Journal of Genetic and Environmental Resources Conservation, 2023, 11(2):96-102.
www.gercj.com Print ISSN: 2306-8663, Online ISSN: 2306 – 8280

Preliminary investigations of high salinity tolerant plants on the banks of Sabkhat al-Jabul

Raed Al-Mohammed[1], Ahmad Majar[1], Laila Abd Alaziz[1], Bader Adin Jalab[3], Wafaa Al-Shebli[2], Mohammed Iyad Abbara[1] and Mohammed Al-Sabrah[1]

[1]Administration of Natural Resource Research, General Commission for Scientific Agricultural Research, [2]Agriculture Research Center in Damascus Countryside and [3]Agriculture Research Center in Aleppo, Syria.

***Corresponding author: raedmd1973@gmail.com**

Received: March 8th 2023; Accepted: June 16th 2023

Abstract

The main aim of this research is to attract the attention of plant breeders, agriculturists, farmers, and others within the world States to the benefits of exploiting halophytes and to raise their profile as economically important plants in a world now facing an increase in soil salinity. Although most of our crop plants are sensitive to salinity, salt-tolerant plants, halophytes, have evolved and offer a potential as crops that can yield in saline areas or areas irrigated with saline water. This research was carried out on the banks of Sabkhat al-Jabul, which is a natural reserve, located 40 km southeast of Aleppo, in Syria, near the city of As-Safira. The length of the sabkha is 40 km from Jabbul in the north to the village of Rasm al-Nafl, and the width of the lake is between 3-10 km, with an area of approximately 260 km². The water depth is between 20cm - 160cm. This reserve is included in the list of fertile wetlands within the Ramsar Convention of 1971 and one of the natural reserves spread across Syria. The ten most important natural plant species spread on the banks of the sabkha and tolerating high salinity were listed. These species are: *Aloe vera, Aeluropus littoralis*, *Juncus subulatus*, *Arthrocnemum glaucum, Seidlitzia Rosmarinus, Salicornia strobilacea, Gressa cretica, Launaea nudicaulis, Pulicaria inuloides, Fagonia bruguieri.* With the aim of attracting the attention of plant breeders, agriculturists, farmers, and others in the region to the possible uses of halophytes. Halophytic species can be grown and irrigated with brackish water where good drainage is available and used for forage or fodder, to stabilize land, and to produce biomass for fuel. In the longer-term, the cultivation of horticultural crops and those grown for nutraceuticals or pharmaceuticals is feasible.

Keywords: Salinity, Plants, Sabkhat al-Jabul.

Introduction

Salinity is one of the important factors threatening agricultural production in most parts of the world, where the problem of salinity has recently become an urgent economic issue due to the increase in the proportion of salinized lands by 10% annually, which leads to a decline in the area of arable lands (ponnamperuma, 1984), 45% of the irrigated lands in Syria are affected by salinity to varying degrees moreover, due to salinity 3000-5000 hectares of land get out agricultural practices annually, in addition to about 366,000 hectares affected by waterlogging and salinity (Abdul-Gawad, 1997). Hazouri and Nadim (1997) indicated there is necessity to use saline water in irrigation to obtain the highest productivity of agricultural crops in the drought periods.

The high costs of salinized lands reclamation demand the need to find highly salinity-tolerant plant species to be used (Al-Ali, 2000), furthermore, the biological method of saline soils reclamation comes to the fore, in conditions of water scarcity, and considered to be the ideal solution for management of saline soils in arid and semi-arid areas (Kamel, 2001).

Salted dust is defined as the dust whose saturated dough is electrically conductive ECe) higher than 4 ds m^{-1}. And often the sodium chloride salt is mainly responsible for this salinity, and this value was chosen from the electrical conductivity of saline soil, which is equivalent to 1/13 of the conductivity of sea water as a critical level to assess salinity (Ringel, 1992), because most salinity-sensitive plant species usually retreat significantly from this level of salinity.

