Ecology and Allelopathic Control of the Invasive Species *Cenchrus echinatus* L. in some of Newly Reclaimed Areas in Nile Delta, Egypt

Shehata, H. S.

Botany Department, Faculty of Science, Zagazig University, Postal Code:44519, Egypt
E-mail: drhanaa_fahmy@hotmail.com

Abstract: *Cenchrus echinatus* L. is an introduced species in Egypt. Field study indicated that it had become recently an invader to the newly reclaimed areas of Egypt. Fifty stands, representing fields of orchards and crops at four governorates (El- Dakahlia, El-Behira, El-Ismailia and El-Sharkia) in the Nile Delta region, were studied. The florestic analysis indicated that ninty-four species (59 annuals, five biennials and thirty perennials) represent 27 families were recorded. The most represented families were: Poaceae (25.53%), followed by family Asteraceae (18.09%) and Chenopodiaceae (8.51%).*C. echinatus* is a therophytic plant that has a Mediterranean distribution intermingled with Irano-Turaian elements.Therophytes predominated the other life forms. The monoregional taxa contributed the highest chorological elements. Four vegetation groups (VG), representing the different studied fields, were produced by the application of TWINSPAN and DECORANA as classification and ordination techniques, respectively. In addition Canonical Correspondance Analysis (CCA) ordination indicated that, sulphates, silt, water-holding capacity, bicarbonates, sand, porosity, calcium and organic carbon were the most effective soil variables on the distribution of *C. echinatus* and its associated species in the different fields.Vegetation group (D) inhabiting the orchards and crops in Al- Behira and Al-Sharkia governorates, was the most diverse one. Evaluation of allelopathic impact of the shoot extracts of *Conyza bonariensis*, and *Acacia saligna* against *C. echinatus* seeds was carried out. The methanolic extract of *C. bonariensis* had the most inhibitory effect on the seed germination and shoot growth of *C. echinatus*, while, the methanolic extract of *A. saligna* had the most inhibitory effect on the root growth of *C.echinatus*. This study indicated that the shoot biomass of *C. bonariensis* and *A. saligna* contain allelochemicals and could be used as a poste-mergence herbicide.
[Shehata, H.S. **Ecology and Allelopathic Control of the Invasive Species *Cenchrus echinatus* L. in some of Newly Reclaimed Areas in Nile Delta, Egypt.** *Life Sci J* 2014;11(6):246-260]. (ISSN:1097-8135). http://www.lifesciencesite.com. 33

Keywords: Floristic composition, Ecological relations, Soil Variables**:** Allelopathy

1. Introduction

The invasive species in the new agricultural lands cause serious problems that require attention to be paid to their negative impact on ecosystem and gene pools (Hegazy *et al* ., 1999). *Cenchrus* L. (sandbur), is a genus of the Poaceae (grass family), which mostly consists of summer annual or less often perennial species of invasive eputation (Cope & Gray, 2009). *C. echinatus* is native to Southern States of North America, Mexico and South America and widely naturalized in tropical regions around the world.Like several *Cenchrus* spp. (*eg. C. longispinus* and *C. spinifex*), it is a notorious invasive and noxious weed of warm temperate, sub-tropical and tropical parts of the world (Cope & Gray, 2009).

C. echinatus is reported for the first time from Spain and confirmed from Egypt. It is a troublesome weed and widely naturalised beyond its native distribution range, but it is a relatively recent newcomer in the Mediterranean area, where it was initially confined to its eastern part (Verloove & Sánchez, 2012). According to Boulos (2005), *C. echinatus* is considered as introduced weed in Egypt.

Individual plant of *C. echinatus* can produce more than 5,000 burs, with 1-3 seeds per bur, these seeds are dispersed by clinging to wooly animals, shoes and human clothes, tires, farm machines and flowing water (Cope & Gray, 2009).

Species diversity is an appropriate term for ecologists who are interested in understanding the mechanisms and effects of certain ecological phenomena, such as pollution, environmental disturbances, etc. It is a function of the number of species present (i.e. species richness) and the evenness with which the individuals are distributed among these species (i.e. species evenness, species equitability, or abundance of each species) (Pielou1969; Spellerberg 1991). Ecological studies of *C. echinatus* explained its high invasion to the studied areas, so allelopathy was conducted in this study to overcome this problem. There were many chemical control methods (synthetic herbicides) used against *C. echinatus* like fluazifop and sethoxydim in onions and soyabeans (Almeida *et al*., 1983; Barros, 1989).

In cabbage, oxyfluorfen, with additional application of chlorthal-dimethyl or trifluralin exhibited a good efficiency against *C. echinatus* (Munroe & Nishimoto, 1988), whereas trifluralin,

alachlor, metolachlor, fluazifop, haloxyfop, fenoxaprop, chloramben and fluorochloridone controled *C. echinatus* in sunflower (Oliveira *et al*., 1989; Avila *et al*., 1991).

There are few literatures about the ecology of *C. echinatus* in Egypt, so the aim of the present work was to characterize the community of the invasive noxious weed *C. echinatus* in the newly reclaimed areas, in the Nile Delta region in Egypt, as well as to determine the soil factors controlling its distribution. In addition, the ecological relations of this invasive species along the prevailing soil variables were also assessed. Also detection of the invasiveness of *C. echinatus* to the newly reclaimed areas in Egypt through estimation of its importance value was assessed. Moreover, allelopathic control, to eradicate *C. echinatus*, was conducted through water and methanol extracts of the shoost of *Conyza bonariensis*, (Asteraceae) and *Acacia saligna* (Fabaceae).

2. Material and Methods

Study Area:

The Nile Delta starts 20 km^2 north of Cairo, it is embraced by the Rosetta and Damietta branches of the River Nile. The area of the Nile Delta is about 22,000 km^2, while the Nile Valley (cultivated lands) is about 12,000 km^2. Thus the Delta comprises about 63% of the Egyptian fertile lands (Abu Al-Izz, 1971).The sampled stands are distributed in many localities (east, west and north of the Nile Delta region) representing the newly reclaimed areas, at El- Dakahlia, El-Behira, El-Ismailia and El-Sharkia (**Figure 1**).The northern part of the Nile Delta lies in the arid zone, and the southern part lies in the hyper-arid one (Egyptian Meteorological Authority, 1996). The climatic conditions are warm summer (20-30 ºC) and mild winter (10-20 ºC). Accordingly, the studied provinces as part of the Nile Delta belong to the arid and/or semi-arid climatic belts of the northern coastal region of Egypt (Zahran & Willis, 2009).

