Influence of the aqueous extract of Tamarix articulata Vahl. leaves on some vegetative growth indicators and medically active substances of Cordia myxa L. Seedlings c.v. Local.

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Abstract. This study was conducted in the wooden canopy of the Department of Horticulture and Landscape / College of Agriculture / Basra University, during the growing season 2017 – 2018. In order to know the effect of the aqueous extract of *Tamarix articulata* Vahl. Of concentrations of (0, 50, 100 and 150 g. L\(^{-1}\)) on some vegetative growth indicators (plant height, stem diameter, number of leaves per plant, leaf area, fresh weight of foliage and the content of chlorophyll in leaves) and medically active substances (percentage of phenols in the leaves and the quantity of phenols in them) of *Cordia myxa* L. Seedlings c.v. Local. The results showed that the aqueous extract of *Tamarix articulata* Vahl. Of (150 g. L\(^{-1}\)), was superior over all other concentrations of this extract, which significantly didn’t differ from its concentration (100 g. L\(^{-1}\)) concerning most characteristics studied in this study. Besides, its concentration of (50 g. L\(^{-1}\)) was significantly, not different from control treatment concerning most studied characteristics.

Keywords: *Tamarix articulata* Vahl., *Cordia myxa* L., phenols, alkaloids.

Introduction

INTRODUCTION The tree *Cordia myxa* L. belongs to the family Boraginaceae, which includes 100 genus and 2000 species, which are distributed in Moderate areas, especially in the Mediterranean and tropical regions. *Cordia* is one of the largest genus in this family [1]. *Cordia myxa* L. has highly nutritious and medicinal values, in all its parts, such as leaves, roots, fruits, seeds, and even bark. It belongs to a group of medicinal plants contain mucilage substances, gummy substances and plant milk that use in medicine field [2]. Most of this genus members or species have beautiful monoecious flowers, with aromatic smell and white color, appear in large terminal clusters [3]. *Cordia* is one of the largest species of this family [1]. The fruits are of higher nutritional value than the stone seed fruits due to their content of vitamins, mineral salts and proteins [4], which are yellow colored, sweet tasted at maturity and closely similar to the locally known pear [5], besides the semi-mature fruits are use as substitute glue with papers, be eaten as pickles and in the treatment of indigestion [6]. The leaves of *Cordia myxa* L. are alternate, wide, oval, and their upper surfaces are glossy and the bottom surface is covered with fuzz. The leaves are used as feed for animals [7]. The average height of trees is 5-7 meters and are evergreen [4]. *Tamarix articulata* Vahl. belongs to the family Tamaricaceae, it is a plant of a medicinal importance that naturally grown in Iraq. This species exhibits southern Europe, North Africa,
and everywhere in Middle East in South Asia to China and Japan and even in the Western Sahara of United States of America [8]. The plant is a tree up to 18 meters high and approximately of 0.6 meters the diameter of stem depending upon the surrounding environmental conditions. The leaves contain various chemicals, where Tamarix articulata Vahl. contains: sodium, magnesium, calcium, potassium, and other minerals, as well as tamarixin, tannins, sugars such as: glucose, dextrin, fructose and sugary juice, and phenolic compounds [9, 10]. Due to the lack of studies concerning the influence of the application of aqueous extracts of Tamarix leaves on the vegetative growth and some medically active substances in Cordia seedling leaves, The present study was conducted which aims to find out the following: 1. The extent of response of Cordia myxa L. to the aqueous extracts of Tamarix articulata Vahl. which applied with the irrigation water on the characteristics of vegetative growth. 2. Determine the best level of Tamarix articulata Vahl. extract which responded to by Cordia myxa L. seedlings, through their vegetative growth indicators and their content of medically active substances.

**Materials and methods**

1. **Location of the experiment:**
   The field experiment was carried out in the wooden shed of the Department of Horticulture and Landscape College of Agriculture University of Basra during the growth season 2017 - 2018 in order to study the effect of the aqueous extract of Tamarix articulata Vahl. on some indicators of vegetative growth of Cordia myxa L. c.v. local.

