is mostly affected positively with temperature range and maximum temperature and negatively with Ca^{++}, Cl^-, Na^+, NaCl, K^+, clay, organic matter and conductivity, relative humidity, precipitation and minimum temperature.

If it was considered that *Pluchea dioscoridis* is standing in the ordination regardless the group in which it occurs, it could be find that it is most affected positively with organic matter, clay, temperature, dew point and negatively with Cl^-, sodium, NaCl, K^+, conductivity, maximum temperature and temperature range. Pearson correlation analysis showed that *P. dioscoridis* is correlated positively with the soil moisture content, temperature, dew point, wind speed and negatively with maximum and minimum temp (Table 5).

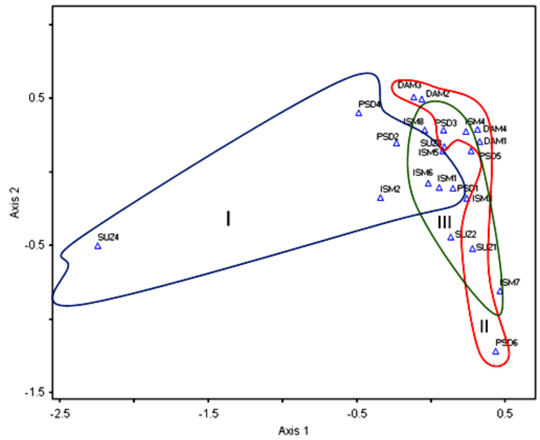

Figure (5). CCA biplot showing the distribution of the studied 22 populations

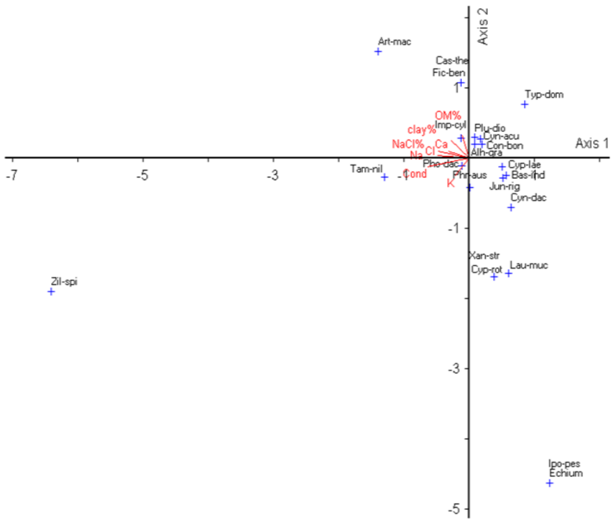

Figure (6): Biplot of CCA showing species–environmental variables relationships along the axes 1 and 2.

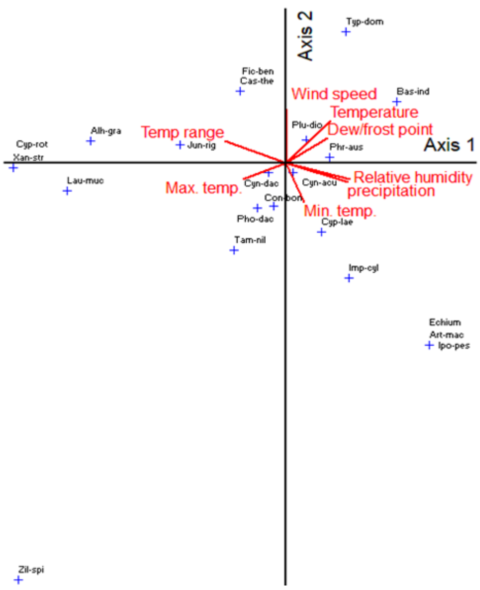

Figure (7): Biplot of CCA showing speciesclimatic variables relationships along the axes 1 and 2.

Stands - Environment relationship

The studied stands were classified into three assemblages at the second level by using TWINSPAN. The position of these assemblages and their relationship with the studied environmental factors were showed by the ordination diagrams (Figures 8, 9). At the edaphic factor ordination, the first assemblage (*Pluchea dioscoridis-Tamarix nilotica*) mostly occupied the upper half of axis1-axis2 plane. This assemblage is mostly affected positively with clay and organic matter. The second assemblage occurs at the upper half of the ordination plane. The assemblage is mostly affected positively with organic matter and clay, while potassium, conductivity, sodium, chloride, and NaCl affect this assemblage negatively. *Pluchea dioscoridis-Cynodon dactylon* assemblage (III) is found on the central and right half of axis1-axis2 plane. This assemblage is mostly affected negatively with NaCl, calcium, sodium and chloride.

