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The Invasive Species *Commelina benghalensis* L.: A Step Towards The Biological Flora of Egypt

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ABSTRACT

Invasive species *Commelina benghalensis* L. was investigated for its morphological, anatomical aspects. Ecological studies were carried out to explore the floristic composition of its community type and assess the factors that affect its invasion to the study area. Furthermore, proximate analysis, mineral composition, phytochemical screening and GC/MS analysis of secondary metabolites were studied to explore the nature of compounds present and evaluate its potential uses. Forty-seven weed species related to 21 families were recorded in *C. benghalensis* community type. Poaceae, Asteraceae and Brassicaceae were the most important families. *Portulaca oleracea*, *Cyperus rotundus*, *Dactyloctenium aegyptium* and *Euphorbia heterophylla* were the common associates. Therophytes were the most frequent life-form (78.7%). The chorological analysis showed the prevalence of paleotropical, cosmopolitan and Mediterranean taxa. A canonical correspondence analysis (CCA) indicated that pH, cations (calcium, potassium, sodium and magnesium), anions (bicarbonates, sulphates and chlorides), soil texture (sand, silt and clay) and organic matter were the most effective soil variables for the distribution of C. *benghalensis* and its associated species in the study area. The highest values of succulence and mean leaf surface area were recorded in mango orchards, while the highest shoot length and phytomass were registered in the habitats of crop fields. The results also indicated that this plant is a valuable source of nutritional, mineral and phytochemical compounds; hence it can be used as potential source of relatively low-cost, palatable forage for livestock and might be of a very important medicinal value and should be explored further to extract new drugs. It should not be included in the harmful weeds.

Keywords: Invasive species, plant communities, secondary metabolites, proximate analysis, chorology.

INTRODUCTION

Commelina benghalensis L. is an aggressive invasive weed (Wilson, 1981; Burns, 2004 and Heneidy, 2010) that produces both aerial and subterranean cleistogamous flowers (Isaac *et al.*, 2013). Its serious growth habit allows to form dense pure stands, they may compete easily with low growing crops such as vegetables, cereals and legumes by smothering them (Holm *et al.*, 1977). Therefore, it is a highly competitive and difficult to control weed (Ferrell *et al.*, 2006).

Commelinaceae is the fifth largest family of Monocotyledons in Tropical Africa (Faden and Hunt, 1991). It is a family of 40 genera and over 600 species distributed from Northern temperate to tropical climates (Webster *et al.*, 2005). This family is separating among families that truly debilitate crop performance (Daehler, 1998). Genus *Commelina* belongs to the Tribe *Commelineae* of subfamily *Commelinoideae* (Reveal and Chase, 2011).

Commelina species are ranked among the worst and extensively disseminated weed species. It is emerging as a potential threat for cultivated land (Isaac *et al*., 2013), those intensive spread of *Commelina spp.* are attributed to the viable seeds being produced both above and below ground. They also possess the ability to root at the nodes and can be propagated from cut stems. Genus *Commelina* is considered as one of the most important troublesome weed in 25 different crops in 28 countries (Webster *et al.*, 2005). In addition, it boosts economic losses and environmental defect (Rocha *et al*., 2007).

In Egypt, family Commelinaceae is represented by 3 genera and 6 species (Boulos, 2005). *Commelina benghalensis* was originally known in Egypt as a very rare species recorded in Gebel Elba (Täckholm, 1974), subsequently it had been reported to be widely distributed, spread rapidly as weed in crop fields of Egypt (Boulos, 2005). Abd El-Ghani and Abdel-Khalik (2006) recorded this plant from Wadi Aideib and Wadi Yahameib of Gebel Elba Natural Reserve. It has been also recorded by Shaltout (2014) among the alien weeds in the Egyptian flora. In addition; It was reported by Abd El-Gawad (2014) among invasive plants in some newly reclaimed areas in Egypt.

Weeds compete with cultivated crops and forages for moisture, light, and nutrients, but many weeds are nutrient-rich, digestible and of medicinal benefits (Lewis and Green, 1995). The composition of arable weed species is ruled by environmental conditions such as temperature and precipitation. Climatic change may become one of the most important determinants for the distribution of arable weeds (Peters *et al.*, 2014). Weed communities are affected by soil characteristics (Pinke *et al*., 2010), allelopathic interactions (Mucina, 1997), agricultural practices and crop type (Andersson and Milberg, 1998 and Andreasen and Skovgaard, 2009).

Commelina benghalensis has been reported in folkloric medicine to poses antimicrobial, anti-inflammatory, analgesic and abortifacient properties (Raquibul Hasan *et al.* 2010; Cuéllar Cuéllar and Okori, 2010). Several studies have been held to investigate its phytochemical constitutes. Del Pero Martínez and Swain (1985) confirmed that flavone C-glycosides are the dominant compounds in Commelinaceae. However, Chioma and

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Omoregie (2010) reported that phytochemical screening of *C. benghalensis* revealed the presence of phlobatannins, carbohydrates, tannins, glycosides, volatile oils, resins, balsams, flavonoids and saponins.

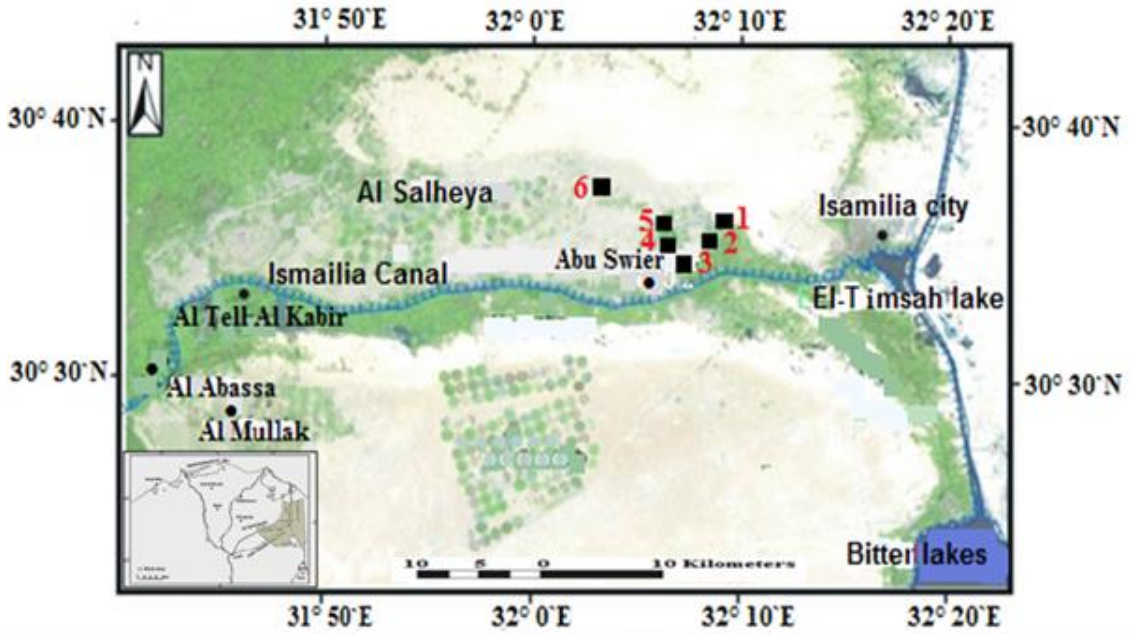
Mbazima (2009) assessed the effect of crude Methanolic extract of *Commelina benghalensis* on cancer cell growth to validate the traditional use of *C. benghalensis* as an anticancer agent; in the same context, Mokgotho (2009) proved antiproliferative activity of both the n-hexane and DCM extracts of *C. benghalensis* against Wil-2 NS cancerous cells. Raquibul Hasan *et al.* (2010) evauated the Analgesic potential of *Commelina benghalensis* and thereby justified its traditional uses in various types of pain. In addition the potential use of the species as a feed supplement for ruminants was proposed by Lanyasunya *et al*. (2008).

It was noticed that livestock in Ismailia governorate feed greedily on *Commelina benghalensis*; this observation formed the basis for the present study which aimed at 1) exploring the morphological, anatomical, taxonomical and phytochemical characteristics of *Commelina benghalensis* in order to redirect focus on the usefulness of the plant; 2) Studying the floristic composition and evaluating the environmental factors controlling its distribution; 3) determining the possible bioactive compounds and evaluate its nutritional value.

