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Ecological and Phytochemical Study on Brassica tournefortii growing in Orchards and Farmland in the Nile Delta, Egypt

M.E. Abu Ziada[1], M.S. Abu Rayia[2], S.R. Al-Halboosi[3]

[1]*Faculty of Science, Mansoura University, Mansoura, Egypt*

[2] *Faculty of Agriculture, Damietta University, New Damietta, Egypt*

[3] *Science College Anbar, Iraq*

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Abstract: This work focused on the biological aspects, dealing with morphology, anatomy, taxonomy, karyotype, palynology and biogeography. B. tournefortii is a winter – spring active broad – leaved annual weed. The chromosomes are 2n = 20 and the pollens are isopolar, trizonocolpate and sinuaperturate. Seeds begin to germinate from January and the emerge peak was by the end of February. The optimum temperature for germination was 25 - 30º C. The decreased amount of rainfall badly affects the rate of germination. Floristic composition of B. tournefortii community comprised 32 species (6 monocots and 26 dicots) related 19 families, with Anagallis arvensis, Vicia monantha and Chenopodium murale are the commonest associates. Therophytes are the main life – form spectrum and the Mediterranean (30 %) and Irano - Turanian (25 %) are the major chorotypes. This community spread in well-drained, moist, loamy-sand textured soil and in full sun. The nutritive value of the shoot system was 89.3 Cal. / 100m. Phenols and flavonoids were recorded in ethyl alcohol and chloroform extracts. The different extracts revealed antioxidant and antimicrobial activities.

Keywords: Eudicots, Brassicaceae, Brassiceae, Brassica, tournefortii

1.Introduction

The weed flora of the farmland and orchards in the Nile Delta comprises about 470 species (22.5 % of the Egyptian flora). All weeds, even those regarded as disadvantageous pests may have some uses. Ecologically, the weeds could be categorized under five main groups: Fodder, drug, fiber, oil and perfume and fuel producing plants **[1 ; 2 and 3].** In Egypt, Brassicaceae is the fourth of eleven large families; its members are distributed over a wide range of habitats in the Nile Delta **[4].** Brassicaceae is represented by 53 genera including 97 species, 9 subspecies and 11 variety **[5].**

Brassica tournefortii is an annual weedy herb native to the Mediterranean basin. It has traditional dietary uses and economic value **[6**] and it is used as a small-scale oil crop in India. Flavonoids were isolated from aerial parts of *B. tournefortii* including: Kaempferols, Robinin and Quercetin. In Pakistan, mustard is the second most important source of oil after cotton **[7].** Many bioactive compounds were recorded in *B. tournefortii* such as phenolics, alkaloids, saponins and flavonoids have been described as allelochemicals **[8 and 9].** Sulphoraphane is a natural isothiocyanate found in Brassica vegetables and is among the bioactive components with antioxidant and antitumor properties **[10].** These vegetables are rich in vitamins C and E and Carotenoids **[11and 12].**

The objective of this study was to deduce how far the economic features of *Brassica tournefortii* will be evaluate its uses as fodder, industrial and or medicinal plant estimating the soil variables were according

2. Materials and methods

Morphological characters were examined using fresh specimens of *Brassica* plants according to **[13]** and the text of flora of Egypt **[14].** For anatomic investigation, thin cross-sections of stem, leaf and root were made as described by **[15]** then examined using light microscope and photographed. Study the

karyotype, root tips were fixed in acetic acid-absolute ethanol (1:3), stained in hydrochloric carmine **[16],** then smeared in 45% acetic acid. Pollen grains were prepared for light microscopy according to **[17].**

Ecological characters

Vegetation analysis: Twenty stands dominated by *B. tournefortii* were studied in detail including; total coverage, a list of species, phenological aspect of growth and cover-abundance estimate of each species. Identification and nomenclature of the species were followed **[5].** Technique of floristic analysis based on the methods of **[18].**The presence estimate of each species was measured according to **[19].**

Habitat conditions: ten soil samples were collected from representative stands, air dried and sieved through 2 mm sieve to remove gravel and debris. The procedures followed in estimating the soil variables were according **[20-23].**

The objective of growth analysis experiment was conducted to obtain the quantitive description of the growth of *B. tournefortii* during its life cycle. The periodical variation in leaves number, assimilating surface area per individual plant as well as successive estimation of the phytomass of different plant organs were applied to deduce the growth characteristics according to the classical growth analysis as described by **[24-26].**

Germination experiments were conducted to find out the effect of salinity, light and dark, temperature and rainfall on the rate of seed germination of *B. tournefortii*, as described in **[27,28].**

Phytochemical analysis: quantitative estimation of the primary metabolites deal with the mean values of moisture content, total ash, crude fibers, total lipids, protein, total carbohydrates and soluble sugars were determined as describe by **[29 and 30].** Flavonoids and phenols estimated using the procedures described by **[31].** Antioxidant activity of the plant extracts evaluated according to **[32**].

3. Results and Discussion

Brassica tournefortii Gouan is a winter – spring active annual, herbaceous weed, belonging to family Brassicaceae (tribe: Brassiceae), according to **[33]** based on molecular systematic. Its origin occurred in south Europe (Spain, Italy and Greece), norther Africa (Egypt, Libya, Tunisia, Algeria and Morocco), western Asia and Pakistan. The Mediterranean region is the center of origin of the 20 – chromosome genome. Three ecotypes of *B. tournefortii* were well adapted to dry environment in central Asia **[34,35].** In Egypt, it is recorded in Nile region, Oases, Mediterranean coast, Isthmic desert and Sinai **[36 and 5].** It is common in field crops, orchards, ditch banks, and also found in waste places and along roadsides.

Morphology

Morphological examination of *B. tournefortii* **(plate 1)** revealed that, it has a single straight tap root 12 – 19 Cm depth. And the stem is herbaceous, solid, dark green, much branched each branch possesses principal naked active apical buds and axillary vegetative active buds. The lower leaves have long petioles, rosette, Lyrate pinnatified, with entire margin and reticulate-pinnate venation. Lamina architecture with cladodromus secondary vein category and the agrophic vein compound with three basal veins. While upper leaves lack petioles and clasping, small, linear with entire margin. The in florescence is simple racemose raceme. Flower is ebracteate, pedicelate, actinomorphic, bisexual, hypogenous. Sepals 4 free and caduceus. Petals are pale yellow, 6-8 mm and cruciform. Stamens 6 in a tetradynamous pattern. Ovary superior, bicarpellary, syncarpous, with narrow replum. Fruit is simple dry dehiscent siliqua 2-4 Cm long and 3-4 mm diameter, 6-10 seeds and dehisces along two suture. Seeds very small 0.2 – 0.5 mm, wingless and have phanerocotylar type of germination.