At the climate variables ordination, populations which belong to a certain climate region occupied the same point as all of them have the same climate data. Populations of the Mediterranean regions occupied the right half of axis1-axis2. This assemblage is mostly affected positively with precipitation, relative humidity, temperature and dew point and negatively with temperature range and maximum temperature.

Table 5. Pearson correlations between environmental factors and *Pluchea dioscoridis* cover. Significance:* ($p \leq 0.05$), ** ($P \leq 0.01$)

Environmental factor	Correlation coefficient
pH	-0.338
Conductivity (µ S)	-0.221
TDS (mg/l)	-0.046
NaCl%	-0.043
Hygroscopic water%	0.358
Organic matter%	0.291
Carb. (Mg/100g)	-0.184
Bicarb. (Mg/100g)	-0.159
Cl (mg/100g)	-0.048
Ca (mg/100g)	0.136
Mg (mg/100g)	0.236
N (mg/100g)	0.418
P (mg/100g)	-0.172
Na (mg/100g)	-0.148
K (mg/100g)	-0.309
Moisture content%	0.472^{*}
Clay%	-0.09
Silt%	0.146
Sand%	-0.083
Precipitation	0.141
Relative humidity%	0.195
Dew/frost point	0.676^{**}
Temperature (°c)	0.695^{**}
Temperature range (°c)	-0.137
Max. temperature (°c)	-0.598-**
Mini. temperature (°c)	-0.456^{*}
Wind speed	0.670^{**}

Populations of the semi-arid and arid regions occurred at the left half of axis1-axis2. The semi-arid populations mostly are affected positively with temperature range and negatively with precipitation, relative humidity and minimum temperature. Arid populations are mostly affected positively with maximum temperature and temperature range and negatively with precipitation and relative humidity.

DISCUSSION

Pluchea dioscoridis is a widespread perennial weed (Simposn, 1932) that mainly inhabits water streams, oases, moist habitats, abandoned fields, depression along roads and railways and demolished houses (Shaltout & Slima, 2007). It was recorded in many types of soils, fine loamy soils (Shaltout & Slima, 2007), clay loam soil (Ahmed *et al*., 2018) and gravel (El-Bana, 2015).

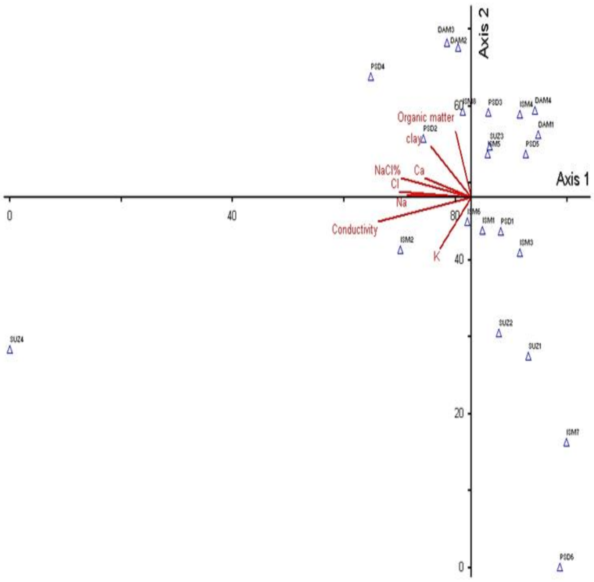

Figure (8): Biplot of CCA showing populations-environmental variables relationships along the axes 1 and 2.

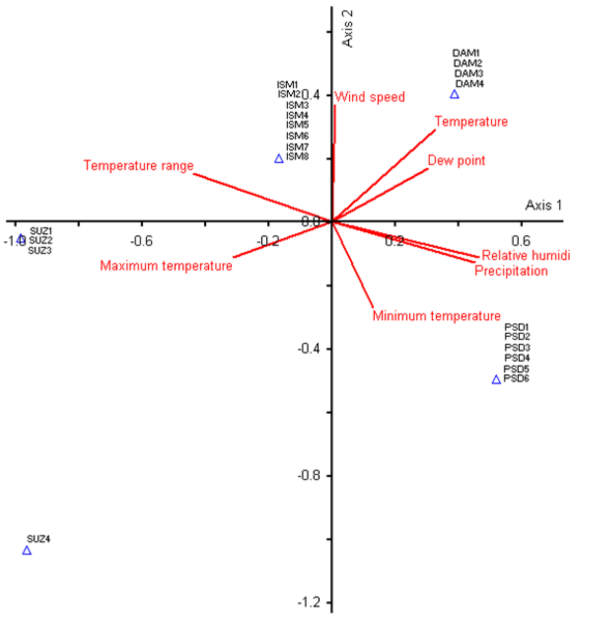

Figure (9): Biplot of CCA showing populations– climatic variables relationships along the axes 1 and 2.