2. **Field experiment tools:**
   1- Cones of metal plate (of 65 cm length and 15 cm diameter).
   2- A quantity of Tamarix articulata Vahl. dried and grinded leaves.
   3- Gauze-like white fabrics as filters.

3. **preparation of Plants:**
   Cordia myxa L. seedlings were brought from a private arboretum in Basra Governorate on 2018/10/24. The seedlings were approximately similar in appearance, age (each of one year), with length of 12.5-25 cm and one main stem.

4. **preparation of the cultivation medium:**
   A mixture of the culturing medium was prepared, consisting of smooth sandy (fine-dust like) soil, as growth medium of Cordia myxa L. seedlings brought from a private nursery in Basra governorate then mixed with Peat moss (six packages, 1 kg weight each), the mixture then distributed into pots of experiment (16 pots).

| Table (1) Some chemical and physical features of cultivation soil. |
|---------------------------------------------------------------|
| **Type of Analysis** | **Value** | **Unit** |
|----------------------|-----------|----------|
| Potential of hydrogen (pH) | 1.8 |          |
| Electrical conductivity (EC) | 6.11 | dS m-1 |
| Sodium Na-1 | 6.11 | mmole L-1 |
| Chloride Cl-1 | 8.93 | mmole L-1 |
| Potassium K+ | 8.93 | mmole L-1 |
| Soil Texture | Lomey Sand soil |
| Sand | 986.0 | g Kg-1 |
| Silt | 9.7 | g Kg-1 |
| Clay | 4.3 | g Kg-1 |

- Samples were analyzed at the laboratories of Department of Soil Science and Water Resources College of Agriculture University of Basra
5. Preparation and cultivation of plants: 
Seedlings were transferred in the new medium and then were planted in agricultural containers it was pots of (5) kg capacity, then irrigation of seedlings was continued until the end of the experiment in 8/5/2018. Thereafter the results were recorded.

6. Factors of the Study:
6-1. Preparation of the extract levels (g. L⁻¹):
The dry material of Tamarix articulata Vahl. leaves was used to prepare the treatments of the experiment. The following weights were used (0, 50, 100 and 150)g to prepare the aqueous extract levels (extracted by hot water). Also same weights of the dried grinded and pressed leaves of Tamarix articulata Vahl. were put in a fabric (medical gauze) then compressed as disc- shape and placed into the cones, which put (these cone s),in a quiet slope manner into the soil of pots planted with Cordia myxa L. seedlings, where the aqueous extracts were added above these filters when irrigating plants. This operation continued until the end of the experiment on 8/6/2018.

6-2. Treatments used:
First: The quantities of dry weight of Tamarix articulata Vahl. leaves (used as filters):
1 - Treatment of the control, i.e., no leaves of Tamarix articulata Vahl. were used in the extract (concentration of 0 g. L⁻¹).
2 - Treatment of aqueous extract of Tamarix articulata Vahl. leaves (concentration of 50 g. L⁻¹).
3 - Treatment of aqueous extract of Tamarix articulata Vahl. leaves (concentration of 100 g. L⁻¹).
4 - Treatment of aqueous extract of Tamarix articulata Vahl. leaves (concentration of 150 g. L⁻¹).

Second: Application dates:
On 10/12/2017 the first Application of the extract of Tamarix articulata Vahl., were done, and the second Application was one month later (that’s to say on 10/1/2018).

7. Characteristics studied:
7-1: Characteristics of vegetative growth:
7-1-1: Plant height (cm):
The plant height were measured from its contact point with soil up to the apical tip of the main stem, using the metric measuring tape.

7-1-2: Stem diameter (mm):
The stem diameter was measured at the middle of the stem using the Vernier Caliper.

7-1-3: Number of leaves (leaf. Plant⁻¹):
The number of leaves per each plant was calculated by accounting the number of leaves found on the main stem and its branches.