MATERIALS AND METHODS

Study Area

The study area located in Ismailia Governorate, between longitudes 31º 40´-32º 38´ E and latitudes 30º 15 -30º 57´ N (Map 1). It belongs to the Eastern Nile Delta that has a number of geomorphological features directly affecting the agricultural activities and land use. The soil of the study area is related to river terraces of fluvial and deltaic origins and wind-blown deposits according to FAO (1964) and Younes *et al*. (1977). The study area belongs to the arid province (Ayyad and Ghabbour, 1986). The mean monthly air temperature varies between 13.03°C in January and 27.31°C in July. The relative humidity varies from 64.75% in January to 51.15% in April. The highest precipitation (26.04 mm) was recorded in November, while the lowest (0.76 mm) was recorded in July. The mean evaporation rate varies between 3.8 mms/day and 9.8 mms/day (Ibrahim, 2017).



Map (1): Showing the different localities in the study area (▭). Studied localities (■) 1: El Warawrah; 2: Fares; 3: Abu Omar; 4: Abu Ragieh; 5: Abu Radwan; 6: Abu Kharwa.

Morphology

Fresh plant materials were collected from their natural habitats and deposited at the Herbarium of Suez Canal University (SCUI). To study the morphological characteristics of *Commelina benghalensis*, fresh and dried specimens were studied and described according to Boulos (2005). Olympus sz61 Stereomicroscope equipped with Optica View 7.3.1.7. En Camera was used for inspecting and collecting morphological data.

Scanning Electron Microscopy (SEM)

Freeze-fractured, and then freeze-dried. The specimenswere sputter-coated with gold palladium and viewed with a JEOL JSMT-5200 scanning electron microscope operated at 25-30 Kv.

Anatomy

About 5mm x 5mm portions were cut from fresh matured and well expanded leaves and stem , then immediately immersed in formalin-glacial acetic acid-ethanol solution (70% FAA) for 24 hours. Thin cross-sections were made as described by (Johansen, 1940). Well stained sections were examined under light microscope and photographed using a Zeiss Camera to

calculate the means and standard error among the different cross-sections. Different references book were used for anatomical description (e.g., Cutler *et al.*, 2008).

Vegetation analysis

Twenty stands (area = 10 m×10 m each) dominated by *Commelina benghalensis* were surveyed at summer and autumn seasons of the year 2016. The stands covered three habitat types in six localities of the study area namely; newly cultivated mango orchards (MN), old cultivated mango orchards (MO) and crop fields (CF). The density was measured by counting the number of individuals of species within each stand and the cover was estimated by using the line-intercept method (Canfield, 1941). The relative values of density and cover of each species were calculated and summed up to give an estimate of its importance value (IV out of 200). The taxonomic nomenclature of the species in the study area was given according to Boulos (1999, 2002, 2005, 2009). Life form of each species was listed according to Raunkiaer (1934). The phytogeographical range of species distribution was carried out according to Good (1974), Wickens (1976) and Abd El-Ghani (1981 and 1985). The presence value (P) of each species was expressed as the number of stands in which a plant species is present in relation to the total number of sampled stands. Phytomass of the studied plant was determined as dry weight per unit area by harvesting plants in five quadrats (0.5 m^2) according to Shukla and Chandel (1996). Fresh (FW) and dry (DW) weights were determined and expressed as g/m^2. The succulence was calculated as a ratio between fresh weight and dry weight (FW/DW) (Khedr and Hegazy, 1998). The average leaf area was measured according to the equation of Kemp (1960): A= K×L×B, where K is Kemp's constant, it equals (0.9) for monocots, L and B is leaf length and leaf width at mid-point respectively.

Soil analysis

Three soil samples were collected from each stand at a depth of 0-50 cm, mixed, air dried and passed through a 2mm sieve to separate gravel and debris. Soil texture was analyzed using the Bouyoucos hydrometer method (Bouyoucos, 1962). Organic matter content was estimated by loss on ignition method according to Allen *et al*. (1974). Determination of calcium carbonate content was carried out using Collin's Calcimeter (Allen *et al.*, 1974). Soil salinity (EC) and soil reaction (pH) were estimated in (1:5) soil-water extract using a digital conductivity meter (Model 76, ES and D, Inc. USA and a digital pH-meter (Model 201, Orion research, USA) respectively. Carbonates (CO_3^{--}) and bicarbonates (HCO_3^-) were determined volumetrically (Pierce *et al.*, 1958). Chlorides (Cl^-) were estimated according to Baruah and Barthakur (1997). Sulphates were determined by the gravimetric method using barium chloride (Piper, 1942). Calcium and magnesium were estimated according to Baruah and Barthakur (1997). Estimation of sodium and potassium were carried out using a flame photometer (Model 410, Corning, England) as described by Allen *et al.* (1974).

Data analysis

The relationships between the vegetation and the soil gradients of the three studied habitats were assessed using Canonical Correspondence Analysis (CCA) (Ter Braak, 1986 and 1994). The input data in this analysis were in two forms: stands versus species importance values (IV) data matrix and stands versus soil variables data matrix. Statistical analysis was carried out using SPSS version 22.0 for windows software.

Proximate composition

Moisture, total ash content, crude protein, fat, total carbohydrates and crude fiber content were estimated according to the procedures described in AOAC (1990). Ether extract (crude fat) was determined by the Soxhlet extraction (Harborne, 1984) .

Mineral content

The macro and micro-elements were estimated in the ash of the *Commelina benghalensis*. Mg, Fe, Cu, Mn and Zn were measured using atomic absorption (Perkin-Elmer atomic absorption Spectrophotometer 2380). Phosphorus (P) was determined by applying molybdenum blue method using a spectrophotometer (T60 UV/VIS Spectrophotometer). Total nitrogen (N) was assessed by the Kjeldahl method. All these procedures are according to (Allen *et al.*, 1974). The calculation of nutritive value (kcal/100 g dry weight) was carried out using the Atwater system as described by the World Health Organization (1985) by multiplying the values obtained for protein, carbohydrates and fat by 4.00, 3.75 and 9.00, respectively, and the results are expressed in k.cal.

Phytochemical analysis

Preliminary phytochemical screening of *C. benghalensis* extract was performed using standard procedures (Harborne, 1998).

GC-MS analysis

Gas Chromatography Mass Spectrometry (GC-MS) analysis separates all the components in the sample and provides a representative spectral output. The analysis was performed using GC Shimadzu QP2010 system and gas chromatograph interfaced to a Mass Spectrometer (GC-MS) equipped with Elite-1 fused silica capillary column. The GC-MS Conditions: Column: (Varian Chrompack CP-Sil 8, 30m length x 0.25mm ID). Carrier gas: Helium with constant flow, 1.0 ml/min. Injector Temperature = 250°C, Split Ratio = 2. Oven Temperature: Program: Start at 40°C withhold time of 1 min, then, 40 to 150°C at a rate of 10°C/min, with no hold, then, 150 to 280°C at a rate of 5°C/min with a hold for 5 min. Total Runtime = 30 min. Injected Volume of the extract = 1 µL. Interface Temperature = 280°C.

The interpretation of the mass spectrum GC-MS was carried out using the database of National Institute Standard and Technology (NIST) having more than 62,000 patterns. The name, molecular weight and structure of

the components of each sample were ascertained using NIST Ver. 2.1 MS data library. The spectrum of the unknown component was compared with the spectrum of the component stored in the NIST library version (NIST Chemistry Web Book) (Joulain and König, 1998) and a database of chemical molecules https://pubchem.ncbi.nlm.nih.gov/search/search.cgi.