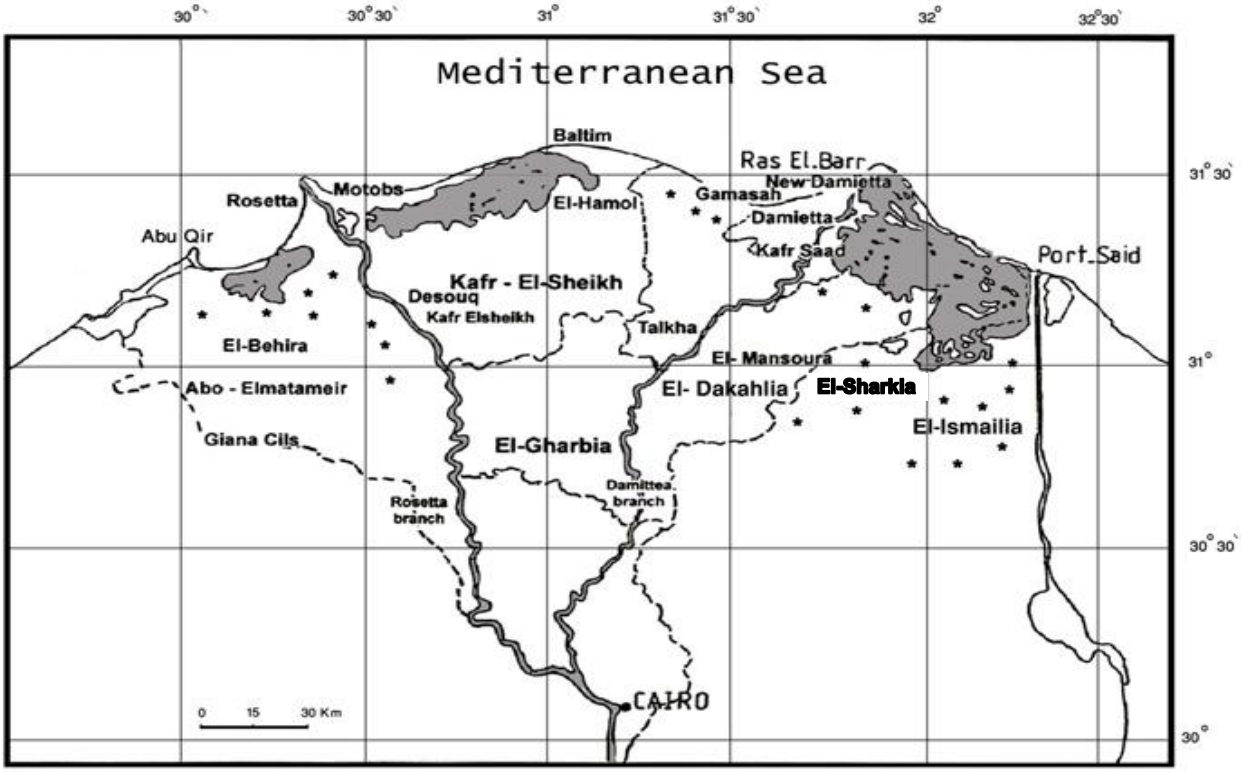


Fig. 1: Map of the Nile Delta, Egypt showing the different localities (*) of the study area

Floristic and Vegetation Analyses:

Fifty stands (1x5m each) distributed in four governorates at which the studied plant is highly spreading and causes yield loss of crops.Stands were distributed as follows :8 ,26 and13 stands of orchards and crops in Al- Ismaillia, Al – Sharkia and El-Behira, respectively,and 3 crop stands in El-Dakahlia (**Table1**).After regular field visits to the different sites of the study area during summer 2012-2013, stands were used for sampling of the vegetation types in the different fields.The reclaimed areas under study were generally cultivated by orchards such as mango, citrus, peach, guava, banana and grape, and crops such as bean, tomato, maize, peanut, watermelon, wheat and cucumber.

Table 1. The studied stands, their locations (reclaimed areas) and the cultivated plants in the four studied governorates.

Stand	Governorate	Location of Reclaimed area	Vegetation group	Cultivated plant
1	Al-Behira	Ganaklees	A	Bean
2	Al-Behira	Al- Asharat Alaaf	A	Tomato
3	Al-Behira	Badr	B	Tomato
4	Al-Ismailia	Wadi Al- Mollak	C	Mango
5	Al-Ismailia	Wadi Al- Mollak	C	Mango
6	Al-Ismailia	Wadi Al- Mollak	C	Maize
7	Al-Ismailia	Wadi Al- Mollak	A	Mango
8	Al-Ismailia	Wadi Al- Mollak	B	Pea nut
9	Al-Ismailia	Wadi Al- Mollak	A	Mango
10	Al-Ismailia	Wadi Al- Mollak	B	Pea nut
11	Al-Ismailia	Wadi Al- Mollak	B	Mango
12	Al-Sharkia	Al -Salhia Al- Gadida	B	Mango
13	Al-Sharkia	Al- Salhia Al- Gadida	B	Citrus
14	Al-Sharkia	Al Salhia Al- Gadida	A	Citrus
15	Al-Sharkia	Al Salhia Al- Gadida	C	Citrus
16	Al-Sharkia	Al Salhia Al- Gadida	A	Maize
17	Al-Dakahlia	Zayan	A	Water melon
18	Al-Dakahlia	Zayan	A	Tomato
19	Al-Dakahlia	Qalabsho	A	Watermelon
20	Al-Behira	Wadi Al- Natrun- Al- Hamra	B	Maize
21	Al-Behira	Wadi Al- Natrun –Kafr Al Arab	C	Peach
22	Al-Behira	Idku	C	Guava
23	Al-Sharkia	Al- Salhia Al- Gadida	D	Wheat
24	Al-Sharkia	Al- Salhia Al- Gadida	D	Wheat
25	Al-Sharkia	Al- Salhia Al- Gadida	D	Tomato
26	Al-Sharkia	Al- Salhia Al- Gadida	D	Citrus
27	Al-Sharkia	Al- Salhia Al- Gadida	D	Mango
28	Al-Sharkia	Al- Salhia Al- Gadida	D	Mango
29	Al-Sharkia	Al- Salhia Al- Gadida	D	Citrus
30	Al-Sharkia	Al- Salhia Al- Gadida	D	pea nut
31	Al-Sharkia	Al- Salhia Al- Qadima	D	Citrus
32	Al-Sharkia	Al- Salhia Al- Qadima	D	Citrus
33	Al-Sharkia	Al- Salhia Al- Qadima	D	Banana
34	Al-Sharkia	Al- Salhia Al- Gadida	C	Grape
35	Al-Sharkia	Al- Salhia Al- Gadida	D	Grape
36	Al-Sharkia	Al- Salhia Al- Gadida	C	Citrus
37	Al-Sharkia	Al- Salhia Al- Gadida	D	Citrus
38	Al-Sharkia	Al- Salhia Al- Gadida	C	Citrus
39	Al-Sharkia	Al- Salhia A- Gadida	C	Citrus
40	Al-Sharkia	Al- Salhia Al- Gadida	D	Mango
41	Al-Sharkia	Al- Salhia Al- Gadida	C	Mango
42	Al-Sharkia	Al- Salhia Al- Gadida	C	Citrus
43	Al-Sharkia	Al- Salhia Al- Gadida	C	Mango
44	Al-Behira	Rashid	D	Guava
45	Al-Behira	Rashid	D	Guava
46	Al-Behira	Rashid	D	Mango
47	Al-Behira	Rashid	D	Guava
48	Al-Behira	Ganaklees	B	Mango
49	Al-Behira	Ganaklees	C	Cucumber
50	Al-Behira	Ganaklees	C	Mango

The associated species with *C.echinatus* had been recorded.These stands were equally distributed in eleven fields of orchards and crops.A chorological analysis of the floristic categories of species was made to assign the recorded species to world geographical groups according to Wickens(1978) and Zohary(1983). In each stand plant species density was measured according to (Shukla & Chandel, 1989). While the plant cover as percentage of ground surface of each species had been estimated, in each stand, using the line-intercept method (Canfield, 1941). Relative values of density and cover were calculated for each species and summed to give an estimate of its importance value (IV), which is out of 200. Identification and nomenclature were according to Täckholm (1974), Boulos (1999-2005 & 2009). Life forms of the recorded species were identified following the Raunkiaer scheme (Raunkiaer, 1937). The global geographical distribution of the recorded species was revised from Täckholm (1974) and Zohary (1973). The

voucher specimens were deposited in Zagazig University herbarium.

Soil Analysis

Three composite soil samples were collected from each stand as a profile of 0-50 cm below the soil surface. Soil texture, porosity and water-holding capacity were determined according to (Allen *et al.*, 1986). Calcium carbonates were determined by titration against 1N NaOH, and soluble chlorides were determined by direct titration against silver nitrate solution (N/35.5) using 5% potassium chromate indicator (Jackson,1962). Oxidizable organic carbon (O.C) was determined using Walkely and black's rapid titration and sulphates were determined gravimetrically, the soluble sulphates precipitated as barium sulphate (Piper, 1947). Soil water extracts of 1:5 were prepared for the determination of salinity (E.C.) by YSI Incorporated Model 33 conductivity meter and electric-pH-meter (model Lutron pH-206) digital analyzer with glass electrode was used to determine soil reaction (pH). Carbonate and bicarbonate were determined by titration method using 0.1 N HCl (Pierce *et al.*, 1958). The extractable cations Na^+ and K^+ were determined using a flame photometer (Model PHF 80 Biologie Spectrophotometer) (Allen *et al.*, 1986), while Ca^{2+} and Mg^{2+} were estimated according to Allen *et al.* (1974) using an atomic absorption spectrometer (PerkinElmer Model 2380). The sodium adsorption ratio (SAR) and potassium adsorption ratio (PAR) were calculated to express the combined effects of the different ions in the soil (Mckell and Goodin,1984). The total soluble nitrogen was determined by the micro-Kjeldahl method. Total dissolved phosphorus (TDP) was determined by digestion, followed by direct stannous namely chloride method (American Public Health Association,1989).