Salinity is one of the most important environmental stresses that threaten agricultural production in arid

and semi-arid areas, in addition to drought and high temperatures, which negatively affect plant biodiversity (Ghazanfar et al, 1995).

The possibility of investing saline lands depends on developing salinity-tolerant pastoral species, with the aim of re-cultivating them in degraded saline lands, and testing their suitability for feed production systems in salinity-affected areas (Peacock et al, 2000; Shannon, 1985).

Some studies indicated that the tolerance of some plants to salinity is not related to the concentration of sodium ions Na +in the leafs, which confirms the presence of different of tolerance levels at cells and plant tissues. The endurance efficiency depends on the nature of the distribution of salt ions between the different parts of the plant, and their storage in the vacuoles (James et al, 2002).

The increasing population growth in the world, which is expected to reach 8.5 billion people by 2025, the food security of this population requires an increase in the production of crop species by 40-50%, and developing countries need to achieve 60% of this increase by increasing The average productivity per unit area of land and the increase in the area of agricultural land, and this requires the reuse of saline irrigation water and the cultivation of the highly salinity-tolerant genotype (Farook, 2004).

The importance of this study, which aims to detect and investigate high salinity-tolerant plant species that reach the salinity of sea water on the banks of al-Jabbul Lake, in order to draw attention to the importance of these species and their exploitation in sustainable development programs due to their various benefits as well as preserving and protecting them from greedy investment, overgrazing or Woodcutting, as well as developing proposals that contribute to the preservation and protection of these species from various dangers. In addition to the urgent need to conduct research on salt-tolerant plant species.

Materials and Methods

Site Location: Sabkhat (Saline Lake in Arabic) Al-Jabbul Lake is a natural reservation, located in 40 km to southeast of Aleppo, adjacent to the city of Al-Safira (Figure 1). It was supplied in two steps, first in 1982 from the wastewater of Maskana sugar factory collected to the east of it, however the second was in 1989, where it enlarged to the north of Khasaf village by the drainage water collected from the surrounding territories. The length of the lake is around 40 km and the width varies from 3 to10 km, with an area of approximately 260 km2. The depth of the water ranges from 20 cm to 160 cm. Sabkhat Al-Jabbul Lake play vital role in preservation of wild life in particular of birds, where it becomes the habitat for bird egging, reproducing and surviving. This reservation is included in the list of fertile wetlands in the Ramsar Convention of 1971 and among the nature reserves spread in Syria. The area is a shelter for many migratory birds. The eastern part of the Sabkha is shallow and is used as a salt pan, where collecting salt conduct in late summer, which is considered an important economic source for the inhabitants of the area.

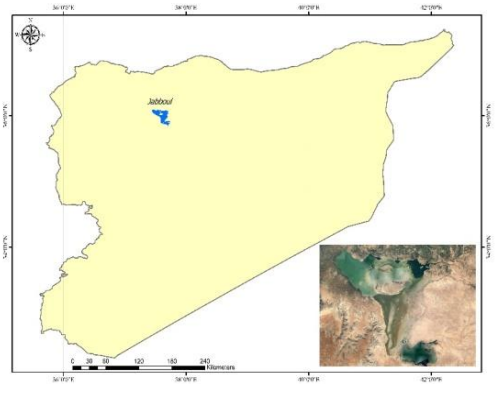

Figure 1: Location of Al-Jabbul Lake (Sabkah)

Based on field tours, inventory statements Relevés, which have been carried out in the region since the beginning of the last century, the taxonomic and environmental information available in the references and specific plant studies, as well as the approved criteria of plant tolerance to soil salinity, the tolerant to high salinity helophytes were determined. The results included the following data:

- The taxonomic status of the species, the scientific name according to the genus and families
- Botanical description of these species, leaves, flowers, fruits, and flowering date.
- The use of each of these types.