Anatomy

The cross section of the stem **(plate 2a)** is circular in outline. It consists of single – layered epidermis covered by thin cuticle of 4.5 µm, followed by 2 – layered collenchyma cells. The cortex of 3-7 layers of isodiametric parenchyma, with abundant aerenchymatous cells. The vascular bundles constitute a ring

surrounding a wide pith of hexagonal parenchyma cells.

The leaf **(plate 2b)** has upper and lower epidermis of oval – rectangular cells, with thickness of 18 µm at adaxial layer and at abaxial surface is 10.5 µm. The leaf is of bifacial type with 1-layered elongated palisade cells and isodiametric spongy cells. The vascular tissues represented by the major vein of the midrib. The root **(plate 2c)** characterized by ruptured epidermis, normal secondary thickening, periderm found in the outer zone. The central portion of the stele is occupied by very little small parenchyma cells, representing the pith.

The chromosomes investigation revealed, no abnormalities **(plate 3)** *B. tournefortii* is 2n = 20 chromosome species. This in accordance with the results reported by **[37 and 38].** Pollen grains are tricolpate, isopolar, radiosymmetrical, with equatorial axis = 48 µm and polar axis = 60 µm. It is trizonocolpate and sinuaperturate **(plate 4).** Those were in compatible with **[39 and 4].**

Taxonomic hierarchy: members of Brassicaceae can be easily recognized by morphological characters, such as cruciform corolla, tetradynamous stamens, fruit is simple dry dehiscent siliqua or silicula **[40 and 41].** According to Angiosperm phylogeny group **[42].** Classification of *B. tournefortii* as follows:

The family Brassicaceae comprised eight tribes based on molecular systematics. These are Brassiceae, Camelineae, Alysseae, anchonieae, Cardamineae, Lepidieae, Sisymbrieae and Malcolmieae **[43**].

Autecology:

a) Vegetation analysis

Table (1) give the floristic composition of 20 stands representing *B. tournefortii* community type. The total plant cover ranges between 10 and 70 %. *Brassica* is the most abundant species (P = 100%). Its growth provides the main bulk of the vegetation cover. Three common associates are *Anagallis arvensis, Vicia monantha* and *Chenopodium murale*, present in 80, 75 and 75% of the stands, respectively. *Bedens pilosa* and *Torilis arvensis* have equal presence estimates (P = 60%). There are eight other associates have presence values ranged between 40 and 55 %. Other 10 ephemerals associated with favorable conditions (P = 25 – 35%). less common associates (8) with presence estimates of 5 – 20 %.

b) Floristic analysis

- **Classification of the recorded species:** The 32 belonging to 19 families **(Fig.1).** The important families are: Poaceae (16 %), Chenopodiaceae and Apiaceae come next and each (10 %). Brassicaceae,
- Fabaceae, Asteraceae, Euphorbiaceae and Malvaceae each represented by (6 %). Another eleven families present with low degree of occurrence (3 %). The total species assemblage includes six monocots and 26 dicots.

Plate (1): Close – up view of *B. tournefortii* plant with much branched stem carries foliage lyrate pinnatified leaves.

- **Life – span:** The species differentiated into perennials (22 %), biennials (6 %) and annuals (72 %) see **Figure (2).**
- **Life – forms:** The species constitute the *B. tournefortii* community are related to 4 types; therophytes (25 species = 78%), hemicryptophytes (4 species = 13%), geophytes (2 species = 6 %) and parasites (single species = 3 %), see **Fig. (3).**
- **Chorotypes:** The vegetation of *Brassica* community categorized into, 19 species (30 %) are Mediterranean; Cosmopolitan, Euro – Siberian and Irano – Turanian are represented by 10, 12 and 16 species (16, 19 and 25 %) while Pantropical and Saharo – Sindian represented by 3 species each (5 %), see **Fig. (4).**

The obtained results are in accordance with **[44,28].**

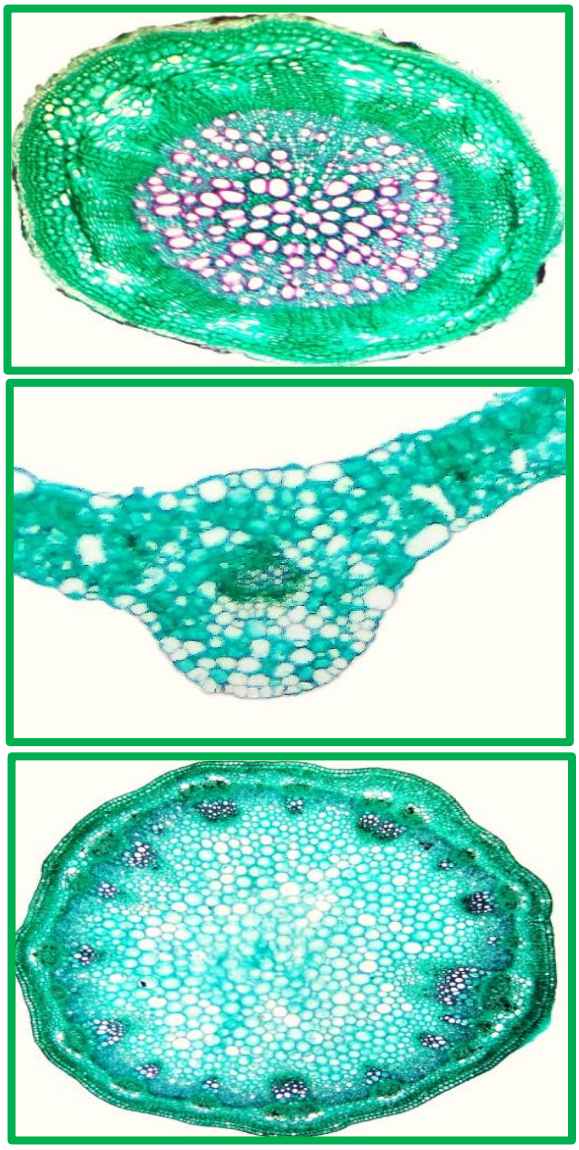

Plate (2): Light microscopy of transverse sections in ***B. tournefortii*** stem (B), Leaf (**b**) and root (**c**).