RESULTS

Morphological Characteristics

Herbaceous, summer annual, 20-36 cm height. Stem slender, creeping to decumbent (Fig.1); fibrous rooting with subterranean cleistogamous flowers; internode 5-10 cm; leaf-sheath 0.5-3 cm closed, ciliate at the mouth with purplish or white bristle along free edge with hooked or straight three cell non-glandular hairs; Leaves spirally arranged, 6-10×2.5-5 cm, ovate to ovate lanceolate, pubescent, acute, pseudo-petiole 0.4-1.8 cm; with 10-12 mm sheathy base with long hairs, leaf venation parallel convergent. Inflorescence leaf-opposed 1 cincinnus (scorpioid cyme); The cincinni enclosed in a folded spathe; spathes 1.5-2.2×1.8-3 conduplicate, broader than length , fused thought their proximate margin ;sessile or shortly pedunculate; lower cincinnus enclosed within the spathe, with 2-3 bisexual flowers; cincinnus peduncle 0.8-1.2 cm; pedicel 4-8 mm, protruding in flower, reflexed and enclosed within the spathe in fruit; upper cincinnus protruding from the spathe; peduncle 1.5-2 cm, with 1 staminate flower; dimorphic flower, Chasmogamous (aerial) flowers, zygomorphic, borne in stalked, or rarely sessile pedicel 4-8 mm; lower sepals 3.5×2.5 mm, oblong; upper sepal 3.5×1.5 mm , elliptic; lower petal blue; paired petals 0.7-0.85×0.9-1.1 cm, with 4-5 mm claw, blue; median stamen with filament 5-7mm; anther 2 mm, lateral stamen with 5-7mm filament; anthers 1.4 mm, blue; staminodes with 4-4.5 mm filaments, antherodes yell-ow; stigma capitate blue. Capsule produced by chasmo-gamous flower 4.5-5.5× 3 mm oblongelliptic; Capsules produced by cleistogamous flowers (Fig. 2b) ellipsoid 5-7x3-4 mm splits along two valves (Fig. 2e), 2- seeded, pyriform, 3-5 ml at the soil surface, dehis-cent, each containing 1 or 2 seeds with circular hilum. Seeds dimorphic 3-5 per capsule with varying size; Aerial seeds 2.5-5×1.5-2.5 mm oblong, obtuse, brown, rugose, irregularly reticulate and dorsal longitudinal ridge, (Fig. 2a), hilum narrow; cleistogamous seeds (Fig. 2c-d) bigger 3.5-5.2× 1.2-2. Curved elliptic, nearly smooth, brown; ventral concave side with a central raised circular ridge (hilum), and a short shallow groove extending transversely. Fl. Jul.-Aug. and Fr. Aug.-Oct.

Figure (1): *Commelina benghalensis* (a) Close up view of *Commelina benghalensis* showing its habit, (b) flower, and (c) intensive plant growth.

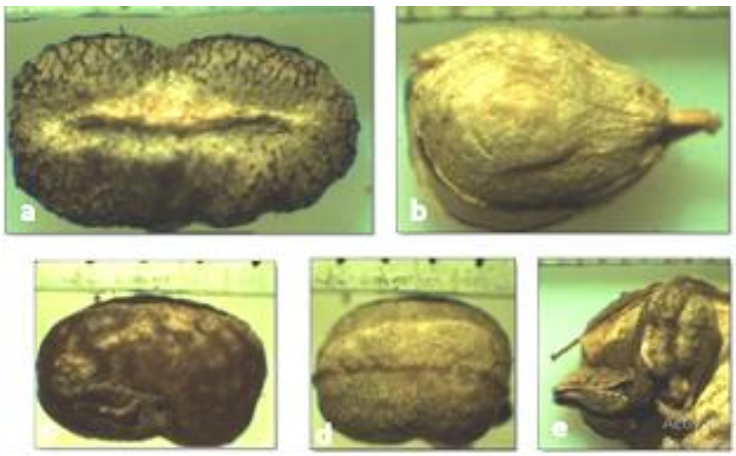


Figure (2): Fruiting parts of *Commelina benghalensi*s. (a) Aerial seed showing irregular reticulate surface and longitudinal ridge, (b) Cleistogamous pyriform capsule, (c) Lateral view of cleistogamous seed, (d) Dorsal view showing concave side, and (e) Dehiscent capsule by valves.

Anatomical properties

- **Stem anatomy**

The transverse section of stem has a primary structure (Fig. 3 b-d). The epidermis consists of a single layer of epidermal cells (2.59±1.95µm diameter) and contains paracytic stomata (Fig. 3c) covered with a thin cuticle at the same level of epidermal cells. Below the epidermis there is an angular collenchyma made up of 3-4 layers of cells, interrupted at the level of the stomata with the chlorenchyma. Cortex consists of circular and polygonal parenchyma (65.83±6.7µm diameter); below the cortex, one fiber ring is incorporated outer collateral vascular bundles. Exterior vascular bundles consist of phloem, metaxylem and protoxylem and surrounded by bundle sheath. The remaining vascular bundles are irregular arranged in the pith. The medullar vascular bundles are reduced to phloem and large Lysigenous lacuna (61.87±2.6µm diameter) (Fig. 3d). The fibers ring has joined collateral vascular bundles located toward the cortex and others located toward the pith.

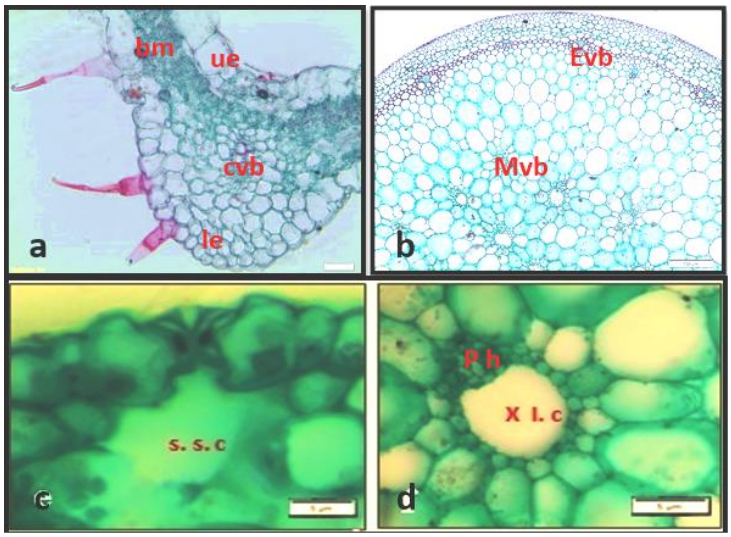


Figure (3): Anatomy of *Commelina benghalensis* L. (a) Leaf cross section (Scale bar = 50µm). (b) Whole cross section of stem (Scale bar = 200µm). (c) Enlarged part of stem epidermis showing stomata and sub-epidermal chamber. (d) Enlarged medullary vascular bundle. Abbreviations: C.V.B (central vascular bundle; b.m (bifacial mesophyl); U.E (upper epidermis); L.E (lower epidermis); C.V.B (central vascular bundle); E.V.B (external vascular bundle); M.V.B (medullary vascular bundle); S.S.C (substomatal chamber); PH (phloem); X.L.C (xylem lysigenous cavity).

- **Leaf anatomy**

Lamina thickness 356.7 ± 2.79 µm (±: standard error). The epidermis (69.05 ± 2.85) usually constituting less than 20 % of the leaf thickness, macrohairs present on the abaxial surface include eglandular uniseriate multicellular hairs with tapering or hook shaped distal cell; papillae is restricted to the leaf margin (Fig. 3a-d). Epidermal cells of both surfaces are arranged in a single-layer of relatively large epidermal cells (69.05 ± 2.85 µm) in length, 78.45 ± 5.29 µm in width, with thin walls rectangular and elongated perpendicularly to the surface. Stomata on the lamina are restricted to the abaxial surface and located at the same level of epidermal cells with substomatal chamber. Bifacial Mesophyll (Fig. 3a) is differentiated into one row of palisade (41.89± 5.07µm) with abundant chloroplast toward the adaxial surface and 3-4 row of isodiametric and irregular shape spongy parenchyma (35.34 ± 1.84 µm) with abundant chloroplast and wide intercellular spaces. Relatively macro-uniseriate hair (182.41 ± 16.389 µm) with pointed distal cells and hooked hair (Fig. 4a-c) are present on abaxial surface and tubular leaf sheath. Papillae and trichomes are restricted to the leaf margin (Fig. 4b). Leaves are dorsiventral, hypostomatic, with hexacytic stomatal complex (Fig. 4d). Lamina is crossed by a parallel venation. The collateral vascular bundles are distributed in the middle region of mesophyll, surrounded by the pericycle and the endodermis.