Our study confirmed the occurrence of *P. dioscoridis* in soil texture ranging from loam to sand. It was recorded also in a wide range of soil moisture content, conductivity, sodium chloride percentage, chlorides, calcium, magnesium, phosphorus and organic matter. This large range of variation in soil factors shows that there are no major barriers to *P. dioscoridis* growth in any type of soil due to the differences in its properties.

The selected study areas where *P. dioscoridis* dominates, lies along the Suez Canal which causes a filtration of the water to the subsoil and make it humid permanently (Lesseps, 1876; El-Kady *et al.*, 2017). Also, the soil of Abu Khalifa region showed an incline land surface due to the nature of the soil and the increase of the underground water (Abou El Azim *et al.*, 2007). So, *P. dioscoridis* - with its deep root system can reach the underground water easier than short-rooted annuals to withstand arid climate which explain its dominance over the annuals species. In contrast, Slima (2006) recorded the dominance of annuals over perennials in the studied populations of *P. dioscoridis* in Nile delta. The distinction in the study area explains the difference in the life span of the associated species; while current study focused on natural vegetation far from cultivated fields, Slima (2006) sampled most of the studied populations at canal slops and edges and drain terraces which are a moisture-rich habitats. So, annual weeds can easily find a plenty of water in addition to the annual cultivated crops. Despite the differences in the associated species life span of competed plants between current study and Slima (2006) study, *P. dioscoridis* dominated all studied habitats in both studies. Over the life forms, therophytes and chamaephytes were the dominants. The dominance of therophytes could be a result of the arid climate and both human activities and animal grazing in the study area (Abd El-Ghani *et al.*, 2017a). Therophytes can tolerate the dryness as they spend the unfavorable dry summer in a form of seeds (Danin & Orshan, 1990; Abd El-Ghani *et al.*, 2017a). Also, the high value of chamaephytes may be due to the ability of its species to resist drought by reducing their transpiring and assimilating organs during arid summer (Danin & Orshan, 1990). So, the dominance of these life forms indicates the ability of *P. dioscoridis* to withstand and grow under arid conditions.

The floristic diversity of the study area is relatively simple as the species have to resist the human activities and arid climatic and environmental conditions. The TWINSPAN analysis divided the vegetation of the study area into three vegetation assemblages. The codominant species in one assemblage were well represented in the others. The main reason is the dependence of site selection on the presence of *P. dioscoridis*. Consequently, the presences of the same co-dominant species are due to the selective choice of the suitable environment for them.

Most of the prominent species of the identified vegetation assemblages were halophytic species as *Juncus rigidus*, *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Zygophyllum coccineum*, *Tamarix nilotic*a and *Phragmites australis*. Most of these plants were recorded in salt marches (El-Shaer & El-Morsy, 2008; Abd El-Ghani, 2000; Abd El-Ghani *et al.*, 2017b). *Tamarix nilotic*a was considered one of the climax types of the saltmarsh vegetation (Abd El-Ghani, 2000). The association of halophytes is due to the location of the study which varies between the Mediterranean coast and the arid inland desert; arid regions usually suffer from salinity concentration (Allbed & Kumar, 2013; El-Keblawy *et al.*, 2015). This association reveals the ability of *P. dioscoridis* to grow in salty habitats in addition to its commonly recorded presence in fresh watered habitats.

Despite the ability of *P. dioscoridis* to grow under salty conditions, the application of CCA on sampled populations showed the negative effect of conductivity, NaCl, chloride, calcium, sodium on the distribution of *P. dioscoridis* populations. Salts in soil reduce the ability of plants to water and nutrients uptake due to the osmotic effect of salts (Parihar *et al.*, 2015). On the other hand, positive correlations were obtained from ordination of *P. dioscoridis* with precipitation, soil organic matter and clay. Precipitation is an active factor in the soil water content in arid and semi-arid regions (Zhang *et al.*, 2010). In this context, both of organic matter and clay percentages increase the water holding capacity of soil (Adamu & Aliyu, 2012) which shows also the preference of *P. dioscoridis* to moist habitats.

The cover of *P. dioscoridis* was also positively correlated with two water-related factors: soil water content and dew point. Dew point is the temperature at which atmospheric moisture is converted to dew. High dew point indicates more moisture in the air. Although dew is unimportant water source to plants, plant can benefit from it during dry months by increasing soil water potential (Malek *et al.*, 1999; Wang *et al.*, 2019). Ben-Asher *et al.*, (2010) determined the role of dew as a factor affecting the efficiency of vegetation water use not as a source of water through creation of a humid environment near the leaf which minimizes transpiration.