7-1-4: Leaf area (cm²):
The leaf area was calculated by taking a random sample of the plant leaves, where 10 leaves were taken and weighted directly by a sensitive electrical balance, so this called fresh weight. Then a cube (a disc) of a known weight was taken from each of these leaves and weighted with the same balance. Then all leaves and cubes were dried inside an electric oven for 24 hours, then weighted with the same balance as the dry weight of the leaves and cubes. Then the leaf area were calculated on the basis of dry weight according to the formula described in [11].

\[ S = \frac{L \times S}{g} \]
Where:
S: The leaf area (cm$^2$)
G: The weight of Dry leaf (g.)
S: The dry cube area (cm$^2$)
g: The dry cube weight (g)

7 - 1-5: Fresh weight of the whole shoot (g):
After pulling off the plants of each single duplicate from the cultivation soil, the shoots were separated from roots at the swelling crown area of Cordia myxa L. plants, and each part was separately washed then dried under direct air. Then the fresh weight of both shoot and root of the plant were measured using a sensitive electrical balance and the values were enlisted in the unit of g. plant$^{-1}$.

7-1-6: concentration of total chlorophyll dye in leaves (SBAD):
The total chlorophyll content was estimated in Cordia myxa L. seedlings using the total chlorophyll meter (direct field reading). The reading was taken for the fourth leaf of the apical tip for all treatments under study which were recorded using the meter above in the units of SBAD.

7-1-7: Percentage of phenols in leaves (%):
Phenolic compounds were extracted from the leaves of Cordia myxa L. according to [12]. The results were estimated using the following equation:

Percentage of phenolic compounds based on Gallic acid = \( \frac{G}{S} \times \frac{a}{(M \times M)} \times \frac{(m)}{h(n \times m)} \times 100 \)

7-1-8: Estimation of alkaloids (mg):
The alkaloids were extracted in the leaves of Cordia myxa L. according to the method described in [13].

7-2: Experimental Design and Statistical Analysis:
The experiment was carried out statistically according to the Randomized Complete Block Design (R.C.B.D). The experiment was of four levels of the aqueous extract of Tamarix articulata Vahl. (0, 50, 100 and 150 g. L$^{-1}$), which were used and randomly distributed into four replicates, so that the total number of experimental units became (16) units, and each experimental unit was one seedling of Cordia myxa L. The statistical analysis of the experiment data done using the SPPS program. The treatments averages were compared using the Revised Least Significant Difference Revised LSD and at a probability level of 0.05 and according to [14].

Results and discussion
1- Effect of aqueous extract levels of Tamarix articulata Vahl. leaves on some vegetative growth characteristics of Cordia myxa L. seedlings c.v. Local:
Table (2) data appears the effect of the aqueous extract levels of Tamarix articulata Vahl. on the height, the main stem diameter and the number of leaves per Cordia myxa L. plant. As noted in the above table data, the treatment (150 g. L$^{-1}$) was significantly superior by exhibiting the maximal height of the plant which reached (90.14) cm, which significantly did not differ from the treatment of (100 g . L$^{-1}$) of (88.06) cm. While the control treatment (0 g. L$^{-1}$) exhibited the minimal height of (72.00) cm. These differences may be due to the effect of Tamarix articulata Vahl. extract on plant height, where it contains many nutrients that directly and indirectly contributed to the improvement of plant growth characteristics [9, 10].
Table (2) also displays, that the effect of aqueous extract level (150 g. L⁻¹) where significantly superior, too in its effect on the main stem diameter of the plant, and gave the widest diameter of the main stem of *Cordia myxa* L. reached an average of (13.91) mm, which significantly did not differ from the treatment of (100 g. L⁻¹) in the diameter of the main stem of the plant, which has a diameter of 13.66 mm. While the control ratio (0 g. L⁻¹) gave the lowest rate in this capacity, which was 9.66 mm. These differences may be due to the effect of *Tamarix articulata* Vahl. extract in the diameter of the plant stem in that it contains many nutrients that directly and indirectly contributed to the improvement of plant growth features [9, 10]. As for the effect of *Tamarix articulata* Vahl. extract on the number of leaves of *Cordia myxa* L.