Ecological results

Floristic composition

The recorded species in the *Commelina benghalensis* community type were 47 species belonging to 41 genera and related to 21 families. Poaceae, Asteraceae, Brassicaceae and Euphorbiaceae were the most common families as they contribute more than 49% of the recorded species (Table 1). The recorded species were classified into 42 annuals (89.4%), 4 perennials (8.5%) and one biennial species. Based on the life-forms, these species were grouped under three types: therophytes (37 species = 78.7%), hemicryptophytes (8 species =17.1%) and geophytes (2 species = 4.3%). Paleotropical taxa were the main chorotype (13 species) followed by Cosmopolitan and Mediterranean taxa (12 species each). Pantropical and Neotropical taxa represented by 8 and 2 species, respectively.

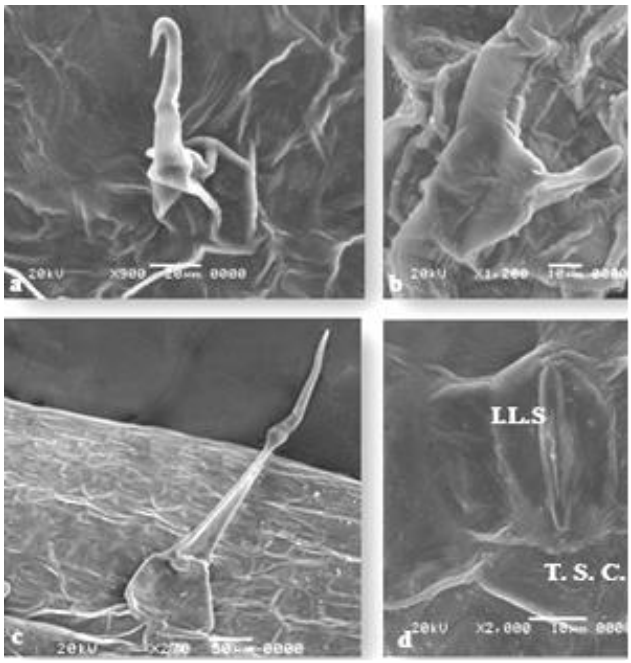


Figure (4): SEM photograph of abaxial surface of *Commelina benghalensis* leaf. (a) Hooked hair. (b) one-celled papillae on the leaf margin. (c) Eglandular unisriate multicellular hair with pointed distal cell. (d) enlarged view of paracytic stomata showing terminal subsidiary cell (T.S.C.); innermost lateral subsidiary cell (l. S. C.); outermost lateral subsidiary cell (O.L.S).

Vegetation analysis

Table (2) shows the mean importance values of *Commelina benghalensis* and its associated species in the three studied habitats. Notably, *Commelina benghalensis* was the dominant species in the three habitats. It attained the highest importance values (65.8, 47.2 and 98.79) in old cultivated mango orchards (MO), newly cultivated mango orchards (MN) and crop fields (CF) habitat), respectively. The most common associated species in old cultivated mango orchards habitat (MO) were *Galinsoga parviflora* (IV=37.1) and *Digitaria sanguinalis* (IV=11.3). While, *Euphorbia heterophylla* (IV=37.4), *Ipomea hederacea* (IV=32.1), *Cynodon dactylon* (IV=20.7) and *Bidens pilosa* (IV=10.1) represented the most common associated species in newly cultivated mango orchards habitat (MN). The most common associated species in crop fields habitat (CF) includes *Portulaca oleracea* (IV=18.5), *Cyperus rotundus* (IV=13.6) and *Dactyloctenium aegyptium* (IV=10.4).

Soil characteristics

The soil characteristics of the habitats supporting *Commelina benghalensis* community type are shown in table (3). Results show that stands of old cultivated mango orchards (MO) characterized by the highest levels of sand fractions (79.09%**)**, organic matter (1.40%**)**, electrical conductivity (0.84 ms/cm), chlorides (56.81 ppm**)** and magnesium (24.71 mg 100 g^{-1}), but the lowest values of silt (7.87%), clay (13.04%), water holding capacity (45.80%), calcium carbonates (1.45 %), pH (8.39) and bicarbonates (94.69 ppm). Newly cultivated mango orchards stands (MN) had the highest values of clay **(**16.27%**)**, water holding capacity (54.00%**)**, pH **(**8.55**)**, calcium carbonates **(**1.94%**)**, sulphates (648.33 ppm**)** and calcium cation (626.67 mg 100 g^{-1}**)** but the lowest values of sand (74.40%), organic matter (0.79 %), electrical conductivity (0.65 ms/cm), chlorides (47.37 ppm), magnesium (24.00 mg 100 g^{-1}), sodium (3.60 mg 100 g^{-1}) and potassium (8.47 mg 100 g^{-1}). Soil of crop fields habitat (CF) had the highest values of silt (9.59%**)**, soluble carbonates (1.71 ppm), bicarbonates (105.24 ppm**)**, sodium (4.43 mg100 g^{-1}) and potassium (9.46 mg100 g^{-1}**),** but the lowest of sulphates (172.83 ppm) and calcium (547.14 mg 100 g^{-1}).

The relationships between *Commelina benghalensis* and its common associated species with the soil variables are shown on the ordination diagram produced by Canonical Correspondence Analysis (CCA) of the biplot of species-soil variables (Fig. 5). It is obvious that, pH, cations (calcium, potassium, sodium and magnesium), anions (bicarbonates, sulphates and chlorides), soil texture (sand, silt and clay) and organic matter were the most effective soil variables on the distribution of C. *benghalensis* and its common associated species in the different habitats. *Cyperus rotundus* and *Portulaca oleracea* showed strong relationship with silt fraction, CaCo3, sodium, soluble carbonates and potassium. While, *C. benghalensis* and *Dactyloctenium aegyptium* exhibited a clear relationship with bicarbonates, organic matter, electrical conductivity and sand fraction. The sulphates, water holding capacity, clay fraction, calcium and magnesium are the most effective variables on *Euphorbia heterophylla* and *Digitaria sanguinalis.* On the other hand, *Bidens pilosa*, *Ipomea hederacea* and *Galinsoga parviflora* are only affected by chloride.