Plate (3): Chromosomes of *B. tournefortii* 2n= 20

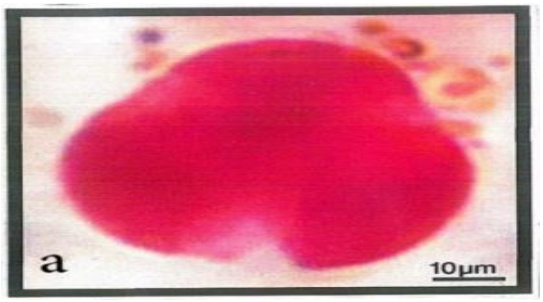

Plate (4): Macrophotographs of Pollen grains of *B. tournefortii*

c) Habitat conditions

As shown in **Table (2).** The soil supporting *B. tournefortii* is loamy – sand textured with the main bulk of soil particles size lies within class 0.500 – 0.211 mm and class 0.211 – 0.104 mm (27.33 % and 38.37 %). The silt fraction attained mean value of 24.24 %. The percentage of clay particles is generally low with mean value of 1.7 ± 0.134 %. Moisture content fluctuated from 4.95 to 9.89 %. Water – holding capacity was moderate and varied within a narrow range (42.58 – 49.42 %). Organic carbon (0.03 – 1.05 %), $CaCo_3$ (3.12 – 9.65 %), total soluble salts (mean = 0.29 %), sulphates are the main anions (0.12 – 0.37 %), bicarbonate (0.061 – 0.274 %). The soil reaction is neutral to slightly alkaline with pH (6.75 – 7.43). This community is confined to fine textured soil, dark – coloured, moderate moisture and neutral to slightly alkaline soil. These results are in accordance with those obtained by **[45,46].**

Seeds germination experiments give indication that, *B. tournefortii* is sensitive to salinity and the highest rate of seeds germination was achieved with distilled water (96 %) then decline with increase of salinity level **(Fig. 5).** Also, give impression that the optimum temperature of germination was 30 - 35º C within this range germination was 62 %. **(Fig. 6)** Light is an important climatic factor affecting seeds germination. Percentage of germination was 89 % under continuous light, followed by 74 % with alternating light and darkness then reached 58 % at continuous darkness **(Fig. 7).** The percentage of seeds germination of *B. tournefortii* attained 46, 72 and 79 % at 20, 25 and 30 mm rainfall and become 90 % with saturated soil. The decreased amount of rainfall is badly affected the rate of germination. **(Fig. 8)**.

Table (1): Floristic compostion in twenty representative stands of ***Brassica tournefortii*** community type at El Dakahlia Governorate. Cover- abundance estimate according to modified (1 - 5) Domin scale. Aspect of growth**: g** = in foliage, **F** = flowering, **r** = fruiting. **P** = presence (%). **Life span**: **Ann**. = annual, **Bi** = biennial, **per** = perennial. Life forms: **Th** = therophytes , **H** = hemicryptophtes , **G** = geophytes **, P** = parasites . **Floristic categories**: **COSM** = cosmopolitan, **PAL** = palaeotropical , **PAN** = pantropical , **ME**= Mediterranean , **ER-SR**= Euro- Siberian , **SA-SI**= Saharo- sindian, **IR-TR**= Irano- Turanian and **S-Z**= Sudano- Zambezian .