Multivariate and Statistical Analyses

In the present study, two trends of multivariate analyses namely classification and ordination were applied. Two-Way indicator species analysis (TWINSPAN) was used for classification (Hill, 1979 and Gauch & Whittaker, 1981), while the ordination techniques applied were the Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) using CANOCO (ter braak, 1986, 1988). The statistical treatments applied in the present study were according to Snedecor & Cochran (1968).

Diversity Measurements

Species richness for each vegetation group was calculated as the average number of species per stand. Relative evenness or equitability (Shannon-Weaver index) of the importance value of species was expressed as:

$$H' = \sum_{i=1}^{s} P_i \ln (P_i)$$

where Pi = ni / N = proportional abundance of species in a habitat made up of species, ni = the number of stands containing species i and N = S ni.

The Shannon-evenness index (E) was used to quantify the evenness component of diversity and was calculated as:

$$E = \frac{H'}{\ln_s}$$

The Simpson's index, D (relative concentration of dominance) was calculated as:

$$D = \frac{\sum_i [n_i \times (n_i - 1)]}{[N \times (N - 1)]}$$

where, ni is the total number of a particular species and N is the total number of all species (Magurran,1988).

The simple linear correlation coefficient was calculated for assessing the relationship between the estimated soil variables on one hand, and the common species, on the other hand. The variation in the soil variables in relation to the vegetation groups were assessed using one way analysis of variance (ANOVA).These techniques were according to SPSS software (SPSS ,1999).

Allelopathy trial

Weed seed source

The seeds of *C. echinatu*s were collected from different localities in the study area. Seeds were sterilized with 0.3% calcium hypochlorite, rinsed by distilled water and dried on filter paper in the laboratory at room temperature for 7 days (Uremis *et al*., 2005).

Collection and preparation of plant material

Conyza bonariensis and *Acacia saligna* shoots were harvested at the vegetative stage from Zagazig area and from Gamasa, respectively. The collected shoots were washed with distilled water and left to dry in room temperature in a shaded place for several days until complete dryness.The dried samples were ground into powder with the help of electric grinder and sieved through 2 mm sieve mesh to obtain fine powder, packed in a polyethylene bag, then stored in a refrigerator at 4 ºC**.**

Preparation of aqueous and methanolic extracts:

For bioassay tests 10 g of the fine dried powder shoots of each plant (*C. bonariensis* and *A. saligna*) was extracted separately by dissolving them in 100 ml distilled water. Another 10g of each of the same tested plants was dissolved separetely in 100 ml methanol. Both aqueous and methanolic extracts were filtered through one layer Whatman No.1 filter papers to remove excess debris. The pH values were adjusted to 7 with 1N HCl, then the two test extracts were kept in a refrigerator at 4ºC, until further use.The two obtained test extracts were considered as stock solution and a series of solutions with differend concentrations of 2%, 4%, 6%, 8% and 10% (w/v) were prepared by dilution with sterile distilled water(Rice,1972).

Germination Bioassays:

Two layers of Whatman No.1filter papers were placed in 90-mm-diameter glass petri dishes.Twenty-five seeds were placed in each petri dish,followed by the addition of 10 mL of plant aqueous and methanolic extracts separately to the prepared concentrations (2%, 4%, 6%, 8% and 10% w/v). For control distilled water was added to sterilized *C. echinatus* seeds without addition of powder extracts and left at room temperature at (25 ºC). Starting from the first day after experiment began, germinated seeds were counted and removed daily. A seed with a radical of 0.5 cm was considered germinated. The experimental design was carried out as a randomized complete block (RCB) with three replicates. The experiment was repeated twice and the percentage of germination was calculated.Rate of germination was calculated by dividing the number of germinated seeds each day by the number of days and summing the values. The inhibition percentage was calculated using the following equation given by Chung *et al* . (2001):

Inhibition percentage = [(CG-TG)/CG)] ×100]

Where, CG: germination rate in control treatment; TG:germination rate in extract treatment. The data were subjected to ANOVA, and the mean values were separated on the basis of Least Significant Difference (LSD) at 0.05 probability level using the COSTAT 6.3 program.

Growth bioassays

The seeds of *C. echinatus* were germinated on filter paper in the dark at room temperature at (25 ºC) for 2 days.Fifteen germinated seeds were transferred to petri dishes,which were filled with 25 g of sterilized quartz sand, and 10 mL of the two tested extracts were added separately to the concentrations (2 %, 4%, 6%, 8% and 10 % w/v). In addition, a control sample was added to the experiment without any treatment. The experiment was designed as RCB with 3 replicates and it was separated twice. Shoot and root lengths of seedlings were measured at 15 days after treatment (DAT) and growth inhibition of shoot and root lengths were calculated using the following equation:

Growth inhibition = [(LC-LT)/LC)] ×100]

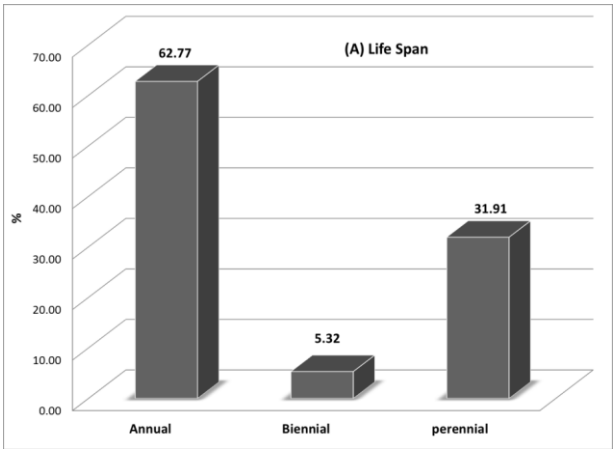
Where, growth inhibition in percentage; LT: shoot or root length of powder treated weed; LC: shoot or root length of untreated control weed. All the obtained data were transformed to percent of control. Data were subjected to ANOVA and the mean values were separated based on Least Significant Difference (LSD) at 0.05 probability level using the COSTAT 6.3 program.

3. Results

i. Floristic Features:

The floristic analysis of the study area showed that the total number of the recorded plant species surveyed in the present study was 94 species belonging to 79 genera and 27 families. The most represented families were: Poaceae (25.53%), followed by family Asteraceae (18.09%) and Chenopodiaceae (8.51%). The plant life-span in the study area was shown in **Figure (2A).** The total number of plant species in the present study was 94. These species were classified into three major groups, according to their life span: 59 annuals (62.77%), five biennials (5.32%) and 30 perennials (31.91%). The plant life-forms in the study area were grouped under seven types as follows: therophytes, hemicryptophytes, geophytes, chamaephytes, nanophanerophytes, helophytes and parasites (**Figure 2b**). The majority of the recorded species were therophytes (66.32%), followed by hemicryptophytes (15.79%), geophytes (7.37%), chamaephytes (5.26%) and nanophanero-phytes (3.16%). The lowest represented life-forms were helophytes and parasites by 1.05% each.

The chorological analysis of the recorded species (*Table 2*) revealed that 39 of them (41.49 % of the total recorded species) were Mediterranean taxa. These taxa were pluriregionals (43.59%), biregionals (35.89%) and monoregional (20.51%). It had been also found that 49 species of the total number of recorded species were Cosmopolitan (18.09 %), Pantropical (11.70%), Palaeotropical (10.64%), Saharo- Sindian (7.45%), Neotropical (3.19 %) and Irano- Turaninan (1.06%). Generally, the monoregional elements were represented by 57 species (60.64%), while biregionals contributed 20 species (21.28%) and pluriregionals 17 species (18.09%) of the total recorded species.