Table (1): Floristic composition of the *Commelina benghalensis* community type

Species	Life span	Life form	Floristic category	P (%)
Aizoaceae				
Trianthema portulacastrum L.	Ann	H	PAN	30
Amaranthaceae				
Amaranthus hybridus L.	Ann	Th	PAL	45
Amaranthus lividus L.	Ann	Th	ME + IR-TR	15
Chenopodium album L.	Ann	Th	COSM	5
Chenopodum murale L.	Ann	Th	COSM	35
Asclepiadaceae				
Cynanchum acutum L.	Per	H	ME + IR-TR	10
Asteraceae				
Bidens pilosa L.	Ann	Th	PAN	45
Conyza bonariensis (L.) Cronquist	Ann	Th	NEO	5
Eclipta prostrata (L.) L.	Ann	Th	NEO	5
Galinsoga parviflora Cav.	Ann	Th	COSM	45
Sonchus oleraceus L.	Ann	Th	COSM	30
Xanthium strumarium L.	Ann	Th	COSM	5
Brassicaceae				
Brassica tournefortii Gouan.	Ann	Th	ME + IR-TR+SA-SI	5
Capsella bursa-pastoris (L.)Medik	Ann	Th	COSM	5
Cronopus didymus (L.) Sm	Ann	Th	COSM	10
Erucastrum arabicum Fisch.&C.A. Mey.	Ann	Th	SA-SI+S-Z+PAL	20
Caryophylaceae				
Stellaria pallida (Dumort.) Murb.	Ann	Th	ME+ER-SR	10
Cleomaceae				
Gynandropsis gynandra (L.) Briq	Ann	Th	PAL	45
Commelinaceae				
Commelina benghalensis L.	Ann	H	PAL+SA-SI	100
Convolvulaceae				
Convolvulus arvensis L.	Per	H	COSM	15
Ipomoea hederacea Jacq.	Ann	H	PAL + NEO	15
Ipomoea obscura (L.) Ker Gawl.	Ann	H	PAL+ SA-SI	5
Cyperaceae				
Cyperus rotundus L.	Per	G	PAN	55
Euphorbiaceae				
Euphorbia helioscopia L.	Ann	Th	ME + IR-TR+SA-SI	5
Euphorbia heterophylla L.	Ann	Th	PAN	60
Euphorbia hirta L.	Ann	Th	PAN	5
Euphorbia peplus L.	Ann	Th	ME+IR-TR+ER-SR	35
Lamiaceae				
Lamium amplexicaule L.	Ann	Th	ME+IR-TR+ER-SR	10
Malvaceae				
Malva parviflora L.	Ann	Th	ME+IR-TR	20
Sida alba L.	Bi	Th	PAN	10
Poaceae				
Brachiaria deflexa (Schumach.) Robyns	Ann	Th	PAL	10
Bromus catherticus Vahl	Ann	Th	COSM	5
Cenchrus biflorus Roxb.	Ann	Th	NEO	20
Cynodon dactylon (L.) Pers	Per	G	PAN	15
Dactyloctenium aegyptium (L.)Willd.	Ann	Th	PAL	50
Digitaria sangunalis (L.) Scop.	Ann	Th	PAL	60
Echinocloa colona (L.) Link	Ann	Th	PAN	25
Eluesine indica (L.) Gaerth.	Ann	Th	PAL	20
Setaria verticilata (L.) P. Beauv.	Ann	Th	PAL	40
Polygonaceae				
Emex spinosa (L.) Campd.	Ann	Th	ME+SA-SI	20
Rumex dentatus L.	Ann	Th	ME+IR-TR+ER-SR	20
Portulacaceae				
Portulaca oleracea L.	Ann	Th	COSM	45
Scrophulariaceae				
Veronica polita Fr.	Ann	H	ME+IR-TR+ER-SR	5
Solanaceae				
Solanum nigrum L.	Ann	Th	COSM	15
Tiliaceae				
Corchorus olitorius L.	Ann	Th	PAN	15
Urticaceae				
Urtica urens L.	Ann	Th	ME+IR-TR+ER-SR	10
Zygophyllaceae				
Tribulus terrestris L.	Ann	H	COSM	5

Abbreviations: **Chorotype**: COSM= cosmopolitan, PAL= Palaeotropical, PAN=Pantropical, S-Z=Sudanono-Zambezian, ME=Mediterranean, SA-SI=Saharo-Sindian, IR-TR=Irano-Turanian, ER-SR= Euro-Siberian, NEO =Neotropical. **Life form**: Th=Therophytes, H= Hemicryptophytes, He=Helophytes, G=Geophyteytes. **Life span**: Ann=annual, Bi =biennial, Per = perennial.

Table (2): Mean importance values of the *Commelina benghalensis* and its associated species in the three studied habitats.

Species	Habitat		
	MO	MN	CF
***Commelina benghalensis* L.**	65.8	47.2	98.8
***Euphorbia heterophylla* L.**	10.5	37.4	10.74
***Cyperus rotundus* L.**	8.56	1.6	13.6
***Dactyloctenium aegyptium* (L.)Willd.**	7.08	3.87	10.44
***Digitaria sangunalis* (L.) Scop.**	11.3	2.90	5.9
***Setaria verticillata* (L.) P. Beauv.**	1.97	1.43	8.1
***Bidens pilosa* L.**	8.06	10.1	-
***Amaranthus hybridus* L.**	5.16	2.57	-
***Cenchrus biflorus* Roxb.**	1.92	1.13	-
***Cynanchum acutum* L.**	0.57	3.53	-
***Echinochloa colona* (L.) Link**	2.13	1.00	-
***Erucastrum arabicum* Fisch.&C.A. Mey.**	1.71	2.03	-
***Galinsoga parviflora* Cav.**	37.1	-	1.2
***Portulaca oleracea* L.**	2.31	-	18.5
***Trianthema portulacastrum* L.**	1.78	-	6.77
***Gynandropsis gynandra* (L.) Briq.**	1.08	-	6.27
***Chenopodum murale* L.**	7.91	-	3.51
***Convolvulus arvensis* L.**	0.14	-	1.03
***Sonchus oleraceus* L.**	4.92	-	1.41
***Rumex dentatus* L.**	5.68	-	0.4
***Urtica urens* L.**	0.19	-	0.57
***Malva parviflora* L.**	1.2	-	1.09
***Cynodon dactylon* (L.) Pers.**	-	20.7	2.73
***Emex spinosa* (L.) Campd.**	-	6.3	3.5
***Corchorus olitorius* L.**	-	4.5	1.61
***Euphorbia peplus* L.**	4.18	-	-
***Solanum nigrum* L.**	2.1	-	-
***Lamium amplexicaule* L.**	1.82	-	-
***Eluesine indica* (L.) Gaerth.**	1.66	-	-
***Brachiaria deflexa* (Schumach.) Robyns**	1.38	-	-
***Cronopus didymus* (L.) Sm**	0.74	-	-
***Amaranthus lividus* L.**	0.73	-	-
***Veronica polita* Fr.**	0.79	-	-
***Stellaria pallida* (Dumort.) Murb.**	0.69	-	-
***Tribulus terrestris* L.**	0.58	-	-
***Ipomea obscura* (L.) Ker Gawl.**	0.38	-	-
***Eclipta prostrata* (L.)**	0.27	-	-
***Capsella bursa-pastoris* (L.)Medik**	0.24	-	-
***Ipomea hederacea* Jacq.**	-	32.1	-
***Sida alba* L.**	-	5.83	-
***Euphorbia hirta* L.**	-	5.8	-
***Xanthium strumarium* L.**	-	4.87	-
***Euphorbia helioscopia* L.**	-	2.93	-
***Conyza bonariensis* (L.) Cronquist**	-	2.27	-
***Brassica tournefortii* Gouan.**	-	1.43	-
***Bromus catherticus* Vahl**	-	-	0.67
***Chenopodium album* L.**	-	-	1.59

(MO) old cultivated mango orchards, (MN) newly cultivated mango orchards, (CF) crop fields

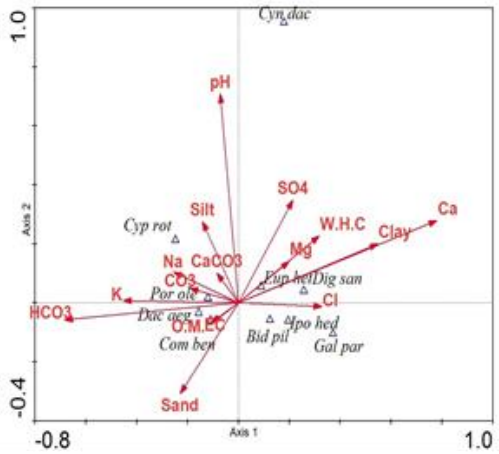


Figure (5): Biplot of CCA showing the relationships between *Commelina benghalensis* and its common associated species with the soil variables in the three studied habitats. Species names are abbreviated to the first three letters of genus and species.