The data in Table (2) show that the effect of the aqueous extract levels of *Tamarix articulata* Vahl. was also significant under the level (150 g.) and gave the greatest number of leaves per plant of (22.06 leaf Plant⁻¹) which significantly did not differ from the treatment of (100 g. L⁻¹) in the number of leaves per plant, which reached the average number of leaves per plant of (21.15 leaf Plant⁻¹). While the control treatment (0 g. L⁻¹) gave the lowest rate in this feature of (11.33 leaf Plant⁻¹). The differences may be due to the effect of the extract of *Tamarix articulata* Vahl. in the number of plant leaves that it contains many nutrients Which have directly and indirectly contributed in the improvement of plant growth features (nutrients such as: sodium, magnesium, calcium, potassium, and other minerals, as well as tamarksin, tannins and sugars such as: glucose, dextrin, fructose, sugar syrup, besides to phenolic compounds) [9, 10].

| Concentrations of aqueous extract (g. L⁻¹) | Plant height (cm) | The main stem diameter (mm) | Number of leaves (leaf. Plant⁻¹) |
|------------------------------------------|------------------|----------------------------|----------------------------------|
| 0                                        | 72.00            | 9.66                       | 11.33                            |
| 50                                       | 80.00            | 10.40                      | 17.00                            |
| 100                                      | 88.06            | 13.66                      | 21.15                            |
| 150                                      | 90.14            | 13.91                      | 22.06                            |
| Revised L.S.D ≤0.05                      | 4.48             | 1.03                       | 1.23                             |

2. Effect of aqueous extract levels of *Tamarix articulata* Vahl. leaves on some vegetative growth characteristics of *Cordia myxa* L. c.v. Local:

The data in Table (3) reveal the effect of aqueous extract levels of *Tamarix articulata* Vahl. in the leaf area, the total chlorophyll, and the fresh weight of the shoot of *Cordia myxa* L. This table data indicate that the treatment (100 g. L⁻¹) was significantly superior and gave the largest leaf area of the plant of (52.22 cm²), which significantly did not differ from the treatment (150 g. L⁻¹) of (50.47 cm²). While the control treatment (0 g. L⁻¹) possessed the lowest leaf area of (37.99 cm²⁻¹). These differences may be caused by the effect of the extract of *Tamarix articulata* Vahl. on the leaf area that it contains many nutrients which contributed directly and indirectly to improve the growth characteristics of plants.

And for the effect of the aqueous extract levels of *Tamarix articulata* Vahl. on the chlorophyll content in *Cordia myxa* L. The data in Table (3) indicate that the result of the statistical analysis of this trait indicates that there are no significant differences amongst the factors.

Concerning the effect of *Tamarix articulata* Vahl. extract on the fresh weight ratio of the shoot of *Cordia myxa* L. plant, the data in Table (3) show that the effect of the aqueous extract levels for *Tamarix articulata* Vahl. was also significant in this trait. Where the extract treatment (150 g. L⁻¹) was significantly superior by producing the heaviest fresh weight of the total shoot of *Cordia myxa* L. of (351.22 g), that significantly did not differ from the treatment (100 and 50 g. L⁻¹) of (348.69 and 347.32 g) respectively. While the control treatment (0 g. L⁻¹) was of the lowest fresh weight of (298.11 g).
These differences may be resulted from the effect of *Tamarix articulata* Vahl. extract on the fresh weight of the plant that it contains many nutrients contributed directly and indirectly to improve the quality of this weight, such as: (sodium, magnesium, calcium, potassium and other minerals, as well as tamarksin, tannins and sugars such as: glucose, dextrin, fructose, sugar syrup, besides to phenolic compounds) [9, 10].

**Table (3):** Effect of aqueous extract levels for *Tamarix articulata* Vahl. in some vegetative growth characteristics of *Cordia myxa* L. c.v. Local.

| Concentrations of aqueous extract (g. L⁻¹) | Leaf area (cm²) | characteristics studied | fresh weight of shoot (g) |
|------------------------------------------|----------------|--------------------------|--------------------------|
| 0                                        | 37.99          | 17.66                    | 298.11                   |
| 50                                       | 40.73          | 19.40                    | 347.32                   |
| 100                                      | 52.22          | 19.61                    | 348.69                   |
| 150                                      | 50.47          | 19.90                    | 351.22                   |
| Revised L.S.D ≤0.05                      | 3.66           | N.S                     | 6.14                     |