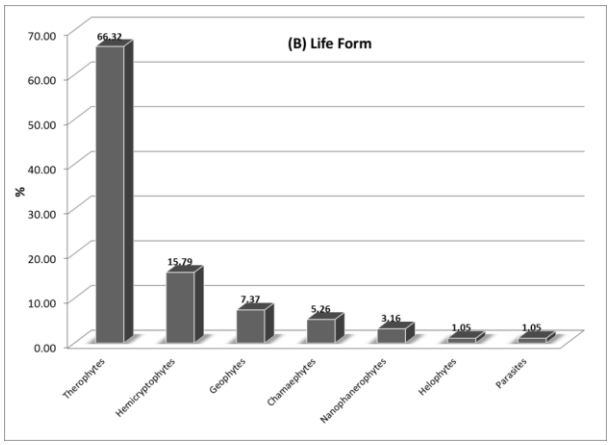


Fig. 2. Plant life-span (A) and life-form of the study area (B).

Table 2. Number of species and percentage of various floristic categories in the study area.

Floristic category	Total number	Percentage	Type
COSM	17	18.09	COSM
PAN	11	11.70	Monoregional
PAL	10	10.64	
NEO	3	3.19	
IR-TR	1	1.06	
ME	8	8.51	
SA-SI	7	7.45	
ME+IR-TR	8	8.51	Biregional
ME+ER-SR	1	1.06	
ME+PAL	1	1.06	
ME+SA-SI	4	4.26	
SA-SI+S-Z	4	4.26	
SA-SI+IR-TR	1	1.06	
S-Z+IR-TR	1	1.06	
ME+IR-TR+ER-SR	11	11.70	Pluriregional
ME+IR-TR+SA-SI	5	5.32	
ME+SA-SI+ER-SR	1	1.06	
Total	94	100	

Abbreviations:

COSM	Cosmopolitan	NEO	Neotropical	SA-SI	Saharo-Sindian
PAN	Pantropical	ME	Mediterranean	IR-TR	Irano-Turanina
PAL	Palaeotropical	ER-SR	Euro-Siberian	S-Z	Sudano-Zambezian

ii.Vegetation classification:

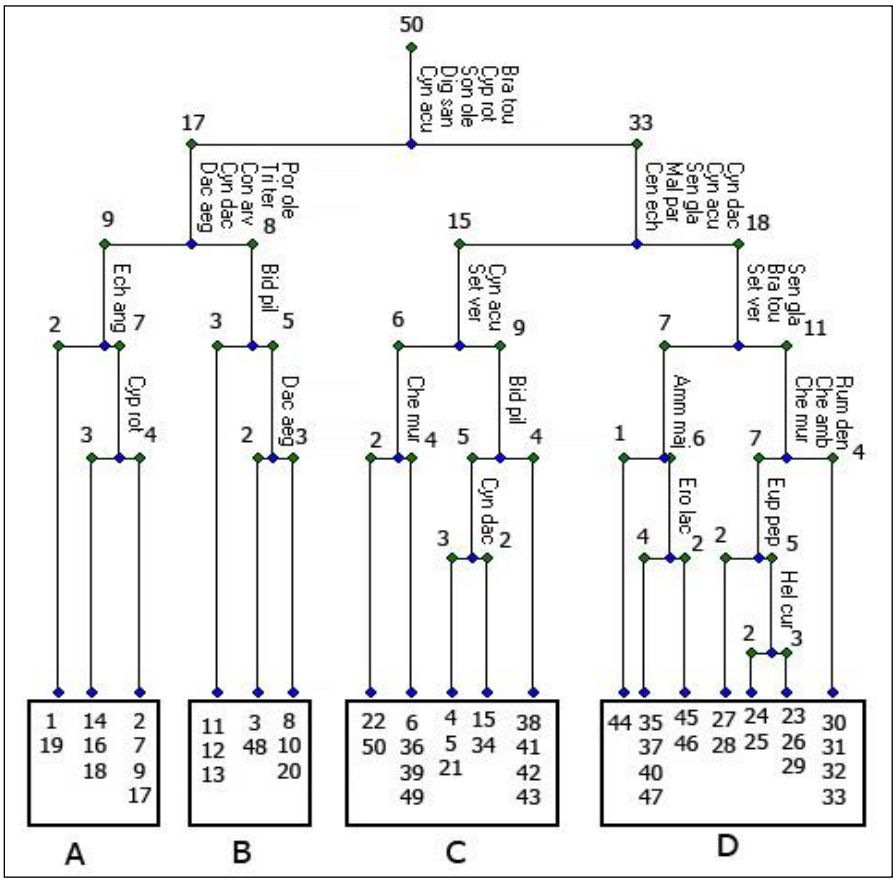


Fig. 3: Two Way Indicator Species Analysis (TWINSPAN) dendrogram of 50 sampled stands based on the importance values of 94 plant species. The indicator species are abbreviated by the first three letters of genus and species respectively.

Table 3: Mean value and coefficient of variation of the importance value of recorded species in the different vegetation groups resulting from TWINSPAN classification of the study area.