Species	Families	Life span	Life form	Floristic categories	Stands																					P %
					60	50	50	40	40	30	40	10	30	40	50	60	70	40	30	30	20	40	50	10		
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Brassica tournefortii Gouan	Brassicaceae	Ann	Th	ME+IR-TR+SA-SI	5f	5f	5f	5f		5r	5f	5f	5f	5f	5f	5f	5r	5r	5f	5f	5f	5f	5r	5f	100
L. Anagallis arvensis L.	Primulaceae	Ann	Th	COSM	3f	2f	-	1f	5f	-	-	3f	2f	-	3f	3f	3f	2f	1f	1f	3f	1f	2f	3f	80
Vicia monantha L.	Fabaceae	Ann	Th	ME+ER-SR	3f	2g	1g	1g	3f	-	2g	-	-	3g	2f	2r	-	1r	1f	3f	3g	3g	1r	1g	75
Chenopodiastrum murale L.	Chenopodiaceae	Ann	Th	COSM	1g	3g	-	-	-	-	1g	2g	2g	2g	2g	3g	3g	3g	1g	-	1g	2g	1g	1g	75
Bidens pilosa L.	Asteraceae	Ann	Th	PAN	-	1f	-	-	-	2f	2f	-	-	3f	-	-	1f	-	1f	1f	2f	3f	3f	2f	60
Torilis arvensis (Huds)Link	Apiaceae	Ann	Th	ME+IR-TR+ER-SR	-	2g	-	1g	2f	3g	3g	-	-	-	1g	1g	1g	-	3g	1g	1g	2g	-	-	60
Euphorbia helioscopia L.	Cyperaceae	Ann	Th	PAN	2f	-	-	2f	2g	1r	-	-	-	3f	3r	-	-	2f	-	3r	-	3r	2r	2f	55
Ammi majus L	Portulacaceae	Ann	Th	COSM	-	-	2f	2f	1f	1f	-	-	2f	-	-	1f	-	2f	1f	3f	1f	-	2f	3f	55
Cyperus rotundus	Asteraceae	Per	G	ME	-	2g	-	1f	-	-	2f	2f	-	1f	1f	-	2f	-	3f	2f	-	2f	-	-	55
Portulaca oleracea L.	Apiaceae	Ann	Th	ME+IR-TR+ER-SR	-	-	3f	-	1f	-	2f	2f	-	2f	-	2f	-	3f	-	2f	3f	-	2f	-	50
Anthemis cotula L.	Euphorbiaceae	Ann	Th	ME+IR-TR+ER-SR	2f	-	-	3f	3f	2f	-	2f	-	2f	-	2f	-	-	3f	-	3f	-	-	2f	45
Euphorbia peplus L.	Lamiaceae	Ann	Th	ME+IR-TR+ER-SR	-	2g	-	2g	-	2g	3g	-	-	1g	-	3g	-	1g	-	2g	-	2g	-	-	45
Lamium amplexicaule L.	Poaceae	Ann	Th	ME+IR-TR+ER-SR	-	-	2f	-	2f	-	3f	-	-	2f	-	2f	-	3f	-	3f	-	3f	-	-	40
Phalaris minor L.	Convolvulaceae	Ann	Th	ME+IR-TR+ER-SR	-	2g	-	2g	-	-	-	3g	-	2g	-	-	1g	-	-	2g	-	2g	-	2g	40
Convolvulus arvensis L.	Orobanchaceae	Per	H	COSM	-	2f	-	-	-	2f	-	3f	-	-	-	-	2f	-	1f	-	-	2f	1f	-	35
Orobanche crenata Forssk	Malvaceae	Ann	P	ME+IR-TR	-	-	-	-	2r	1r	-	1r	-	1r	-	1r	-	1g	-	-	2g	-	-	-	35
Malva parviflora L.	Polygonaceae	Ann	Th	ME+IR-TR	-	-	1g	-	-	2g	1g	1g	-	-	2g	1g	-	-	-	-	-	1g	-	-	35
Rumex dentatus L.	Fabaceae	Ann	Th	ME+IR-TR+ER-SR	2g	-	-	-	-	1g	2g	-	-	-	-	4g	3g	-	-	-	-	-	2g	-	30
Melilotus indicus L.	Plantaginaceae	Per	H	ME+IR-TR+SA-SI	-	2f	-	2f	-	-	-	3f	-	-	1f	-	-	2f	-	2f	-	-	-	-	30
Plantago major L.	Poaceae	Per	G,H	COSM	-	-	2g	-	-	-	1g	-	-	2g	-	-	1g	-	-	-	-	2g	-	1g	30
Phragmites australis L.	Poaceae	Ann	Th	COSM	-	2g	-	-	1g	-	-	-	1g	-	-	2g	-	2g	-	-	1g	-	-	-	30
Poa annua L.	Caryophyllaceae	Ann	Th	COSM	1g	-	1g	-	-	1g	-	-	-	2g	-	-	1g	-	-	2g	-	-	-	-	30
Spergularia marina L.	Chenopodiaceae	Ann	Th	ME+IR-TR+ER-SR	-	2f	-	-	2f	-	-	-	-	1f	-	-	-	-	-	1g	-	-	1f	-	25
Chenopodium ficifolium L.	Ranunculaceae	Ann	Th	ME+ER-SR	-	-	1g	-	-	2g	-	-	-	-	1g	-	-	-	2g	-	-	1g	-	-	25
Polypogon monspeliensis L.	Chenopodiaceae	Ann	Th	COSM	-	-	2g	-	-	-	-	1g	-	-	-	-	-	-	-	1g	-	-	-	2g	20
Apium eptophyllum L	Malvaceae	Ann	Th	COSM	-	-	-	2g	-	-	-	-	-	-	-	-	-	2g	-	-	1g	-	-	-	15
Sisymbrium irio L.	Poaceae	Ann	Th	ME+IR-TR+ER-SR	-	-	-	-	-	-	-	-	-	-	1r	-	-	-	2r	-	-	-	-	1r	15
Ranunculus sceleratus L.	Oxalidaceae	Ann	Th	ME+ER-SR	2f	-	-	-	-	-	-	-	-	1f	-	-	-	-	-	-	1f	-	-	-	15
Beta vulgaris L.		Bi	Th	COSM	-	-	1g	-	-	-	-	-	-	-	-	-	-	-	-	1g	-	-	-	-	10
Sida alba L.		Bi	Th	COSM	-	-	-	1r	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Imperata cylindrica L.		Per	H	ME+IR-TR+ER-SR	-	-	-	-	-	-	1g	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Oxalis corniculata L.		Per	H	ME+IR-TR+ER-SR																					5
				ME+IR-TR+ER-SR																					
				PAN																					
				ME+IR-TR+ER-SR																					
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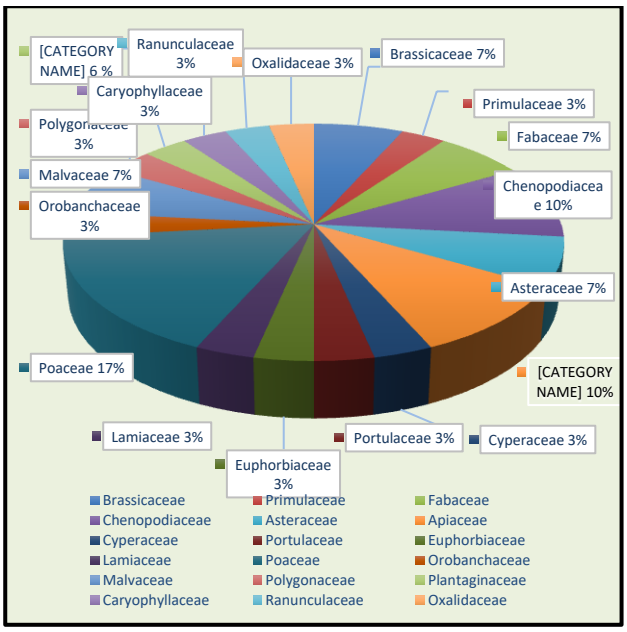

Fig. (1): Plant families of the recorded species in *Brassica tournefortii* community type.

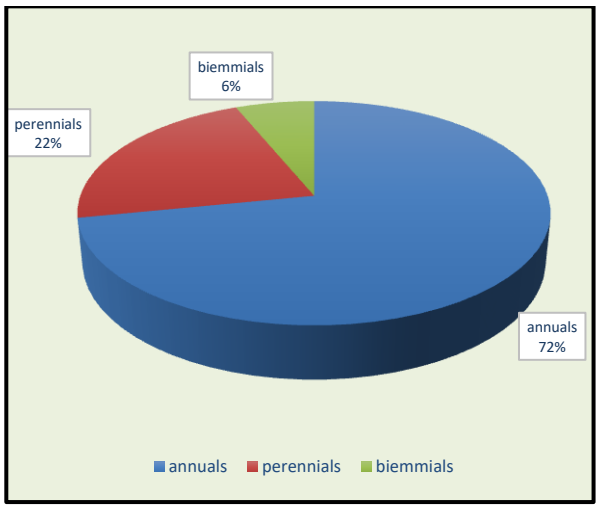

Fig (2): Life Span of the recorded species in *Brassica tournefortii* community type.

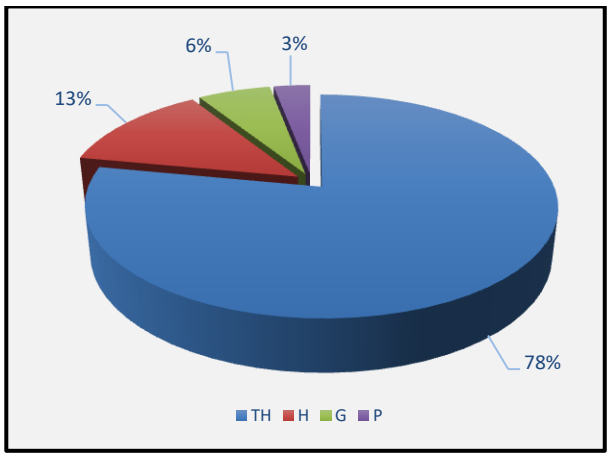

Fig (3): Life form spectra of the recorded species in *Brassica tournefortii* community. **Th** = Therophytes, **H** = Hemicryptophytes, **G** = Geophytes, **P** = Parasites.