Results and Discussion

The field expedition showed that he Soils of the studied area are, in the surface layer of 30 cm, highly saline with neutral to slightly alkaline pH of around 7.25 – 7.7, moreover the electrical conductivity (EC) was very high with the values of 2.5 – 92 dS/m, with domination of Cl^- and SO_4^{-2} anions and Na^+, Ca^{+2} nd Mg^{+2}, however no indications of alkalization of the soil as the ESP in all ESP less than 15% (table 1).

Table 1: Chemical properties of studied area.

Site	pH	EC, dS/m	TDS, ppm	Anions, meq/l					Cations, meq/l					SAR	ESP
				CO_3^{2-}	HCO_3^-	SO_4^{-2}	Cl^-	Total	Ca^{2+}	Mg^{2+}	Na^+	K^+	Total		
Abo Seneiah	7.25	26.5	16960	T	0.94	13.61	18.4	33	9.4	5.2	18	0.35	33	6.7	<15%
AlJeren	7.6	92	58880	T	0.6	1.1	100	101.7	10	22	69	0.7	101.7	17.25	<15%
Om Miyal	7.4	25.85	17184	T	0.45	16.05	9.6	26.1	8.3	5.25	12.5	0.1	26.1	4.81	<15%
Rojem Akash	7.7	31.95	20448	T	1.12	15.84	6.48	23.4	10.8	3.0	9.5	0.14	23.4	3.61	<15%

Salt-tolerant plants can tolerate growing in saline environments with salinity equal to sea water or greater. ASWAS and the specialized references mentioned that there are more than 2500 salt-tolerant plants distributed in different parts of the globe. Salinity tolerant plants are characterized by qualities that help them to withstand and resist salinity. There is no doubt that halophytic plants share one characteristic, which is the ability of their protoplasm to tolerate the presence of a large amount of salts in the cell, in addition to the three following plants characteristics mentioned in the works of Bitanuni (1986), which make them able to tolerate presence of high concentration of dissolved salts:

- **Juiciness**: It means its ability to retain a large amount of water in its stems and leaves, and this phenomenon can be explained by the attempt of these plants to dilute the cellular juice, whose concentration increases due to the absorption of chlorides.
- **Secretion of salts:** Some halophytic plants secrete salts through saline glands located on their leaves or stems, and within these glands there are a number of active cells work to pump the concentrated saline solution from the plant cells to the outside. Such as *Aeluropus littoralis* (Gouan) Pari, *Juncus subulatus Forsk*, *Gressa cretica* L.
- **Elimination of some parts of the plant**: a phenomenon of partial death for the continuation of life, and the reason for this phenomenon is the concentration of salts in some parts of the plant throughout the growing season, when the concentration of salts reaches the critical level, parts of the plant die and fall off, removing large amount of salt.

The most important natural plant species tolerant to high salinity, which spread on the banks of Sabkhat al-Jabbul are the following:

1. *Aloe vera* (L) Burm. F. family *Aloaceae (Sab'r* in Arab.):

A perennial succulent plant, green color, with upright stems, up to 1 m height, with soft leaves, long waxy, abundant at the base with spear-shaped and serrated edges, often concave with spiny edges 30-20 cm long 10-4 and cm wide (figure 2). The floral complex consists of many flowers up to 70 cm long, where the cup is short and membranous. The flowers are beautiful, drooping, and yellowish-red with 3-2cm long, moreover the flower cover is tubular, petal-like, with three lobes, and moreover the insemination aperture is prominent. The fruit is with the form of a soft and round capsule, regarding the seed so they are numerous and small of gray or black color. The flowering phase usually continue from January to April, it tolerates high salinity and spreads

near sabkha, can be used for installation of cosmetic and medical preparations.

Figure (2): *Aloe vera* (L) Burm. F. family *Aloaceae (Sab'r* in Arab.) flowering in the bank of Al-jabbul (The source is the Authors)

2. *Aeluropus littoralis* (Gouan) *Pari* family *Gramineae (Aacrash* in Arab):

A perennial herb, recumbent, with aerial stems or rhizomes, in addition to a bunch of hollow stems filled with nodes, and upright flowering stems, up to 20 cm long, stems are woody, spreading later covered with intertwined hairy scales .The leaf is flat, lanceolate, often tapering of 2-3 cm long, without lancets, the inflorescence is dense with a spherical or oblong apex of 1-1.5 cm long with capillary panicles, however the lower canal is often tapered, the fruit is dry, unopened, with one seed. Flowering from March to May, moreover it tolerates very high salinity up to the salinity of sea water > 35 dS/m and it is edible for grazing animals. (Figure 3).