Our results indicated the positive correlation and association of *P. dioscoridis* with average temperature and the negative correlation and association with minimum and maximum temperature. The changes in the upper and lower temperature limits affects plants over multiple ways as reduction in germination percentage and growth, shift in flowering time and decline in grain yield (Peng *et al.*, 2004; Von Holle *et al.*, 2010; Chen *et al.*, 2017). So, we can deduce that *P. dioscoridis* can tolerate the expected warming but within its limits.

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All results support the importance of water in the presence and distribution of the plant. The distances between populations were large in the arid region compared with other regions which indicate the importance of a water source for persistence of it. At the same time, the plant tolerates efficiently the salty soil and warm climate. So, we can conclude that climate change may affect distribution of *P. dioscoridis* in natural habitats mainly due to the deficiency of water, not due to warming or salinity. It can continue its invasion to reclaimed lands and natural habitats that receive water accidently or periodically.

CONCLUSION

P. dioscoridis can grow in many regions (Mediterranean, and inland (semi-arid and arid)) with different environmental conditions. The data of climate and soil revealed the ability of this plant to survive under a wide range of edaphic factors and a warm moist climate. *P. dioscoridis* populations are mainly affected by two major categories of environmental factors: a positive effect of water related factors (represented by total soil water content, clay, organic matter, precipitation, relative humidity and dew point) and a negative effect of salinity (represented by chloride, conductivity, NaCl, potassium, sodium and calcium). So, the distribution and invasion of *P. dioscoridis* is expected to be affected in the natural habitats by the expected climate change. *P. dioscoridis* and its association with halophytes can be an indicator of an environmental system exposed accidently, periodically or permanently to amounts of water.

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أثر العوامل البيئية علي توزيع نبات البرنوف (*Pluchea dioscoridis* (L.) DC.)

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الملخص العربــي

تعد دراسة العوامل المؤثرة على توزيع النباتات من الامور الهامة لفهم سلوك النباتات في ظل تغير المناخ الحالي والمتوقع. تهدف هذه الدراسة إلى تقييم توزيع نبات البرنوف *P. dioscoridis* والعوامل البيئية الرئيسية التي تؤثر عليه خاصة الجفاف. تمت دراسة اثنان وعشرون عشيرة تمثل الموائل المتوسطية والشبه القاحلة والقاحلة علي طول منطقة الدراسة. كما تم جمع عينات من التربة وتحليلها. اظهرت تحاليل التربة ان هناك فروقا معنوية في خصائص التربة بين المناطق المدروسة. كما اظهرت قدرة النبات علي العيش في ظروف بيئية عالية التنوع من حيث الملوحة. تم تعريف اثنين وستين نوعًا من النباتات (34 نباتًا معمرًا و 28 نباتًا سنويًا) تنتمي إلى 31 عائلة. وكانت العائلات المركبة والنجيلية والرمرامية هي الأكثر تمثيلا. سجلت الحوليات (Therophytes) ويليها النباتات الفوق السطحية (Chamaephytes) اعلي نسب أشكال الحياة المسجلة. اوضح التحليل الفلوري ان أعلى العناصر تمثيلاً هي عناصر البحر الأبيض المتوسط (37.3٪) تليها نباتات الصحراء السندية (35.6٪). حدد تحليل TWINSPAN ثلاث مجموعات نباتية اساسية. ترتبط كل مجموعة بمنطقة مناخية رئيسية علي الاقل. وباستخدام برنامج التطابق الكنسي (CCA) امكن فصل المجموعات النباتية الناتجة عن استخدام تحليل التصنيف ثنائي الاتجاه. كما اظهر ان المحتوي المائي للتربة والملوحة والكلوريدات و الصوديوم والبوتاسيوم والكالسيوم ونسبة المواد العضوية هي اكثر عوامل التربة فاعلية في توزيع نبات البرنوف *P. dioscoridis.* في حين ان هطول الامطار والرطوبة النسبية نقطة تكون الندي و متوسط درجات الحرارة و كذلك درجات الحرارة الصغري والعظمي هي اكثر العوامل المناخية تأثيرا علي توزيع البرنوف. ويتضح من هذا الجزء من الدراسة مدي التأثير الايجابي للعوامل المرتبطة بتوافر الماء والتأثير السلبي للعوامل المرتبطة بالملوحة مما يشير للتأثير السلبي للجفاف علي هذا النبات.