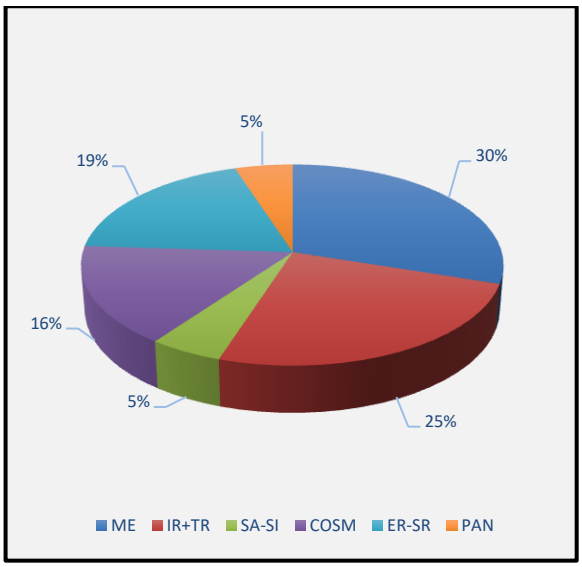

Fig (4): Chorotypes of the recorded species in *B. tournefortii* community type. **Cosm** =Cosmopolitan, **ER-SR** = Euro-Siberian, **PAN** = Pantropical, **ME** = Mediterranean, **IR-TR** = Irano-Turanian, **SA-SI** = Saharo- Sindian.

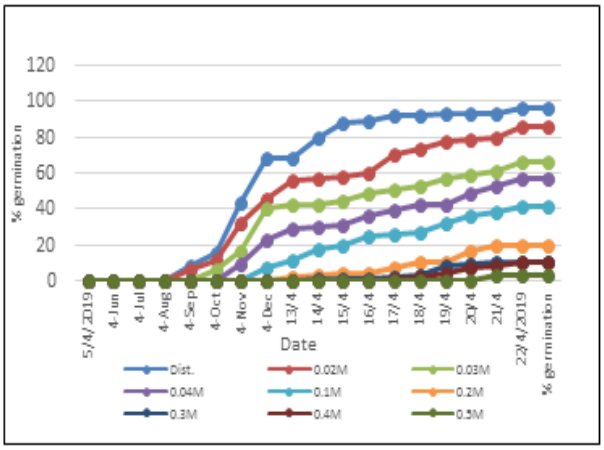

Fig.(5): Seed germination of *B. tournefortii* under different levels of salinity (5/4/2019 – 22/4/2019).

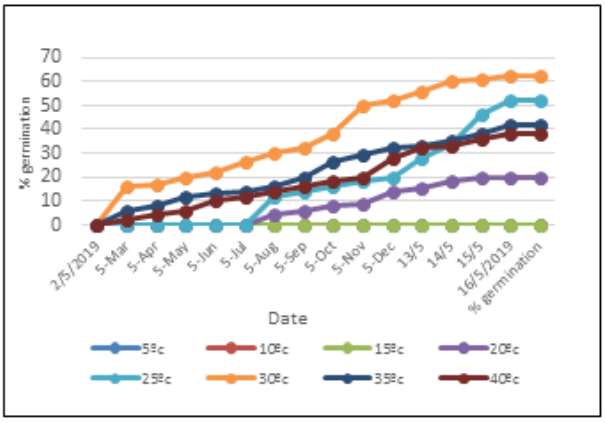

Fig. (6): Seed germination of *B. tournefortii* under different levels of temperature (2/5/2019 – 16/5/2019).

Table (2): Analysis of soil samples collected, from ten representative stands of *Brassica tournefortii* community type. M.C. = moisture Content, Por = porosity, W. H.C. =water –holding capacity, Org. C. =organic carbon and T.S.S. = total soluble salt.

Samples No.	Physical characteristic										Chemical chrematistic							
	Mechanical analysis							M.C %	Por. %	W.H.C %	Org.C %	CaCO3 %	Analysis of 1 : 5 Water extract					
	Particles size mm (%)												T.S.S %	Cl^- %	$SO4^-$ %	$CO3^-$ %	$HCO3^-$ %	PH
	>2.057	2.057-1.003	1.003-0.500	0.500-0.211	0.211-0.104	0.104-0.053	<0.053											
1	0.20	1.06	4.17	30.42	40.82	20.74	1.70	6.59	45.7	43.45	0.04	7.25	0.26	0.01	0.24	0.0	0.091	7.43
2	0.43	1.99	5.59	27.46	40.80	21.23	1.02	9.89	40.15	46.89	0.08	4.17	0.40	0.01	0.28	0.0	0.183	7.26
3	0.85	1.35	5.91	29.65	36.43	22.62	1.80	4.95	48.15	42.95	0.58	9.65	0.28	0.01	0.20	0.0	0.274	7.24
4	0.96	1.14	4.78	28.62	36.28	25.9	1.92	8.81	46.32	49.42	1.05	4.65	0.37	0.01	0.32	0.0	0.152	7.40
5	0.59	1.68	5.87	27.75	37.80	24.28	1.07	8.41	47.95	48.62	0.06	4.90	0.12	0.04	0.12	0.0	0.061	7.26
6	0.95	1.79	5.93	27.39	36.62	25.41	1.08	5.74	47.4	42.92	0.38	4.75	0.36	0.01	0.37	0.0	0.091	7.07
7	0.48	1.26	6.17	25.85	39.25	25.33	1.05	6.99	47.4	45.21	0.03	7.50	0.23	0.01	0.16	0.0	0.122	6.83
8	0.85	1.78	4.83	26.51	38.11	26.03	1.25	8.61	40.4	45.62	0.08	3.50	0.31	0.03	0.24	0.0	0.122	6.78
9	0.57	1.40	6.16	27.77	39.10	22.54	2.14	8.67	44.85	47.91	0.05	3.12	0.24	0.04	0.16	0.0	0.152	6.75
10	0.99	1.73	6.29	21.90	38.52	28.26	1.71	9.02	45.85	42.58	0.06	4.75	0.21	0.01	0.20	0.0	0.091	7.22
Mean	0.68	1.51	5.57	27.33	38.37	24.24	1.47	7.76	45.47	45.55	0.24	5.42	0.29	0.01	0.22	0.0	0.133	7.12
S.E.	0.085	0.1	0.228	0.74	0.525	0.756	0.134	0.507	0.919	0.808	0.107	0.649	0.027	0.004	0.025	0.0	0.019	0.08

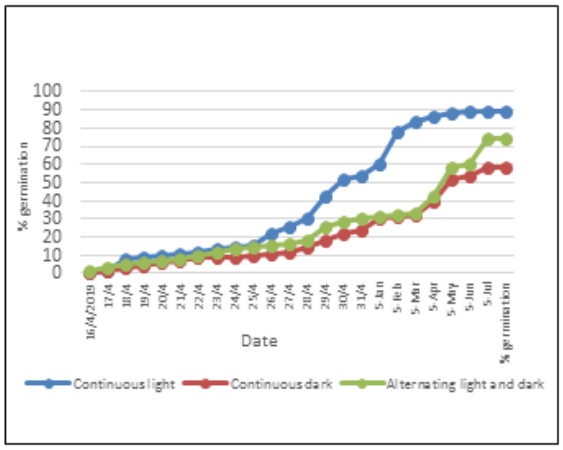

Fig. (7): Seed germination of *B. tournefortii* under different levels of light (16/4/2019 – 7/5/2019).