No.	Species	Vegetation Group							
		A		B		C		D	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	*Aizoon canariense* L.	0.56	3.00	--	--	--	--	--	--
2	*Alhagi graecorum* Boiss	--	--	--	--	--	--	0.95	4.24
3	*Amaranthus graecizans* L.	--	--	1.17	2.83	0.84	3.87	--	--
4	*Amaranthus hybridus* L.	10.40	3.00	--	--	--	--	--	--
5	*Amaranthus lividus* L.	0.53	3.00	4.85	1.31	1.92	3.87	1.51	2.92
6	*Amaranthus viridis* L.	--	--	4.87	2.01	--	--	--	--
7	*Ammi majus* L.	--	--	0.37	2.83	0.85	3.87	0.82	2.93
8	*Anagallis arvensis* var. arvensis L.	--	--	--	--	--	--	1.70	3.40
9	*Atriplex halimus* L.	--	--	--	--	3.81	3.01	0.80	3.00
10	*Avena fatua* L.	--	--	--	--	3.35	2.25	3.13	2.87
11	*Bassia indica* (Wight) A.J.Scott.	--	--	0.29	2.83	7.86	1.37	0.50	4.24
12	*Bassia muricata* (L.) Ach.	--	--	--	--	0.24	3.87	--	--
13	*Beta vulgaris* var. cicla L.	--	--	--	--	--	--	0.54	2.93
14	*Bidens pilosa* L. var. radiata Sch. Bip.	1.18	3.00	14.25	1.40	7.62	1.68	3.21	2.50
15	*Brassica tournefortii* Gouan	--	--	--	--	2.30	2.12	7.39	1.32
16	*Bromus diandrus* Roth	--	--	--	--	--	--	4.45	1.89
17	*Carthamus lanatus* L.	1.77	3.00	--	--	--	--	--	--
18	*Cenchrus echinatus* L.	23.27	0.98	16.04	0.47	31.56	0.71	11.54	0.62
19	*Chenopodium ambrosioides* L.	--	--	--	--	--	--	3.47	2.44
20	*Chenopodium album* L.	--	--	--	--	1.00	2.68	0.93	2.92
21	*Chenopodium giganteum* d. Don	0.24	3.00	2.70	2.83	--	--	--	--
22	*Chenopodium murale* L.	0.21	3.00	1.24	1.91	6.40	1.39	10.47	1.01
23	*Commelina benghalensis* L.	--	--	0.67	2.83	--	--	--	--
24	*Convolvulus arvensis* L.	--	--	6.22	1.17	2.91	2.26	1.21	2.38
25	*Conyza bonariensis* (L.) Cronquist.	4.08	2.62	3.99	2.64	4.69	1.56	4.72	1.42
26	*Corchorus olitorius* L.	0.65	3.00	--	--	--	--	--	--
27	*Cynanchum acutum* L.	--	--	--	--	31.70	1.29	5.52	1.40
28	*Cynodon dactylon* (L.*)* Pers.	23.73	0.80	8.91	2.04	20.22	1.01	9.38	2.19
29	*Cyperus rotundus* L.	6.26	1.48	12.72	1.10	--	--	1.89	3.24
30	*Dactyloctenium aegyptium* (L.) Willd	1.06	2.30	6.71	0.79	5.56	1.94	--	--
31	*Digitaria sanguinalis* (L.) Scop.	9.68	0.91	20.21	1.12	5.62	2.89	--	--
32	*Daucus litoralis* Sm.	--	--	--	--	--	--	0.38	4.24
33	*Echinochloa colona* (L.) Link	--	--	6.85	1.49	0.37	3.87	--	--
34	*Echinochloa crus-galli* (L.) P. Beauv.	--	--	2.70	2.83	--	--	--	--
35	*Echium angustifolium* Mill. Subs.psericeum	8.87	1.99	--	--	--	--	0.40	4.24
36	*Echinops spinosus* L.	--	--	--	--	--	--	0.78	4.24
37	*Emex spinosa* (L) campd	--	--	1.36	2.83	--	--	3.30	1.88
38	*Eleusine indica* (L.) Gaertn	0.78	3.00	7.70	1.78	3.62	3.87	--	--
39	*Erodium laciniatum* (Cav.) Willd	--	--	--	--	--	--	2.56	3.47
40	*Euphorbia heterophylla* L.	--	--	19.40	2.08	1.17	3.87	5.77	1.44
41	*Euphorbia prostrata* Aiton	--	--	--	--	--	--	0.51	4.24
42	*Euphorbia peplus* L.	--	--	0.23	2.83	0.65	3.87	6.37	2.07
43	*Fagonia thebaica* Boiss. var. thebaica	--	--	--	--	--	--	1.01	2.99
44	*Frankenia hirsuta* L.	7.98	2.20	--	--	--	--	--	--
45	*Heliotropium curassavicum L.*	--	--	--	--	5.09	3.13	1.52	3.09
46	*Hordeum murinum* subsp. leporinum L.	--	--	--	--	--	--	2.23	2.40
47	*Imperata cylindrica* (L.) Raeusch.	4.51	1.53	--	--	6.10	1.80	--	--
48	*Lactuca serriola* L.	0.22	3.00	0.48	2.83	--	--	--	--
49	*Launaea capitata* (spreng). Dandy	--	--	1.49	2.83	--	--	--	--
50	*Launaea nudicaulis* (L.) Hook. F.	--	--	1.12	2.83	3.39	2.29	3.22	2.73
51	*Launea mucronata* (Forssk.) Musch	--	--	--	--	0.21	3.87	3.80	2.44
52	*Lolium perenne* L.	--	--	--	--	2.75	2.65	5.76	3.62
53	*Lotus creticus* L.	--	--	--	--	1.16	3.87	0.32	4.24
54	*Malva parviflora* L.	--	--	0.39	2.83	1.52	2.84	12.38	0.97
55	*Medicago sativa* L.	1.29	3.00	--	--	--	--	1.45	2.50
56	*Melilotus indicus* (L.) All.	--	--	--	--	1.85	2.82	2.84	2.69
57	*Mesembryanthemum nodiflorum* L.	--	--	--	--	--	--	1.22	2.61
58	*Orobanche crenata* Forssk.	--	--	--	--	--	--	0.09	4.24
59	*Oxalis corneculata* L.	--	--	1.06	2.83	--	--	--	--
60	*Panicum coloratum*.L.	8.31	1.99	6.37	2.83	--	--	--	--

Table (3): Continued.

61	*Panicum repens* L.	6.36	3.00	4.60	2.83	--	--	--	--
62	*Panicum turgidum* Forssk.	1.55	3.00	--	--	--	--	--	--
63	*Paspalum distichum* L.	--	--	3.12	2.83	--	--	--	--
64	*Pennisetum glaucum* (L.) R. Br.	--	--	--	--	--	--	0.32	4.24
65	*Phragmites australis* (Cav.) Trin. ex Steud.	--	--	--	--	4.30	1.79	--	--
66	*Phalaris minor* Retz.	--	--	--	--	--	--	2.88	2.03
67	*Plantago lagopus* L.	1.49	3.00	--	--	--	--	--	--
68	*Pluchea dioscoridis (*L.) DC.	--	--	3.25	2.83	2.59	2.21	--	--
69	*Polypogon monspeliensis* (L.) Desf.	--	--	--	--	2.62	3.20	4.85	2.08
70	*Poa annua* L.	--	--	--	--	--	--	1.38	2.97
71	*Polygonum equisetiforme* Sibthi & Sm.	1.45	3.00	--	--	--	--	--	--
72	*Pseudognaphalium luteo album (*L.) Hilliard & B.L. Burtt.	--	--	--	--	0.47	3.87	0.50	4.24
73	*Portulaca oleracea* L.	1.59	2.05	11.25	1.59	4.42	2.07	4.13	2.13
74	*Pulicaria undulata* (L.) C. A. Mey.	1.18	1.98	--	--	--	--	4.33	2.30
75	*Raphanus raphanistrum L.* subsp. Rhaphanistrum	2.79	3.00	--	--	--	--	0.34	4.24
76	*Rumex dentatus* L.	--	--	--	--	--	--	1.86	2.32
77	*Rumex vesicarius* L.	--	--	--	--	--	--	3.64	2.33
78	*Reichardia tingitana* (L.) Roth.	8.93	3.00	--	--	--	--	1.06	2.42
79	*Senecio glaucus* L.	--	--	--	--	1.28	2.76	13.26	1.34
80	*Setaria pumila* (Poir.) Roem. & Schult.	--	--	5.93	2.08	--	--	--	--
81	*Setaria verticillata* (L.) P. Beauv.	--	--	5.96	1.50	7.65	1.72	12.19	1.48
82	*Sisymbrium irio* L.	--	--	0.99	2.83	3.55	2.04	5.90	1.79
83	*Solanum nigrum* L.	--	--	1.13	2.83	0.87	2.84	0.71	3.09
84	*Sonchus oleraceus* L.	--	--	--	--	4.05	1.72	7.50	0.90
85	*Spergularia marina (*L.) Griseb	--	--	--	--	--	--	2.35	4.24
86	*Stipa arabica* Trin. & Rupr.	--	--	--	--	--	--	0.34	4.24
87	*Symphyotrichum squamatum* (Spreng.) Nesom	1.35	3.00	--	--	--	--	--	--
88	*Tamarix nilotica (*Ehrenb). Bge	--	--	--	--	--	--	0.27	4.24
89	*Trianthema portulacastrum* L.	11.09	3.00	--	--	--	--	--	--
90	*Tribulus terrestris* L.	16.59	2.11	0.73	2.83	--	--	--	--
91	*Urospermum picroides* (L.) F.W. Schmidt	--	--	--	--	--	--	0.32	4.24
92	*Xanthium strumarium* L.	**25.97**	1.47	8.69	2.57	1.86	2.65	--	--
93	*Zilla spinosa* (L.) Prantl subsp spinosa	--	--	--	--	--	--	0.37	4.24
94	*Zygophyllum simplex* L.	4.26	3.00	--	--	--	--	1.42	3.18

The application of TWINSPAN classification based on the importance values of 94 plant species recorded in the 50 sampled stands led to the recognition of four vegetation groups (**Figure 3 and Table 3**). Group A comprised 9 stands and dominated by *Xanthium strumarium* which had the highest importance value of this group (IV= 25.97). The other important and indicator species with relatively high importance values in this group were *Cynodon dactylon* (IV=23.73) and *C. echinatus* (IV=23.27). In addition, group B included 8 stands and dominated by *Digitaria sanguinalis* (IV=20.21). The other important and indicator species, which attained relatively high importance values in this group were *Euphorbia heterophylla* (IV=19.40), *C. echinatus* (IV=16.04) and *Cyperus rotundus* (IV=12.72).Moreover, group C comprised 15 stands dominated by *Cynanchum acutum* (IV=31.70) and *C. echinatus* (IV=31.56). *C. dactylon* (IV=20.22) was considered as an important associated species in this group. Furthermore, group D comprised 18 stands dominated by *Senecio glaucus* (IV=13.26) and codominated with *Malva parviflora* (IV=12.38), *Setaria verticillata* (IV=12.19), *C. echinatus* (IV=11.54) and *Chenopodium mur*ale (IV=10.47).

iii.Ordination of stands:

The ordination of the sampled stands given by (DCA) was shown in (**Figure 4**). It was clear that, groups A and B separated in the right side of DCA diagram and superimposed with each other (related to each other in the floral composition), while group C clearly separated at the middle of the DCA diagram. Moreover group D separated at left side of the ordination plane.