Figure (3): *Aeluropus littoralis* (Gouan) Pari family Gramineae (Aacrash in Arab.) (The source is the Authors)

3. *Juncus subulatus*, Forsk family *Juncaceae (Asel* in Arab.):

A perennial cylindrical plant, with a strong dark green color, is gathered in bunches, smooth with parallel, hard and creeping upright aerial stems (rhizome),which are pointy and up to 1.5 cm height, leaves are cylindrical, tapering, hollow, without knots with sharp ends, the flowers are small and green, located on the open lateral apex, where the stems continues until the top of the floral gathering, moreover the petals are six, spear-shaped and pointed, where the outer three of them are longer, while the other three are triangular, with a declining pyramidal apex, longer than the petals, regarding seeds so they are numerous, with a short tail at each end, with light brown color, Flowering from April to July. It tolerates very high salinity of > 35 dS/m and used in folk medicine and has multiple industrial uses. (Figure 4).

Figure (4): *Juncus subulatus*, Forsk family *Juncaceae (Asel* in Arab.) *(The source is the Authors).*

4. Arthrocnemum glaucum, (Del.) Ung-Sternb family Chenopodiaceae (Qllam in Arab.):

Succulent shrub, articulated, many branches, up to 80 cm high, the flowers are bisexual in groups with two or three flowers on the axillary scales of the spikes that resemble a sitting pine. The braces are two, attached and permanent. The flower shell is triangular at the top with the form of an inverted pyramid of brown color, the stamens of 1-2 cm length, 2-3. The vesicles are oval, confined to the flower shell. The seeds are very small, oval, slightly compressed. Flowering from April to October. It bears high salinity that reaches the level of sea water salinity and has medicinal uses, and is also used in the soap industry. (Figure 5).

Figure (5) Arthrocnemum glaucum, (Del.) Ung-Sternb family Chenopodiaceae (Qllam in Arab.) (The source is the Authors)

5. Seidlitzia rosmarinus (Ehr.) Bge family Chenopodiaceae:

Low, smooth shrub, up to 60 cm high. Stems densely branched from a woody base, where the lower nodes have longer distances than the upper ones, the branches are opposite, whitish and shiny, where the leaves are opposite and of 5 – 20 cm length, woolly leaves found on the armpits. The stamens are five, prominent, the feature pen is small in size. The stamens are two. The fruit-bearing flower has a small diameter and has uneven wings, the seeds are black and horizontal. Flowering from August to December. Tolerance to salinity and dispersal: It tolerates very high salinity up to the level of sea water salinity, has a low feed value, has medicinal uses and in cleaning clothes (Figure 6).

Figure (6): *Seidlitzia rosmarinus* (Ehr.) Bge family Chenopodiaceae *(The source is the Authors).*

4. *Salicornia strobilacea* Pall family Chenopodiaceae:

Bare dwarf shrub with fleshy branches and 20-50 cm long, stems upward to straight with several branching, where internodes are short, thick, cylindrical, ending with two opposite leaves of membranous edge, oval form, fused to their bases, about 1 mm long and often supporting sterile, short, barren and bud-like branches, where sessile leaves, very short, curved or its long superior to the width, set in four rows. The flower tubes are curvy kidney-like and fall after flowering. The flowers are hermaphroditic, gathered in lateral or terminal panicles that are arranged oppositely in a cone-like or spherical to oblong forms. The sleeve is simple, three-piece, small and about 1.5 mm long, where the masculine is composed of one stamen and the feminine of dual carpels. The fruit is inverted - compressed oval, the fruiting circumference membranous. The seeds are very small (0.5-1 mm), compact, brown, smooth to tuberous. Flowering in May to September. It tolerates high salinity and has a good pastoral value. (Figure 7).