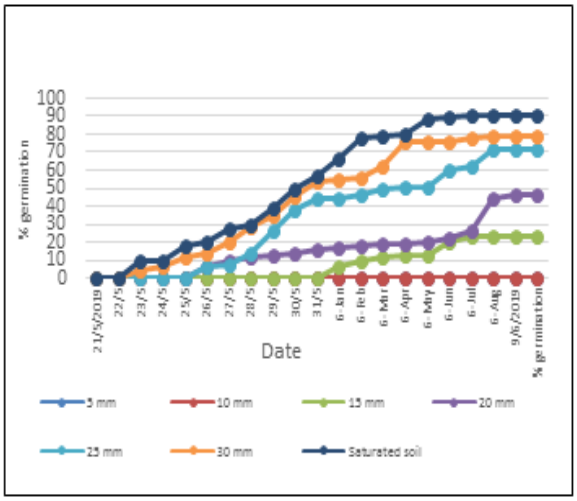

Fig. (8): Seed germination of *B. tournefortii* under different levels of rainfall (21/5/2019 – 9/6/2019).

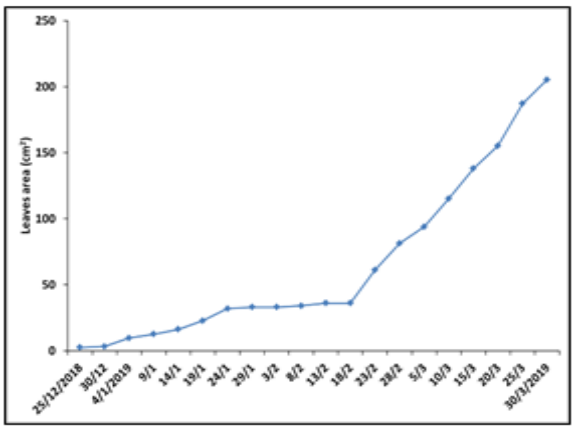

Fig (9): Periodical change of the leaves assimilating surface area of *Brassica tournefortii* plant.

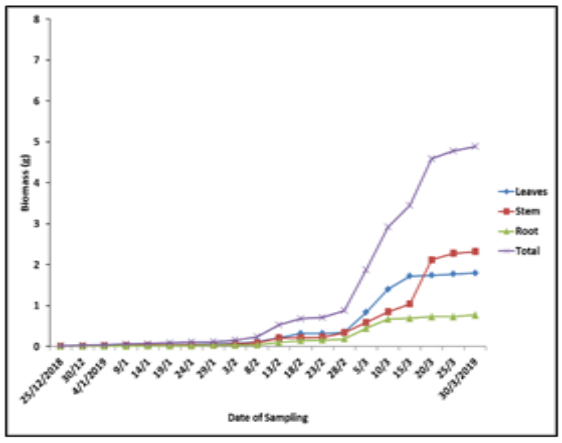

Fig (10): Periodical change of the Biomass of the plant organs

The plant height of *B. tournefortii* showed a tendency to increase from January to the end of

March, with maximum mean height (82 Cm) and mean number of leaves per individual plant 43. The main bulk of Biomass content was contribuled by the leaves and stems 1.8 and 2.3 g dry wt./ plant **(Fig. 9).** The assimilating surface area varied from 2.54 to 205.33 Cm^2 and attained its maximum value after 13 weeks from planting **(Fig. 10).**

Regarding to the growth characters, the relative growth rate (RGR) $_{total}$ was generally higher at early stage of vegetative growth than at maturity. Its maximum value was 0.1584 $gg^{-1}d^{-1}$ during the period 3 – 5 February **(Fig. 11).** The RGR $_{leaves}$ varied from 0.0023 – 0.1750 $gg^{-1}d^{-1}$ and the RGR $_{stems}$was 0.1694 $gg^{-1}d^{-1}$ while the highest RGR $_{roots}$ value was 0.1832$gg^{-1}d^{-1}$. The RASGR of *B. tournefortii* was 0.1321 Cm^2 (Cm^2) $^{-1}d^{-1}$ then tend to decline at the end of vegetative stage **(Fig. 12).** The net assimilating ratio (NAR) has maximum value of 0.0072 Cm^2 (Cm^2) $^{-1}d^{-1}$ **(Fig. 13).** The leaves area ratio (LAR) value changed between 11.9 and 126.0 Cm^2 g^{-1} **(Fig. 14).** The leaves weight ratio (LWR) values varied from 0.01 to 1.0 gg^{-1} **(Fig. 15).** The specific leaf area (Spec. LA) was 1.02 – 198.00 Cm^2 g^{-1} **(Fig. 16).** These results are comparable with the findings of some other investigated weed plants**, [28, 2 and 46].**

The phytochemical investigation revealed that: the residues of successive extraction were high in leaves powder (21.98, 22.31 and 15.64 %) while the lower values recorded in the roots (8.3 – 15.64 %). The lipid content of leaves was (6.0 %). The nutritive value of the shoot system was 89.3 Cal./ 100g. Phenols and Flavonoids were recorded with higher values in ethyl alcohol, chloroform and water extracts. The

Growth analysis

different extracts revealed antioxidant and antimicrobial activities.

One the basis of the above results, it is worthy to note that *B. tournefortii* is a promising as renewable natural resources and are raw material for industrial purposes.