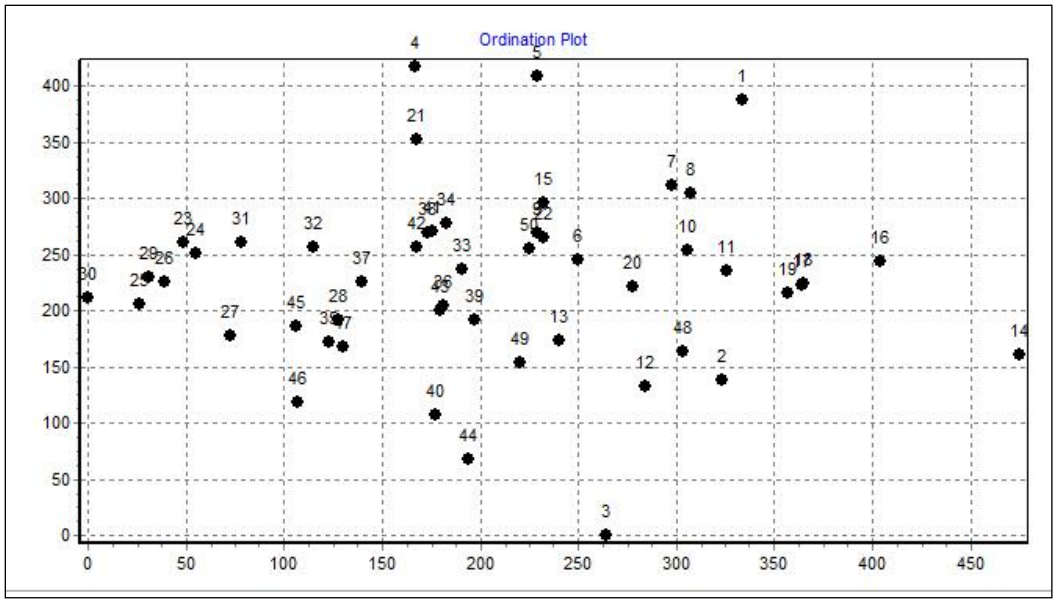


Fig. 4: Detrended Correspondence Analysis (DCA) ordination of 50 sampled stands.

iv.Vegetation-Soil Relationships:

The soil variables of the four vegetation groups derived from TWINSPAN classification were presented in (**Table 4**). The soil texture of the four groups was formed mainly of sand and partly of silt and clay. Soil porosity, pH, water-holding capacity and magnesium were comparable in the four groups, while group A attained the highest values of calcium (19.16 mg /100g^{-1}). Group B attained the highest values of calcium carbonates (13.00%), potassium (20.59 mg/100 g^{-1} dry soil), PAR (6.20) and SAR (12.56). The highest value of sulphates (0.19%) and E.C. (477.35 µmhos/ cm^{-1}) were recorded in group C. Moreover, soluble carbonates and bicarbonates were detected in very low content in all groups.Furthermore group D showed the highest content of total nitrogen (49.54%) and sodium (32.36 mg/100g^{-1}).

Table 4: Mean and standard error of the different soil variables at depth (0–50 cm) in the sampled stands representing the different vegetation groups obtained by TWINSPAN.

Soil Variable		TWINSPAN Vegetation Group			
		A	B	C	D
Sand (%)		92.76±1.59	88.96±2.22	92.02±1.32	90.89±1.15
Silt (%)		5.86±1.22	9.24±1.84	6.69±1.11	7.51±0.99
Clay (%)		1.38±0.40	1.80±0.40	1.30±0.22	1.60±0.19
Porosity (%)		31.06±2.26	26.93±2.07	26.74±1.55	29.95±1.47
W.H.C. (%)		33.34±1.59	33.57±1.69	35.11±1.39	34.41±1.13
pH		7.88±0.08	8.02±0.06	7.95±0.06	7.90±0.04
E.C. (µmohs/cm^{-1})		267.21±140.54	271.11±159.98	477.35±155.32	331.46±134.59
CaCO3 (%)		10.22±2.05	13.00±2.56	8.13±1.49	10.33±1.73
O.C. (%)		0.32±0.08	0.36±0.06	0.30±0.06	0.30±0.04
Cl^- (%)		0.03±0.02	0.03±0.02	0.01±0.00	0.03±0.03
$SO4^{--}$ (%)		0.12±0.03	0.09±0.01	0.19±0.03	0.13±0.03
CO_3^{--} (%)		0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
TDP		0.17±0.02	0.22±0.03	0.21±0.02	0.21±0.02
TN		44.60±14.54	47.11±11.69	54.54±12.22	59.54±9.00
HCO_3^- (%)		0.02±0.00	0.01±0.00	0.02±0.00	0.02±0.00
Na^+	(mg/100g dry soil)	28.65±7.15	40.79±8.47	24.66±4.38	32.36±5.27
K^+		14.00±3.49	20.59±4.53	12.29±2.31	16.83±2.78
Ca^{++}		19.16±6.31	14.90±3.93	7.62±1.82	12.80±2.03
Mg^{++}		8.93±4.02	9.96±4.58	10.54±4.33	9.19±2.99
SAR		9.00±1.94	12.56±1.34	10.22±1.50	9.71±1.10
PAR		4.65±1.05	6.20±0.74	4.92±0.70	5.05±0.63

v. Correlation between Vegetation Gradient and Soil Variables:

The correlation between vegetation and soil characteristics was indicated on the ordination diagram produced by (CCA) (**Figure 5**). Sulphates, silt, water-holding capacity, bicarbonates, sand, porosity, calcium and organic carbon were the most effective soil variables. Electrical conductivity, magnesium and sulphates were correlated with each other, while silt, clay and carbonates were closely correlated.Organic carbon, SAR, water-holding capacity and calcium were correlated with each other. It was clear that, *C. echinatus* the important species in all groups (A,B,C&D) and *D.sanguinalis* (dominant species of group B) were affected by magnesium, sulphates, E.C., organic carbon and calcium carbonates. While *C. dactylon* (important species of groups A & C) was affected by sand, silt ,clay and total nitrogen. Moreover, *S. verticillata* (important species of group D), *C. rotundus* (important species of group B) and *B. piloas* (important species of group B) were affected by carbonates, organic carbon and sodium. Furthermore, *S. glaucus* (dominant species of group D) was affected by total dissolved phosphorus.

vi. Diversity Indices:

The vegetation groups were differentiated according to Simpson's Diversity Index as shown in **(Table 5).** It was clear that; group D attained the highest value of relative concentration of dominance (0.966), while decreased to 0.907 in group A followed by slight increase to 0.944 in group C.

The vegetation groups obtained from TWINSPAN classification varied greatly in the shannon-evenness diversity index **(Table 5).** Group B attained the highest value (0.882), while the lowest (0.768) was recorded in group A. In addition, groups D and C attained values of 0.866 and 0.856 respectively. Thus group B was characterized by more evenness than the other groups.