Figure (7): Salicornia strobilacea Pall family Chenopodiaceae (The source is the Authors).

7. Gressa cretica L family Convolvulaceae:

C. cretica is an erect dwarf shrub can be up to 20 – 38 cm in height. Roots are horizontal, geminate, with lateral branches leading upward to produce aboveground parts. It is a perennial subshrub or herb, usually much branched. Stems are at first erect and then become decumbent, apparently short-lived, gray appressed pilose to sericeous. Leaves on main branches are often larger than those on branch lets, the blade 1–12 mm long, lanceolate, ovate or elliptic- to scale-like, sessile, or shortly petiolate. Flowers are solitary, axillary, and 5–8 mm long, sessile or on short peduncles, bracteate, in spicate to headlike clusters at tips of branchlets, bracteoles unequal in length. Sepals ovate to obovate, imbricate. Corolla salver form, the limb 5-lobed, the lobes mostly ovate, imbricate, spreading to reflexed. Stamens exserted; filaments filiform; styles exserted. Ovary 2-locular, 4-ovulate; styles 2, distinct to the base; stigmas capitate. Fruit is capsular, ovoid, unilocular, 2–4 valved, usually one-seeded. Seeds

are 3–4 mm long, glabrous and smooth, and shining to reticulate, dark brown. (Ganeshaiah et al, 2009; Warrier et al, 1990) Flowering in June to September. It tolerates high salinity that reaches the level of sea water salinity, and it has multiple uses in folk medicine. (Figure 8).

Figure (8): *Gressa cretica* L family Convolvulaceae *(The source is the Authors)*

8. Launaea nudicaulis (L.) Hook. F Family Compositae:

Perennial plant, up to 60 cm high. The stem might be straight or recumbent, branching bilaterally in sequence and branching upwards (Figure 9). Leaves are pink of 3-17 cm long and 2-3 cm wide, flat-shaped, pinnate and located in oblong or oval inner lobes, with serrated cartilaginous lobes. The upper leaves are few and small, the spikes are lateral and terminal, yellow and found on short petioles. The caps are grassy with wide edges. The fruit is small and has two types. The bristles are almost equal in length and white in color. Flowering at the whole year. It tolerates high salinity up to the salinity of sea water, and has various medicinal and food uses.

Figure (9): Launaea nudicaulis (L.) Hook. F Family Compositae (The source is the Authors).

9. Pulicaria inuloides (Poir.) DC Family Compositae:

Perennial, branched and bushy herb, extended up to 50 cm. The branches are complex, woolly, smooth and white (Figure 10). The leaves are non-petal, successive, narrowed to be linear, wavy with 5-20 mm long, moreover very small at the top, woolly, with thick pubescence on both sides. The pink gatherings are single and have variable peaks where its diameter is around 5-10 mm. The visors are staggered and permanent. The florets are yellow, very short, its length equal to the crown of florets. Fruit is smooth, up to 1 mm long. Flowering from February to April. It tolerates high salinity and has medicinal uses as an herbal tea, and is also used as a rash remover.

Figure (10): Pulicaria inuloides (Poir.) DC Family Compositae (The source is the Authors).

10. Fagonia bruguieri DC Family Zygophyllacee:

Perennial, woody, green, with glandular or bare pubescence of 10-30 cm long. The stem is very branching, lying on the ground (Figure 11). The internodes are short, angular and quickly break down. The leaves are opposite, the lower ones are trifoliate and the uppers are simple or bi-leaf, the auricles flat and weak and transform into spines of 1-2 cm long, where most of them are longer than the leaves. The sling is shorter than the leaflets. The leaf is somewhat fleshy, ovate to oblong and of 0.5-1 cm long, its edges are often folded down and its top ends with a short spicule. The flowers are hermaphroditic, shorter than shots, emerging from between the ears, erect at first and then becoming horizontal or slightly drooping. The sepals are five and of 2-3 mm long, permanent ovate to tapering. Petals are five, 2-3 times longer than sepals and pink, the stamens of 10 filaments without scales. The ovary is pentagonal with five-chambered, each