Table (3): Soil characteristics of the habitats supporting *Commelina benghalensis* community

Soil variable	Habitat			Mean	F- ratio
	MO	MN	CF		
Sand %	79.09^{b}±0.67	74.40^{a} ± 0.4	77.71^{ab}±1.64	77.09	2.82^{ns}
Silt %	7.87^{a}±0.32	9.33^{a} ± 0.44	9.59^{a} ±1.24	8.69	1.54^{ns}
Clay %	13.04^{a} ±0.54	16.27^{b} ± 0.25	12.70^{a} ± 1.76	13.41	5.62**
W.H.C %	45.80^{a} ±1.90	54.00^{b} ± 2.80	49.37^{ab} ±1.88	48.28	2.74^{ns}
O.M %	1.4^{b} ±0.94	0.79^{a} ± 0.11	1.06^{ab} ± 0.12	1.19	5.87**
$CaCO_3$ %	1.45^{a} ±0.17	1.94^{a} ± 0.24	1.77^{a} ±0.13	1.64	1.76^{ns}
pH	8.39^{a} ±0.02	8.55^{a} ± 0.16	8.50^{a} ±0.07	8.45	1.55^{ns}
EC (ms/cm)	0.84^{a} ± 0.05	0.65^{a} ± 0.02	0.82^{a} ±0.07	0.81	1.61^{ns}
CO_3^{--} ppm	0.48^{a} ±0.48	0.00^{a} ±0.00	1.71^{a}±1.36	0.84	0.76^{ns}
HCO^{-} ppm	94.69^{a} ±5.20	95.1^{a} ±4.87	105.24 ± 3.47	98.45	1.37^{ns}
Cl^{-} ppm	56.8^{a} ±7.39	47.37^{a} ± 5.93	53.29^{a} ±8.66	54.2	0.22^{ns}
SO^{--} ppm	350.41^{ab}± 85.04	648.33^{b} ±163.97	172.83^{a}±62.36	332.95	4.19*
Ca^{++} (mg100g-1)	580.00^{ab}±17.95	626.67^{b} ±27.28	547.14^{a}±13.58	575.5	2.82^{ns}
Mg^{++} (mg100g-1)	24.71^{a} ±0.59	24.00^{a} ±1.48	24.24^{a} ±0.62	24.43	0.22^{ns}
Na^{+} (mg100g-1)	3.64^{a} ±0.15	3.60^{a} ±0.23	4.43^{b}±0.26	3.91	4.65*
K^{+} (mg100g-1)	9.08^{a} ±0.31	8.47^{a} ±0.37	9.46^{a} ±0.58	9.12	0.75^{ns}

(EC) electrical conductivity; (O.M.) organic matter; (W.H.C) water holding capacity, (MO) old cultivated mango orchards, (MN) newly cultivated mango orchards, (CF) crop fields. *ns* = non- significant at $p \leq 0.05$, *: values are significant at $p \leq 0.05$, **: values are significant at $p \leq 0.01$. Means with different superscript letters are significantly different according Duncan's multiple comparisons (DMRTS).

Variations in shoot length, leaf area, phyto-mass and succulence of *C. benghalensis* in the studied habitats

The variations in shoot length, leaf area, phytomass and succulence of *C. benghalensis* in the studied habitats were shown in table (4). The highest *C. benghalensis* shoot length (78.29 cm) and phytomass (306.24 g DW/m^2) were recorded in the crop field's habitat (CF), while the lowest value of shoot length (56.66 cm) and phytomass (28.97 g DW/m^2) were in newly cultivated mango orchards habitat (MN). On the other hand, the highest succulence (8.6) and leaf area (22.04 $cm^{2\ leaf\text{-}1}$) were recorded in old cultivated mango orchards habitat (MO), but the lowest value of succulence (6.14) and the mean leaf surface area (14.59 $cm^{2\ leaf\text{-}1}$) were in crop fields habitat (FC).

Table (4): Mean ± standard errors of the shoot length, leaf area, phytomass and succulence of *Commelina benghalensis* in the three studied habitats.

Variable	Habitat		
	MO	MN	CF
Shoot length (cm)	63.6 ± 6.62	56.66 ±1.2	78.29 ± 5.42
Leaf area ($cm^{2\ leaf\text{-}1}$)	22.04 ± 1.82	15.70 ± 1.26	14.59 ± 1.56
Phytomass (g DW. /m^2)	185.26± 66.34	28.97± 14.32	306.24 ± 110.53
Succulence	8.60 ± 0.71	8.33 ± 0.19	6.14 ± 0.69

Abbreviations: (MO) old cultivated mango orchards, (MN) newly cultivated mango orchards, (CF) crop fields

Phytochemical results

Proximate composition and mineral content

The moisture content of fresh aerial parts based on wet basis of *C. benghalensis* (M_{wet}) was found to be 89.6 ±0.17%; after oven drying, it still contained a moisture level with a mean value of 10.39 (Table 5).

Proximate analyses of the studied plants shown in table (5) shows highest ash content (31.62±2.1) and relatively high crude protein (15.56), whereas the total carbohydrates was (13.19). Crude fiber and fat content were1.86 and 29.24 respectively.

Table (5): Proximate composition of aerial parts of Commelina benghalensis

Analysis	Mean± SD
Proximate analysis (g/100 g DW)	
Moisture content	10.39±0.09
Crude Protein	15.56±0.07
Crude fiber	1.86±0.3
Crude fat content	29.24±1.3
Carbohydrates	13.19±2.7
Total ash	31.62±2.1
Nutritive value (Cal/100 gm)	374.12

Each value represents the mean ± SD of three determinations on dry weight (DW) basis

Mineral composition

Table (6) showed the values of the mineral compositions in milligram per 100 g dry weight with varying amounts of minerals such as potassium, iron, magnesium, phosphorus, calcium, manganese, zinc and copper. The highest mineral was Calcium with 1830mg/100gm, while the lowest value was 40mg/100gm dry weight for copper.

Table (6): Mineral composition of *Commelina benghalensis.*

Analysis	
Minerals (mg/100 g DW)	**Mean ± SD**
Phosphorus	469.9 ± 0.76
Potassium	1399.9 ±3.22
Calcium	1830 ±9.87
Magnesium	290 ± 1.77
Iron	1080 ± 15.45
Manganese	380 ±0.65
Zinc	460 ± 0.41
Copper	40 ±.03

Values means ± SD are calculated as milligram per 100-gram dry weight (DW) that analyzed individually in triplicate

Phytochemical screening

The results of preliminary phytochemical screening are shown in table (7) indicates the presence of saponins,

tannins, flavonoids, glycosides and phytosterols and absence of alkaloids and phenols.

Table (7): Preliminary phytochemical screening of *Commelina benghalensis*

2^{ry} metabolites	Saponins	Tannins	Alkaloids	Flavonoids	Phenols	glycosides	phytosterols
Result	+	+	-	+	-	+	+

+ for positive result; - for negative result

Identification of phytochemical components

The GC-MS analysis of the ethanol extract of *Commelina benghalensis* revealed the presence of fourteen compounds that could contribute the medicinal quality of the plant. The identification of the phytochemical compounds was confirmed based on the retention time and molecular formula. The fragmentation patterns for some of the peaks were compared with that of the library of compounds. The ethanol extract constituents along with their retention time and their molecular weight are tabulated in table (8).

The GC-MS analysis revealed the presence of 14 compounds at two different retention times (3.749 and 19.91 minutes). The molecular weights of the compounds separated at the retention time of 3.749 min ranged from 142-268; while the molecular weight of the compounds separated at the retention time of 19.91 min ranged from 96 to 334.

Table (8): The molecular weight, molecular formula and decided names for the compounds extracted by GC-MS analysis at two different retention times in ethanolic extract of *Commelina benghalensis* (Aerial parts)

Se	RT (Min.)	M. wt	Mol. Formula	Compound Decided Name
1	19.91	208	$C_{11}H_{12}O_4$	2,3-Dimethoxycinnamic acid
2	19.91	297	$C_{18}H_{19}NO_3$	L-Proline, N-(1-naphthoyl)-, ethyl ester
3	19.91	334	$C_{21}H_{34}O_3$	Myristic acid, 4-methoxyphenyl ester
4	19.91	254	$C_{14}H_{22}O_4$	9-Oxabicyclo(3.3.1)nonan-2
5	3.749	142	$C_{10}H_{22}$	n-Decane
6	3.749	184	$C_{13}H_{28}$	Tridecane
7	3.749	198	$C_{14}H_{30}$	2-Methyltridecane
8	3.749	170	$C_{12}H_{26}$	2,2,4,6,6-PentaMethylheptane
9	3.749	268	$C_{19}H_{40}$	2,6,10,14-tetramethylpentadecane
10	19.91	204	$C_{15}H_{24}$	Germacrene D
11	19.91	188	$C_{11}H_{24}O_2$	2-Methyl-2,5-decanediol
12	3.749	176	$C_{12}H_{16}O$	4-Methyl-1-phenylpentan-2-one
13	19.91	192	$C_{11}H_{12}O_3$	Myristicin
14	19.91	96	C_6H_8O	2,5-Dimethylfuran