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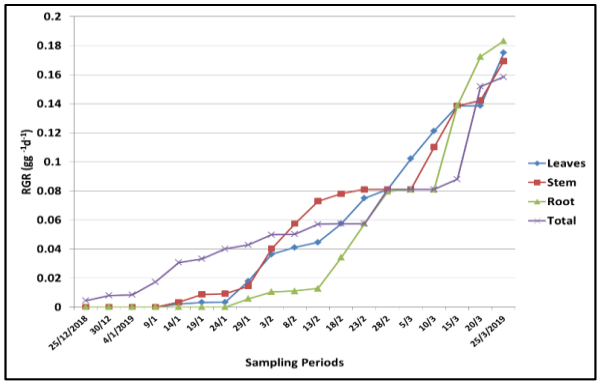


Fig (11): Relative Growth Rate of *B. tournefortii*

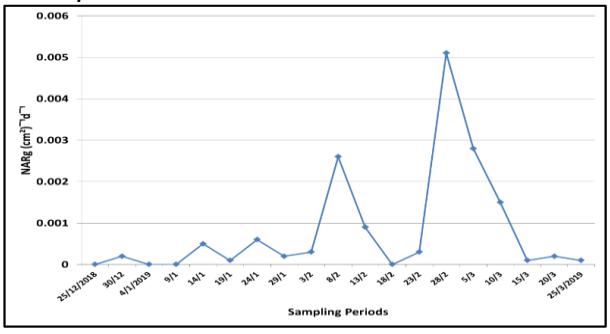


Fig (12): Relative Assimilating Surface Growth Rate of *Brassica tourneforti i*

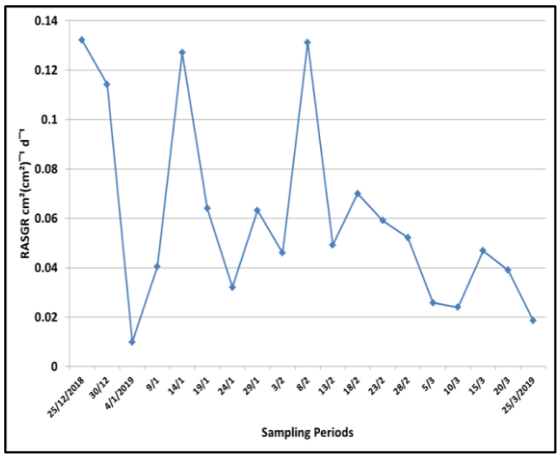


Fig (13): Net Assimilation Rate of *B. tournefortii*

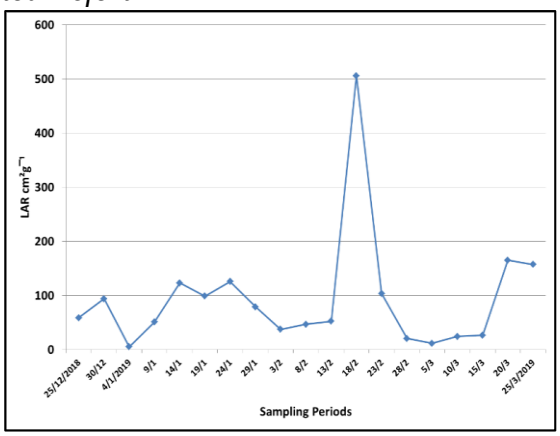
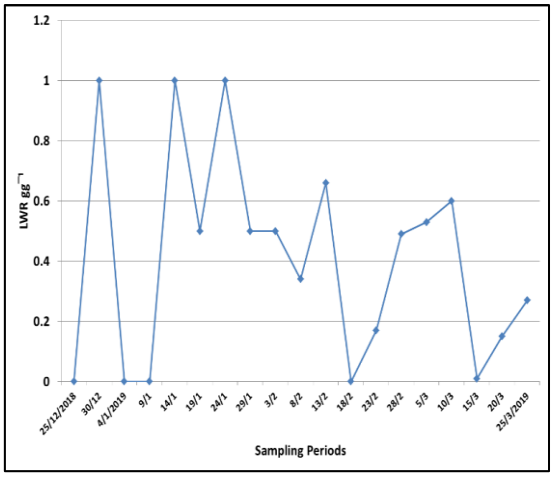
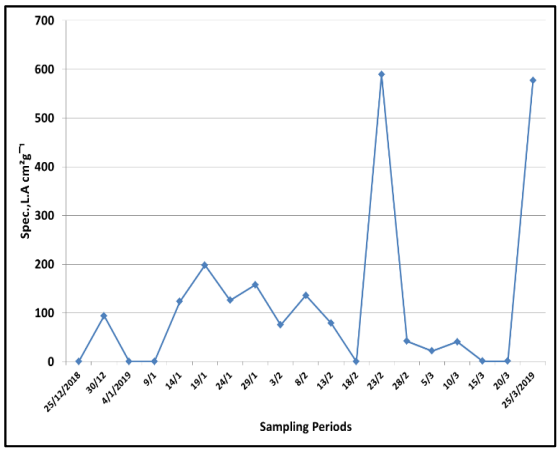


Fig (14): Leaf Area Ratio of *B. tournefortii*.





References

1 Awad, E. R. (2001). Ecological studies on the weed flora of the orchards in the Nile Delta and their nutritive potentialities. M. Sc. Thesis, Fac. Sci.Mans. Univ. Egypt.

2 Omar, G. (2006). Plant life of the different habitats in the North Nile Delta of Egypt: Ecology and fodder potentialities. *Egypt: Fac. Sci., Mans. Univ*. pp 303.

3 Sadek, M. A. L. (2008). *Ecological study on the weed flora in El Dakahlia governorate, Egypt* , M. Sc. Thesis, Fac. Sci. Mans. Univ. pp167.

4 Abd El-Moteleb, M. A. A. (2013). Ecology and Molecular Taxonomy of some Taxa of Family Brassicaceae. M. Sci. Thesis. Bot. Dep. Fac. Sci.Mans. Univ., 239 pp.

5 Boulos, L. (2002): Flora of Egypt. Al Hadara Publising, Cairo, Egypt. Vol**. (1):** 210-212.

6 Guarrera, P. M.; and Savo**,** V. (2016). Wild food plants used in traditional vegetable mixtures in Italy. *Journal of ethnopharmacology*, ***185***: 202-234.

7 Christopher, L. Osterwalder, A; Y; and Tucci. (2005)."Clarifying Business Models: Origins, Present, and Future of the Concept, "Communications of the Association for Information Systems: Vol. **16,** Article 1.

8 Blum, U. (2011). Plant-Plant Allelopathic Interactions: Phenolic Acids, Cover Crops and Weed Emergence. London, UK: Springer.

9 Cheema, Z. A.; Farooq, M.; and Khaliq, A. (2013). Application of allelopathy in crop production: success story from Pakistan. In *Allelopathy*, (pp. 113-143).

10 Kalpana, D. P, D.; Gayathri, R.; Gunassekaran, G. R.; Murugan, S.; and Sakthisekaran, D. (2013). Apoptotic role of natural isothiocyanate from broccoli (*Brassica oleracea* italica) in experimental chemical lung carcinogenesis. *Pharmaceutical biology*, ***51*(5)**: 621-628.