contains two ovules. The pen is permanent, pentagonal and shorter than the case, the stigma is simple. The fruit is a can, about 4 mm long, pubescent along the edge, inverted conical, pentagonal and divided at maturity into five chambers, each contains one seed and opens later. The seeds are about 2 mm long, ovate with a narrow edge and apparently tuberous and glossy brown. Flowering from March to April. It tolerate very high salinity and can be used in traditional medicine and as spice.

Figure (11): *Fagonia bruguieri* DC Family Zygophyllacee *(The source is the Authors).*

Conclusions

- The region is rich in distinct species of salt-tolerant plants to varying degrees.
- The species that tolerate high salinity have many uses, including food, medical, industrial uses, or they can be used for decoration, landscaping, or fodder use.
- The importance of these types comes from the fact that they can be grown on saline lands outside the scope of agricultural investment and thus benefit from these lands and achieve an economic return through the multiple benefits of these plants.
- Reducing soil salinity: Plants tolerant of seawater salinity, when cultured in saline soils, work to reclaim them by reducing the percentage of salts present in these soils.
- Providing feed for animals, especially in the current conditions, with the high prices of feed and the difficulty of importing. It is possible to rely on these species to provide the fodder material due to the nutrients contained in some types of these plants by cultivating them in saline soils.

References

Abdel-Gawad, Al-Jilani (1997) Soil Degradation and Desertification in the Arab World, Journal of Agriculture and Water in Dry Areas in the Arab World, No. 17-September, pages: 28-55.

Farooq, S. (2004). Salt tolerance in Aegilops species Asuccess story Psospects of Saline Agriculture in the Arabian Peninsula. pp. 121-134.

Ghazanfar, SA; Miller, AG; Mcleish, I.; Cope, T. A.; Cribb, P. and AlRawahi, SH (1995). Plant conservation in Oman. Part-I. A study of the endemic, regionally endemic and threaten plants of the sultanate of Oman. April 1995.15 p. Sult an Qaboos University, Oman.

Hazoury, Abbas and Nadim, Khalil (1997). The Effect of Irrigation with Salt Water on the Productivity of the Harem Eggplant, Aleppo University Research Journal, No. 21.

Kamel, Mohamed Walid, Abdullah (2001). A storage test method for salinity pastoral plants, Journal of the Arab Agricultural Engineer, Union of Arab Agricultural Engineers in Damascus, No. 52, pp. 37-40.

Kamal Al-Din Hassan Al-Battanoni (1986). Environment and Plant Protection in the State of Qatar, first edition, Qatar University, Doha - Qatar 414 pages.

Peakock, J. m.; Ferguson, ME.; Alhadrami, GA; McCann, IR; AlHajoj, A.; Salh and Karnik, R. (2000). Conservation through utilization- a case study of the indigenous forest grasses of the Arabian Peninsula. Paper presented at the International Confrence on the Conservation of Biodiversity in the Arid Regions. Kuwait, March, 29-29.

Ponnamperuma, FN (1984). Role of cultivar tolerance in increasing rice production on saline lands. In: Salinity Tolerance in Plants-Strategies for Crop Improvement. (ed.) R.C. Staples and GA Toenniessen. 255-271.

Rengel, Z. (1992). The role of calcium in salt toxicity plant cell Environ. 15th 625-632.

Shannon, MC (1985). Principles and strategies in breeding high salt tolerance. Plant and Soil. 89: 227-241.

Ganeshaiah KN, Vasudeva R, Uma Shaanker R. 2009. In search of Sanjeevani. Curr Sci., 97: 484-9.

Warrier PK, Nambier VP, Ramankutty C. Indian medicinal plants a compendium of 500 species. Vol. 1. New Delhi India: CSIR; 1990. p. 219.