2 - **Effect of aqueous extract levels of *Tamarix articulata* Vahl. on some medically active substances of *Cordia myxa* L. seedlings c.v. Local:**

*Percentage of phenols (%):*

It is clear from Table (4) that the treatment of the aqueous extract of *Tamarix articulata* Vahl. had a significant influence on the percentage of phenols content in leaf, where the treatment of extract (150 g. L⁻¹) recorded the highest concentration of phenols in leaf (3.11%), while the treatment (0 g. L⁻¹) was of the lowest concentration of this substance (1.57%), which significantly did not differ from the treatment of (50 g. L⁻¹) of (2.07%). This result may be due to the fact that phenolic compounds are normally produced by the plant to give it a natural immunity against the fungal and viral diseases, by accumulating in neighboring cells, in addition to its important role in the growth and reproduction of the plant, and it is considered as one of the factors of natural resistance of plants, where they make cell walls impermeable of water and gases, thus being responsible for giving the hardness trait of plants [15].

*Percentage of alkaloids (%):*

Table (4) exhibits the impact of the aqueous extract levels of *Tamarix articulata* Vahl. leaves on the percentage of total alkaloids in leaves of *Cordia myxa* L. where the treatment (150 g. L⁻¹) produced The highest concentration of total alkaloids in the leaf of (9.43%), while the control treatment gave the lowest concentration of alkaloids in the leaf (2.67%), that significantly did not differ from the treatment of (50 g. L⁻¹), Where the rate was (4.56%), The effect of the extract of *Tamarix articulata* Vahl. in increasing the percentage of alkaloids may be attributed to their effect on the genetic expression of secondary metabolites, by which is one of the most effective method for producing the alkaloids in the field of medicinal plants [16]. In addition the aqueous extract levels of *Tamarix articulata* Vahl. leaves plays a role in the regulating of physiological processes such as carbon and nitrates assimilation, and growth, this in turn reflects on the growth of shoot, these processes, which nitrogen is the basis for them, that reflect in the synthesis ad increase of total alkaloids [17].
Table (4) Effect of aqueous extract levels of *Tamarix articulata* Vahl. on some medically active substances of *Cordia myxa* L. seedlings c.v. Local:

| Concentrations of water extract (g. L$^{-1}$) | Percentage of phenol (%) | Percentage of alkaloid (%) |
|---------------------------------------------|--------------------------|----------------------------|
| 0                                           | 1.57                     | 2.67                       |
| 50                                          | 2.07                     | 4.56                       |
| 100                                         | 2.28                     | 7.91                       |
| 150                                         | 3.11                     | 9.43                       |
| Revised L.S.D ≤ 0.05                        | 0.91                     | 2.03                       |

Conclusions:

It is concluded from the current study that the treatment of the aqueous extract of *Tamarix articulata* Vahl. at the level of 150 g. L$^{-1}$ was the superior over all levels which significantly did not differ from the level 100 g. L$^{-1}$ in most of characteristics studied in the current study. As well as the treatment of 50 g. L$^{-1}$ significantly did not differ from the control treatment in most studied traits.

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Appendixes:

**Appendix (1):** *Tamarix articulata* Vahl. tree in our environment.

**Appendix (2):** Drying procedure of *Tamarix articulata* Vahl. leaves.
Appendix (3): Grinding procedure of *Tamarix articulata* Vahl. Leaves.

Appendix (4): Placing of the metal cones inside the pots.

Appendix (5): Placing of the filters of *Tamarix articulata* Vahl. Leaves inside the metal cones which fixed into the soil of pots.
Appendix (6): A method of water application onto the filters of Tamarix articulata Vahl. leaves (for making their extract levels) that placed inside the metal cones which inserted inside the soil of pots where Cordia myxa L. seedlings were cultivated.

Appendix (7): Increasing the growth indicators of Cordia myxa L. seedlings, after one month from treating them with the aqueous extract of Tamarix articulata Vahl. leaves (the treatment was 50 g dry weight of Tamarix articulata Vahl. leaves per one liter of distilled water)

a - At the beginning of treatment  

b - After one month from treatment.