DISCUSSION

Commelina benghalensis L. was chosen for investigation due to its vigorous and invasive (Burns, 2004) growth habit in the study area. Plant communities dominated by *C.benghalensis* were studied. It has been examined in morphological, anatomical, phytochemical and ecological aspects to evaluate its effectiveness and impact of different factors on its growth. The morphological traits of *Commelina benghalensis* L. could be significant if considered with anatomical features (Tomlinson, 1966; Gajurel and Shrestha, 2009). The results of the current study confirmed this concept. Morphogically, the most distinctive characters are its decumbent diffused habit, fibrous root with cleistogamous flower, sheathy pseudo-petiole, ovate leaf, cymes enclosed in conduplicate funnel shaped spathe, blue zygomorphic chasmogamous flower that rapidly fed out when exposed to sun light. Besides it has characteristics cleistogamous flowers, it is also distinguished by dimorphic flowers, fruit and seeds. Although the results generally agree with the flora of Egypt (Boulos, 2005), the seeds and capsules characters were not accurately defined. Capsule produced by chasmogamous flower was oblongelliptic 4.5-5.5×3 mm; while the capsule produced by cleistogamous flowers was ellipsoid 5-7x3-4 mm splits along two valves, dehiscent, each containing 1 or 2 seeds with. Seeds dimorphic 3-5 per capsule with varying size; Aerial seeds 2.5-5×1.5-2.5 mm oblong, obtuse, brown, rugose, irregularly reticulate and dorsal longitudinal ridge, hilum narrow; cleistogamous seeds bigger 3.5-5.2×1.2-2. Curved elliptic, nearly smooth, brown, ventral concave side with a central raised circular ridge and a short shallow groove extending transversely. The findings of dimorphic capsules and seeds justify the different dormancy properties (Budd *et al.*, 1979) and vigorous growth.

Anatomical characters have utilized in resolving quite a number of taxonomic problems at both the generic and specific levels (Kadiri, 2006). The micromorphological finding reveals that the stomata are hexaparacytic due to arrangement of six subsidiary cells is circular shape, where the two lateral pairs parallel to the long axis of the pore and two polar (terminal) cells; the second lateral pair as long as the stomatal complex. This type could be described as a modification of the tetracytic type with an additional pair of lateral subsidiary cells (Cotthem, 1970). This feature matches with the findings of (Tomlinson, 1966), (Faden and Hunt, 1991) and (Butler, 2017). Regarding trichomes, the pubescent leaf and stem are of two types of uniseriate, eglandular and multicellular hairs with both pointed and hooked distal cell in accordance with Oladipo (2014). It also has one-celled papillae restricted to leaf margin. Those types of trichomes constitutes important distinguishing features that demarcate the genus *Commelina* (Tomlinson,

1966). Stem anatomy can be differentiated by stomata at the same level with the epidermal cell, substomatal cavity, and outer ring of collateral vascular bundle surrounded by fiber sheath while the medullar vascular bundles are reduced to phloem and large Lysigenous lacuna. Leaf lamina thickness (356.7 ± 2.79) and large size of cells with thin wall indicates the leaf succulence. Similar anatomical traits were previously demonstrated to family Commelinaceae (Novoa *et al.,* 2012; Novoa and Arambarri, 2016).

The floristic components of *Commelina benghalensis* community were 47 species belonging to 21 families. Poaceae, Asteraceae and Brassicaceae were the most important as they contribute more than 49 % of the species. These leading families were reported to be the most frequent in other studies on the cultivated lands of Egypt by (Abd El-Hamid, 2005) and (Mashaly *et al.*, 2012). Regarding the plant longevity, 89.4% of the recorded species are annuals, (8.5%) perennials and one species biennial. The dominance of annuals could be attributed to their high reproductive capacity and ecological, morphological and genetic plasticity under high levels of disturbance (Harper, 1977). Moreover, they have the ability to produce the flowers early in their life span in order to ensure some seed production even in a year when the growing season is cut short (Sans and Masalles, 1995) .

The life form spectra provide information, which may help in assessing the response of vegetation to variations in environmental factors (Ayyad and Ghabbour, 1986). The present study showed that therophytes had the highest contribution, followed by hemicryptophytes and geophytes. Therophytes represent the main floristic element in the cultivated land. Many of these have a short life cycle, which enable them to cope with the instability of the agro-ecosystems in which they occur and their ability to produce heteromorphic seeds (Abu Ziada *et al.*, 2014) .

Chorological analysis of the floristic data in the present study revealed that the palaeotropical, Mediterranean and cosmopolitan taxa form a relatively high proportion of species. This is can be attributed to the relatively high contribution of summer annual species in the *Commelina benghalensis* community. Abd El-Hamid (2005) reported that, most of the summer annual weeds belong to the paleotropical category, while winter weeds belong to Mediterranean and Cosmopolitan categories. The high contribution of the Mediterranean taxa in the study area agreed with the most current of weed flora of Egypt (Kosinova, 1974; El-Hadidi, 1993).

The vegetation analysis of summer crops and orchards in the study area indicated the dominance of *Commelina benghalensis* in the three studied habitats, while *Portulaca oleracea*, *Galinsoga parviflora*, *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Euphorbia heterophylla*, *Ipomoea hederacea* and *Bidens pilosa* represented the most common associated species. This finding contradicts with that reported by Abd El-Hamid (2005) in the same region in which, *Digitaria sanguinalis*, *Cynodon dactylon*, *Portulaca oleracea*, *Cyperus rotundus* and *Euphorbia heterophylla* were the dominant species in the summer crops; while in the present study, these species are recorded as the common species associated with *C. benghalensis*. The dominance of *C. benghalensis* could be attributed to its unique biological characteristics which are represented by its fast spread as it can propagate by both sexual and vegetative, it produces aerial and subterranean seeds from its chasmogamous and cleistogamous flowers (Maheshwari, 1955). It can produce up to 1600 seeds per plant, roots readily at the nodes of creeping stems and regenerates rapidly in this fashion when broken or cut (Holm, 1977). The rate of reproduction of this plant rivals that of any agronomic weed (Webster *et al.*, 2005). The change of dominant species could be attributed to the regular weeding, either mechanically or through the use of herbicides in summer crops which decrease the number of weed species and causes the change in weed flora, especially the dominant ones. The agricultural practices and crop plants have the major effect on the weed flora (Krupinsky *et al.*, 2006).

Soil characteristics are considered as important environmental factors affected weed community structure and diversity (Fried and Norton, 2008; Pinke *et al*., 2010). The inspection of CCA ordination diagram showed that *Commelina benghalensis* exhibited a clear relationship with organic matter and sand fraction. These findings is rather similar with that reported by Ahmad *et al.* (2016) in which *Commelina benghalensis* is found in abundance in communities that exposed to moderate moist condition with application of irrigation and fertilizers. In addition, *C. benghalensis* is considered a rainy season weed which require moist soil condition for establishment and can survive dry condition after its establishment (Kaul *et al*., 2002). *C. benghalensis* grows well on all soil types of variable pH and moisture levels (Webster *et al.*, 2005).

The shoot length and phytomass of *C. benghalensis* recorded the highest values in the crop fields (CF). This could be attributed to high light intensity and continuous addition of fertilizers compared to mango orchards. Light directly affects growth, morphology and accumulation of biomass of plants. Under low light, growth and development of plants are retarded and rate of biomass accumulation and seed production decrease (Reich *et al.*, 1992) and (Lambers *et al*., 2008). Riar *et al.* (2016) pointed out that, growth and competitiveness of *C. benghalensis* would primarily be influenced by fertilization in the crop system. The highest leaf area was recorded in old cultivated mango orchards (MO) with high trees and large canopy, which decrease the light intensity. This finding is incompatible with Riar *et al.* (2016) who concluded that shading had little effect on total leaf number and leaf area of *C. benghalensis* plant. Regnier *et al.* (1988) observed the greater specific leaf area and leaf area ratio under reduced light conditions with *Datura stramonium* L., *Abutilon theophrasti* Medik. and Soybean. Shade enhanced *Isatis tinctorial*' s light-harvesting efficiency by increasing leaf area (Monaco *et al*., 2005).