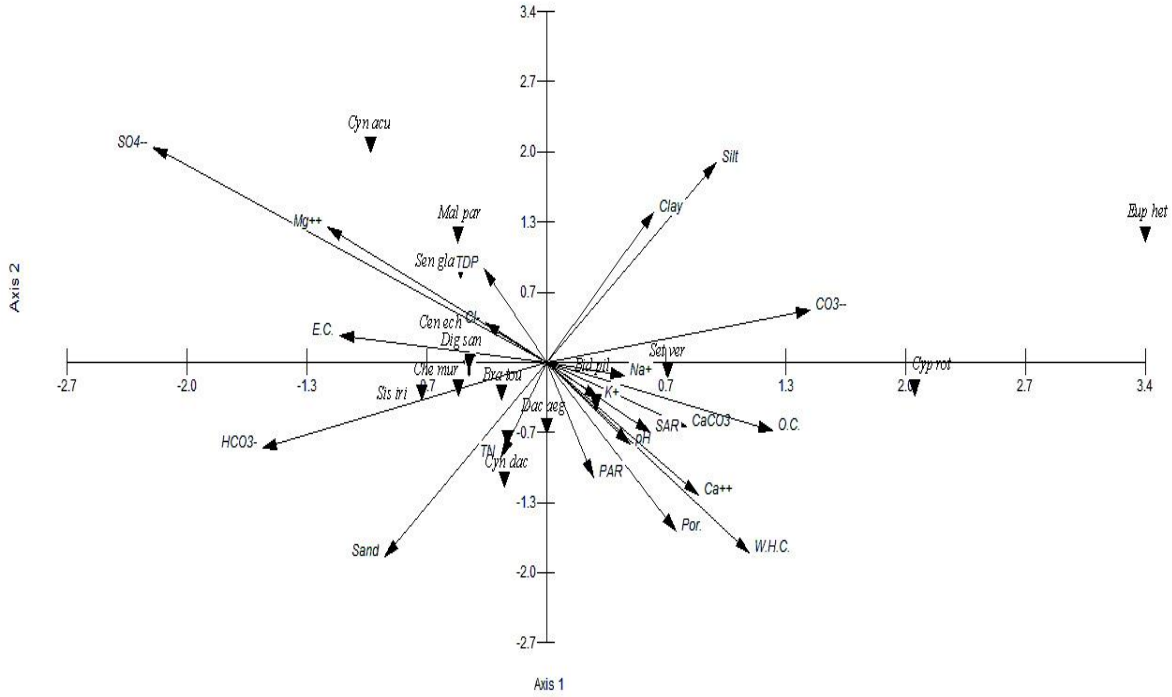


Fig. 5: Canonical Correspondence Analysis (CCA) ordination diagram of plant species along the gradient of environmental variables (arrows). The indicator and preferential species were indicated by three first letters of genus and species respectively.

Table 5: Species diversity of the different vegetation groups obtained from TWINSPAN analysis in the study area.

Diversity index	Vegetation Group			
	A	B	C	D
Simpson's diversity index (D)	0.907	0.952	0.944	0.966
Shannon-evenness diversity index (E)	0.768	0.882	0.856	0.866

vii. Allelopathy Trial:

Effect of *C. bonariensis* and *A. saligna* extracts on *C. echinatus* seed germination:

The effect of aqueous and methanolic extracts of *C. bonariensis* and *A. saligna* shoots on the seed germination of *C. echinatus* is shown in (**Table 6**). After five days of treatment, most of the extracts significantly ($p \leq 0.05$) reduced the germination of *C. echinatus*. The methanolic extract of *C. bonariensis* had the most significant affect (100% inhibition at10g/L). While, the *A. saligna* aqueous extract had the lowest effect.

Table 6: Effect of different extracts of *Conyza bonariensis* and *Acacia saligna* shoots on the germination percentage (mean value ± standard error) of *Cenchrus echinatus* seeds at 5 DAT.

Concentration (g /L)	Plant species			
	Conyza bonariensis		*Acacia saligna*	
	Methanol	Water	Methanol	Water
2	57.86 ± 0.23 ^{g}	55.71 ± 0.00 ^{g}	23.32 ± 0.25 ^{b}	20.25 ± 0.23 ^{a}
4	79.32 ± 0.54 ^{i}	76.35 ± 4.86 ^{i}	40.25 ± 1.11 ^{d}	35.23 ± 1.01 ^{c}
6	81.21 ± 1.23 ^{j}	77.46 ± 4.61 ^{i}	45.85 ± 0.54 ^{e}	39.98 ± 0.65 ^{d}
8	89.24 ± 2.32 ^{l}	88.57 ± 6.70 ^{k}	56.36 ± 0.65 ^{g}	48.65 ± 0.55 ^{f}
10	100.00 ± 0.27 ^{n}	95.36 ± 2.43 ^{m}	62.21 ± 0.54 ^{h}	57.56 ± 1.01 ^{g}
$LSD_{0.05}$	1.66			

DAT:Days after treatment. Different superscript letters indicate values significantly lower than the respective control ($P \leq 0.05$).

Effect of *C. bonariensis* and *A. saligna* extracts on *C. echinatus* root growth:

The inhibitory activity of aqueous and methanolic extracts of *C. bonariensis* and *A. saligna* shoots on the root growth after 12 days from treatment is showed in Table (7). All extracts significantly reduced root growth of *C. echinatus* at both high and low concentrations. The methanolic extract of *A. saligna* was the most effective extract (85.32% inhibition at 10g/L); while the water extract of *C. bonariensis* was the lowest effective one.

Table 7: Effect of different plant extracts of *Conyza bonariensis* and *Acacia saligna* shoots on the seedling root length (mm) inhibition percentage (mean value ± standard error) of *Cenchrus echinatus* at 12 DAT.

Concentration (g/L)	Plant species			
	Conyza bonariensis		*Acacia saligna*	
	Methanol	Water	Methanol	Water
2	6.32 ± 0.23 ^{a}	5.56 ± 0.56 ^{a}	6.32 ± 1.02 ^{a}	5.98 ± 1.23 ^{a}
4	15.23 ± 0.65 ^{c}	13.56 ± 0.76 ^{b}	16.25 ± 0.68 ^{c}	15.23 ± 0.98 ^{c}
6	55.23 ± 1.02 ^{e}	51.65 ± 1.00 ^{d}	56.36 ± 0.58 ^{e}	52.65 ± 0.99 ^{d}
8	72.23 ± 2.03 ^{g}	68.65 ± 2.00 ^{f}	78.36 ± 2.03 ^{h}	75.23 ± 1.11 ^{g}
10	81.23 ± 1.24 ^{i}	74.62 ± 1.28 ^{g}	85.32 ± 2.32 ^{j}	76.28 ± 2.12 ^{h}
$LSD_{0.05}$	1.43			

DAT:Days after treatment. Different superscript letters indicate values significantly lower than the respective control ($P \leq 0.05$).

Effect of *C. bonariensis* and *A. saligna* shoot extracts on *C. echinatus* shoot growth:

The inhibitory activity of aqueous and methanolic extracts of *C. bonariensis* and *A. saligna* shoots on the shoot growth of *C. echinatus* after 12 days are showed in (**Table 8).** All extracts significantly reduced shoot growth of *C. echinatus* at both high and low concentrations. The methanolic extract of *C. bonariensis* had the most significantly effect (98.31% inhibition at 10g/L), while, its aqueous extract was the lowest effective. Generally the methanolic extracst was effective than aqueous extracts.

Table 8: Effect of different t extracts of *Conyza bonariensis* and *Acacia saligna* shoots on the seedling shoot length (mm) inhibition percentage (mean value ± standard error) of *Cenchrus echinatus* at 12 DAT.

Concentration (g /L)	Plant species			
	Conyza bonariensis		*Acacia saligna*	
	Methanol	Water	Methanol	Water
2	13.2 ± 1.21 [d]	11.91 ± 1.02 [c]	8.98 ± 1.02 [b]	7.68 ± 1.56 [a]
4	16.32 ± 2.02 [e]	13.99 ± 0.85 [e]	11.23 ± 0.65 [c]	10.23 ± 3.56 [c]
6	75.65 ± 0.56 [j]	72.02 ± 0.98 [h]	65.32 ± 1.05 [g]	60.25 ± 1.23 [f]
8	95.32 ± 0.65 [l]	91.19 ± 0.99 [k]	70.69 ± 2.56 [h]	71.58 ± 0.99 [h]
10	98.31 ± 1.02 [m]	74.09 ± 0.12 [i]	82.32 ± 3.56 [j]	80.74 ± 0.98 [j]
$LSD_{0.05}$	1.20			

DAT: Days after treatment. Different superscript letters indicate values significantly lower than the respective control ($P \leq 0.05$).