11 Jahangir, M.; Kim, H. K.; Choi, Y. H.; and Verpoorte, R. (2009). Health-affecting compounds in Brassicaceae. *Comprehensive Reviews in*

*Food Science and Food Safety***, *8*(2):** 31-43.

12 Kim, M. K.; and Park, J. H. Y. (2009). Cruciferous vegetable intake and the risk of human cancer: epidemiological evidence: Conference on 'Multidisciplinary approaches to nutritional problems' Symposium on 'Nutrition and health'. *Proceedings of the Nutrition Society*, *68*(1): 103-110.

13 Metcalfe, C. R. and Chalk, L. (1979**).** Anatomy of the Dicotyledons. Vol. **1.** Oxford.

14 Peacock, P. and Bradbury, S. (1973). Peacock´s Elementary Micro-Technique, 4th ed., Edward Arnold.

15 Snow, R. (1963). Alcoholic hydrochloric acid-carmine as a stain for chromosomes in squash preparations. *Stain tech*, *38*(1): 9-13.

16 Erdtman, G. (1960). The acetolysis method-a revised description. *Sven Bot Tidskr*, ***54***, 516-564.

17 Kent, M. and Coker, P. (1992). Vegetation description and analysis: A practical aproach (No. 581.5072 K475V.).

18 Shukla, R. S. and Chandel, P. S. (1989). Plant Ecology and Soil Science. S. Chand and Company Ltd., Ram Nagar, New Delhi.

19 Carter, M. R.; and Gregorich, E. G. (2008). Soil water content. *Soil sampling and methods of analysis. 2nd edn.(Eds MR Carter, EG Gregorich)* 939-962.

20 Margesin, R.; and Schinner, F. (Eds.). (2005). *Manual for soil analysis-monitoring and assessing soil bioremediation* (**Vol. 5**). Springer Science & Business Media.

21 Klute, A. (1986). Water retention: laboratory methods. *Methods of soil analysis: physical and mineralogical methods*, 635-662.

22 Baruah, T.C. and Barthakur, H.P. (1997). A Text Book of Soil Analysis, Vika poblishing House Pvt Ltd., New Delhi, 334 pp.

23 Milner, C. and Hughes, R. E. (1970). Methods for the measurement of the primary production of grassland. I. B. P. Hand Book. 6: 70.

24 *Kvet, J.; Ondok, J. P.; Necas, J. and Jarvis, P. G. (1971).* Methods of growth analysis. Plant Phytosynthetic Production, 343-391.

25 Evans, G. C. (1972). The quantitative analysis of plant growth (**Vol. 1**). Univ of California Press.

26 El-Shami, M. M. A (1989). Autecological and Phytochemical Studies on Lygos Raetam (Forssk) Haywood. M. Sc. Thesis, Sci., Mans. Univ. Egypt, 229 pp.

27 Masoud, G. F. (2004). Ecological studies of family Amaranthaceae in Egypt. M. Sci. Thesis, Fac. Sci.Mans. Univ., Egypt. 174pp.

28 Indrayan, A.K.; Sharma, S.; Durgapal, D., Kumar, N. and Kumar, M. (2005). Determination of nutritive value and analysis of mineral elements for some medicinally plants. Curr. Sci., 89: 1252 – 1255.

29 Sadasivam, S. and Manickam**,** A. (2008). Biochemical Methods. 3rd ed. New Age International Limited, New Delhi.

30 Zhishen, J.; Mengcheng, T.; and Jianming, W. (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food chem., ***64*(4):** 555-559.

31 Kitts, B.; and Beding, T. (2000). The next generation of IC measurement- the digital IC-landscape. *Journal of Intellectual Capital,* **1(3):** 263-273.

32 Al-Shehbaz, I. A. and Warwick, S. I. (2007). Two new tribes (Dontostemoneae and Malcolmieae) in the Brassicaceae (Cruciferae). *Harvard Pap Bot*, ***12*(2):** 429-434.

33 Choudhary, B. R.; and Joshi, P. (2001). Crossability of *Brassica tournefortii* and B. rapa, and morphology and cytology of their F1 hybrids. *Theoretical and Applied Genetics*, ***102*(6-7)**: 1123-1128.

34 Minnich, R. A. and Sanders, A. C. (2000). *Brassica tournefortii* Gouan. In: Bossard CC, Randall JM, Hoshovsky MC, editors. Invasive Plants of California's wildlands. Berkeley, CA, USA: university of California Press, pp. 68-72.

35 Täckholm, V. (1974). Student' Flora of Egypt, 2nd ed. Cairo Univ. Cooper. Prin. Comp, 887pp.

36 Sun, V. G.; (1970). Breeding plants of *Brassica*. *J. agric. Ass. China*.**71**: 41-52.

37 Prakash, S.; and Narain, A. (1971). Genomic status of *Brassica tournefortii* Gouan. *Theoretical and App. Genetics*, ***41*(5):** 203-204.

38 Marzouk, M. M.; Kawashty, S. A.; Ibrahium, L. F.; Saleh, N. A.; and Al-Nowaihi, A. S. M. (2008). Two new kaempferol glycosides from *Matthiola longipetala* (subsp. livida) (Delile) Maire and carcinogenic evaluation of its extract. *Natural Product Communications*, ***3*(8):** 1934578X0800300817.

39 Franzke, A.; Lysak, M. A.; Al-Shehbaz, I. A.; Koch, M. A.; and Mummenhoff, K. (2011). Cabbage family affairs: the evolutionary history of Brassicaceae. *Trends in plant science*, ***16*(2):** 108-116.

40 Heywood, V. H. (1993). Broadening the basis of plant resource conservation. In *Gene Conservation and Exploitation*. Springer, Boston, MA, 1 – 13pp.

41 Angiosperm Phylogeny Group. (2009). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Bot. J. Linnean Society*, ***161*(2):** 105-121.

42 Al-Shehbaz, I. A.; Beilstein, M. A. and Kellogg, E. A. (2006). Systematics and phylogeny of the Brassicaceae (Cruciferae): an overview. *Plant Systematics and Evolution*, ***259***(2-4): 89-120.

43 El-Shazly, S. M. (2013). Autecological study on some plants of family Malvaceae, Egypt. M. Sc. Thesis, Fac. Sci. Mansoura Univ. p 209.

44 Al-Sodany, Y. M. (1998)**.** Vegetation analysis of canals, drains and lakes of northern part of Nile Delta Region. Ph. D. Thesis, Fac. Sci., Tanta Univ., Egypt).

45 Asmeda, A. A. (2013). Ecology and phytochemistry of some taxa of family labiatae (lamiaceae). M SC thesis, Fac Sci Man s univ Egy P 145.