The potential quality of *Commelina benghalensis* plant was investigated. The proximate analysis showed that the moisture content based on wet basis of *C. benghalensis* (Mwet) was found to be 89.6 ± 0.17; and

this result with the anatomical and ecological data ensure the succulence nature of the plant. The high-water content in *C. benghalensis* makes it ideal to use as fodder. According to Squires *et al*. (1994) the forage species having high ash had higher palatability, also moderate moisture content makes feed more palatable.

The quality assessment of the functional properties of plant is measured by ash content (Onwuka, 2005). High level of total ash, up to 31.62 ± 2.1% in the aerial parts of the plant indicates high inorganic components (Chioma and Omoregie, 2010). Crude fiber in plant is an indication of the level of non-digestible carbohydrate, cellulose and lignin, its low level (1.86 ± 0.3) is considered appropriate; therefore, its presence in low level can increase nutrient usage and prevent intestinal irritation (Bouba *et al.*, 2012). As the fiber content of a forage increases, its energy content decreases (Stokes and Prostko, 1998). Furthermore, the plant is a moderate source of protein (15.56 ± 0.07g/100g). Kearl (1982) suggested that 11-13% level of crude protein in the diet is sufficient for maintenance and growth requirements of sheep and goats, thus the investigated crude protein value is relatively high. The results of the fat analysis indicated that the plant contains a reasonable content of fat (29.24 ± 1.3). Lipid as a good source of energy contributes to important cell processes and aids in transport of fat soluble vitamins (Pamela *et al.,* 2005).

According to Le Houérou (1980) and Heneidy and Bidak (2003) the forage value of the consumed plant is the result of its nutritive value. It was believed that livestock will refuse eating weeds with low nutritive value, so expensive and time-consuming measures are often used for their control (Marten and Andersen, 1975). The nutritive value of aerial parts of *Commelina benghalensis* was 374.12Cal/100gm, hence, the plant can contribute to the caloric requirement of livestock.

The mineral compositions of aerial parts of *C. benghalensis*, illustrate that it has significant levels of macroelements (Calcium 1830 ± 9.87, potassium 1399.9 ± 3.22 and phosphorus 469.9 ± 0.76). Macro minerals are required at concentrations greater than 100 ppm and have important physiological functions of the diet and therefore, must be supplemented to livestock when forages or rations are deficient or have the incur-rect proportions of macro minerals; while trace minerals are required at concentrations less than 100 ppm (Doxey, 1992). The ratio of Ca/P (4:1) was an accept-able ratio, that is between 1:1 and 7:1, as long as there is enough phosphorus (P) to meet the animal's nutritional requirements (Santos *et al.*, 2004). Zinc (460 ± 0.41 mg/100g) is required for the structural integrity of enzymes where zinc metalloenzymes involved in nucleic acid and protein synthesis (Abdel-Mageed and Oehme, 1990). Copper is very vital in diet because it is involved in the proper usage of iron that was 1080 ± 15.45. The potassium content was 1399.9 ±3.22 mg/100 g. Potassium is very vital in regulation of water and acid-base balance in the body. Manganese (380 ± 0.65 mg/100g) as an essential trace element was based on measurements of reproductive parameters and has also been identified as an essential component in bone and cartilage formation and growth (Paterson and Engle, 2005). The potassium content was 290 ± 1.77 mg/100g, It is vital in regulation of water and acid-base balance in the body (EFSA, 2006). These results match with the findings of Gole *et al*. (2013) that *C. benghalensis* has potential to uptake mineral.

Phytochemical examinations of aerial parts extracts revealed the presence of saponin, tannins, flavonoid, glycosides and phytosterols. These results have been established by Augustine *et al*. (2013) and Tadesse *et al.* (2016). The phytoconstituent rich ethanolic extract was elucidated using GC-MS as one of the best techniques which allows simultaneous assessment of a variety of components in the plant (Hussain and Maqbool, 2014). Among the decided compound 2,3-Dimethoxycinnamic acid that was previously recognized as a naturally occurring aromatic fatty acid among the members of the aromatic fatty acid class of differentiation-inducers with potential use in cancer intervention (Liu *et al.*, 1995); Furthermore, Myristic Fatty acid also had been shown to have potent anti-cancer properties (Tatsuya *et al.*, 2003).

Another observed compound was L-Proline, N-(1-naphthoyl), ethyl ester. Zhang *et al.* (2016) recorded that proline amino acid is a precursor for hydroxyproline, which is used to synthesize collagen; so, this protein is used to cushion joints and repair. Germacrenes are typically produced in a number of plant species for their antimicrobial activity (Flamini *et al*., 2005). Previous studies on chemical investigation of *C.benghalensis* by GC-MS revealed the presence of fourteen different compounds; the most investigated compounds were belonging to acid group. Others suggested that this plant was a potential source of 10 pharmacologically active chemical compounds and therefore investigate its antifungal, antimicrobial and anti-inflammatory activity (Cuéllar Cuéllar and Okori, 2010; Augustine *et al.*, 2013; Kadam, 2016).

CONCLUSION

In conclusion, findings of the morphological, anatomical, mineral and proximate composition and phytochemical constituents showed that succulent invasive weed *Commelina benghalensis* can be considered a palatable and relatively low-cost source of nutrition for livestock, besides it could be used as a potential source of new useful drugs. Isolation of bioactive compounds and studying their biological activity are necessary for future studies. It also can be concluded from the results that *Commelina benghalensis* has the potential to flourish well in different habitat types and tolerate environmental stress.

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الوعلان البنغالى النوع الغازي : خطوة نحو الفلورا البيولوجية في مصر

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الملخص العربي

استهدف البحث اجراء دراسة متكاملة لنبات الوعلان البنغالى *Commelina benghalensis*L من النواحى الظاهرية والتشريحية، كما أجريت دراسات بيئية لوصف التركيب االفلورى لمجتمعه النباتى وتقييم العوامل التي تؤثر على غزوه لمنطقة الدراسة. وعلاوة على ذلك تم استقصاءالمكونات الكيميائية و القيمة الغذائية والمعادن ونواتج الأيض الثانوية للنبات ومن خلال جهازGC / MS (كروماتوغرافيا الغاز - مطياف الكتلة) تم استكشاف طبيعة المركبات النشطة حيويا وتقييم استخداماتها المحتملة. وأسفرت الدراسة البيئية عن تسجيل سبعة وأربعين نوعًا من الحشائش المرتبطة بنبات الوعلان البنغالى، تنتمى إلى21فصيلة نباتية و كانت الفصائل النجيلية، المركبة والصليبية أهم هذه الفاصائل، و كانت نباتات الرجلة، السعد، رجل الحرباية ولبن الحمارة أهم النباتات المصاحبة له: كما وجد أن طراز الحوليات كان الأكثر شيوعا (78.7٪) بالمنطقة. و أظهر التحليل الفلورى سيادة العناصر الاستوائية القديمة والعالمية والمتوسطية و أشار تحليل برنامج التوزيع التطابقى الكنسي (CCA) إلى أن الأس الهيدروجيني، الكاتيونات (الكالسيوم، البوتاسيوم، الصوديوم والماغنيسيوم)، الأنيونات (البيكربونات، الكبريتات والكلوريدات)، قوام التربة (الرمل، الطمي والطين) والمواد العضوية كانت عوامل التربة الأكثر تأثيرا فى توزيع الوعلان البنغالى والأنواع المصاحبة له في منطقة الدراسة. كما سجلت الدراسة أعلى قيم للعصارية و متوسط مساحة سطح الورقة لنبات الوعلان البنغالى في بساتين المانجو، في حين تم تسجيل أعلى طول وكتلة نباتية له في موائل حقول المحاصيل.وأشارت النتائج أيضا إلى أن هذا النبات يعد مصدرا قيما للمركبات الغذائية والمعدنية والكيميائية النباتية؛ ومن ثم يمكن استخدامه كمصدر قليل التكلفة للعلف المستساغ نسبياً للماشية وقد يكون ذو قيمة طبية كبيرة للغاية ويجب استغلاله بشكل أكبر لاستخراج أدوية جديدة ومن ثم لا ينبغي أن تدرج ضمن الأعشاب الضارة. كما أنه له القدرة على العيش فى بيئات متعددة ويتحمل الاجهاد البيئى.