4. Discussion

The natural plant wealth in the present study was composed of 94 species belonging to 79 genera and 29 families. The major families were Poaceae, Asteraceae and Chenopodiaceae which contributed collectively about 52.13 % of the total recorded species. This indicated that, these four families include the leading taxa and constituted the major bulk of the flora of the study area.This result agreed more or less with the findings of many researchers in the plant ecology of Nile Delta (Abd El- Fattah *et al*., 1992; Shalaby, 1995; Awad, 2001; Mashaly, 2001).

The life form spectra provided information which may help in assessing the response of vegetation to variation in environmental factors. The Mediterranean climate was designated as a therophyte climate because of the high percentage (>50% of the total species) of this life form in several Mediterranean floras (Raven,1971). This was confirmed later by (Quezel, 1978) in North Africa. On the basis of plant longevity, the annuals were the dominant life-span which had higher reproductive capacity and ecological, morphological and genetic plasticity (Kowarik, 1985). In the present study the annuals were represented by 59 species (62.77%) of the total number of the recorded species. The high contribution of annuals can be attributed to their short life cycle that enables them to resist the instability of the ecosystem, this agreed with the studies of Mashaly (1987&2001), Shalaby (1995), Awad (2001), and El-Halawany *et al*. (2010).

The floristic categories of the recorded species showed that the monoregional taxa had the highest contribution, followed by the bi-regional, cosmopolitan and pluriregional, this is not in accordance with (Zohary,1973) who referred to the dominance of inter-regional species (bi-,tri-and pluri-regional) over mono-regional ones to the presence of inter-zonal habitats,such as anthropogenic or hydro-,halo- and psammophilous sites, and these habitats were absent in the present study.

Phytogeographically, Egypt is the meeting point of floristic elements belonging to at least four phytogeographical regions: African Sudano-Zambezian, Asiatic Irano-Turanian, Afro-Asiatic Saharo-Sindian and Euro-Afro-Asiatic Mediterranean (El-Hadidi, 1993). In addition the floristic analysis indicated that the Mediterranean elemenst were represented by relatively high percentage of plant species (41.49 %). This was confirmed by many studies in the Nile Delta (Al-Sodany, 1992; Awad, 2001; Mashaly, 1987; Mashaly, 2001; Shalaby, 1995; Shaltout *et al*., 2005).

In the present study, the phytosociological analysis revealed that the vegetation was classified by TWINSPAN into four vegetation groups. Group A dominated by *X. strumarium*, while *C. dactylon* and *C. echinatus* were important species of this group. In addition group B dominated by *D. sanguinalis*, while *E. heterophylla*, *C. echinatus* and *C. rotundus* were the important species. Group C dominated by *C. acutum* and *C. echinatus*, whereas *C. dactylon* was important species in this group. Group D dominated by *S. glaucus*, while *M. parviflora*, *S. verticillata*, *C. echinatus* and *C. murale* were important species in this group. These data reflected the weedy invasions of *C. echinatus* in the study area. High importance values of *C. echinatus* in the four vegetation groups showed its ability of invasion in the newly reclaimed areas. The success of an alien species depends on the degree of invasiveness, that is, the potentiality to establish and spread. A few simple biological attributes can be considered strong predictors of potential invasiveness of a species (Rejmanek, 2000).

Weed communities are affected by many factors such as soil characteristics (Pinke *et al*., 2010). The application of (CCA) suggested that the most effective soil variables that had a significant correlation with the distribution of vegetation groups, were: sulphates, silt, water-holding capacity, bicarbonates, sand, porosity, calcium and organic carbon. this was in agreement with those of Omar (2006). Soil texture may affect soil or productivity via influence on the water holding-

capacity, infiltration rate, moisture availability for plants and consequently plant nutrition (Sperry &Hacke, 2002).

The variations in species diversity among the different habitat types may be attributed to the differences in soil characteristics, substrate discontinuities and the allelopathic effect of one or more invasive species depending on their relative dominance among other associated species (James *et al*.,2006). Species diversity increased as the number of species per sample increased and as the abundance of species within a sample became even (Pielou,1969). Consequently the vegetation of group D that was represented by the largest number of stands and the largest number of fields of orchards and crops was more diverse than the other groups,this may be due to the biotic factors such as allelopathic interactions that may play a role in influencing the distribution of vegetation in nature, the yield of various crop species, germination and weed interference (Mucina, 1997).

The results of allelopathy trial revealed that shoot growth was more inhibited with aqueous and methanolic extracts of *C. bonariensis* than root growth and the inhibitory effect of these extracts was much more pronounced on germination than on growth. An indirect relation between a lower germination rate and allelopathic inhibition may be the consequence of inhibition of water uptake (Tawaba and Turk, 2003). Germination and growth were inhibited by aqueous and methanolic extracts of the two tested plants. The degree of inhibition was dependent on the concentration of extracts (Kayode and Ayeni, 2009) and Ashrafi *et al*., (2008). The results revealed also that seed germination, root and shoot growth of *C. echinatus* were more reduced with the methanolic extract of *C. bonariensis* than the aqueous extract of *C. bonariensis* and than the aqueous and methanolic extracts of *A. saligna*. Weed respons to methanolic extract in the physiological processes may be due to a selective activity of allelochemicals for target species and a different level of weed species tolerance to such allelochemicals, (Dennis, 1993). Ahmed, (2014) reported that the bioactive chemical constituents of *C. bonariensis* had high contents of phenolics, tannins, alkaloids, flavonoids and saponins.Thus the inhibitory effect of *C. bonariensis* on seed germination and seedling growth of *C. echinatus* may be due to the presence of these allelochemicals. The methanolic extract of *A. saligna* had more inhibitory effect on germination, root and shoot growth of *C.echinatus* than its aqueous extract. This was similar to the findings obtained by Asma *et al* ., (2013) who found that the methanolic extract of vegetative reproductive parts of *A. saligna* reduced the seedling elongation of 2 crops: *Triticum aestivum* L. and *Lactuca sativa* L. and 2 weeds *Peganum harmala* L. and *Silybum marianum* L. greater than its aqueous extract. Kohli *et al.*, (2006) and Seigler (2003) found that some *Acacia* spp. affected crops through allelopathy, as their litters interfered with the establishment and growth of adjoining crop plants due to presence of numerous substances including phenolic compounds in the litter. Some of these substances act as allelochemicals Reigosa *et al.* (1999) and influence germination and seedling growth Zhou *et al*. (2006).

We noticed that roots of the plant exposed to allelochemicals (aqueous and methanolic extracts of *A. saligna)* became brownish, stunted, and void of root hairs.This might be due to a rapid inhibiting effect on respiration of the root tips, which ultimately reduced elongation.Identical results were reported by Shahid *et al*. (2006) when they tested the aqueous extract of *Acacia nilotica* on wheat and its weeds.

The effects of allelopathy on germination and growth of plants may occur through a variety of mechanisms including reduced mitotic activity in roots and hypocotyls, suppressed hormone activity, reduced rate of ion uptake, inhibited photosynthesis and respiration, induced protein formation,and decreased permeability of cell membranes (Rice,1986).

Conclusion

Our field study indicated that *C. echinatus* is an invasive wild weed, flourishing nearly in all studied fields. It had a high importance value and it was an important plant in all the identified vegetation groups. Allelopathic effect of shoots of *C. bonar*iensis and *A. saligna* were coducted for eradication of this troublesome weed.

The allelopathic effect from methanolic extract of *C. bonariensis* showed an inhibitory effect on seed germination of *C. echinatus* seeds, hence the allelochemicals extracted from methanolic exract of *C. bonariensis* can be employed for the natural control of *C. echinatus* thus, achieving the aim of environmental safety. There is a need for further studies to be carried out on identifying the inhibiting allelochemicals of the investigated species.

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