

## Effect of levels salinity water on seedling growth of *Acacia senegal* at the Nursery, North Kordofan state, Sudan

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### Abstract

This study was conducted in Shikan nursery, Elobied, North Kordofan, from three sources of *Acacia senegal* seeds (Al-Rahad, Al-Aabasia and Um- Keradem) at January 2022. This study aims to determine the effect of saline water levels on growth of *Acacia senegal* seedlings. Different salt water levels were used to irrigate seedlings. The response to salt water stress at general level was good with appearance of significant differences at beginning of experiment and these differences disappeared at end of experiment. This indicates that *Acacia senegal* seedlings were more tolerant of salt water stress to the level of 2898 ms/cm total dissolved salts (T.D.S), can be used for irrigation, especially for *Acacia senegal* seedlings with a pH between (7.1-8.4). To reduce seedling death, low salinity levels can be relied upon.

**Keywords:** Salinity water; Growth; Seedlings

### 1. Introduction

Gum Arabic belt in Sudan is characterized by a variety of climates and soils, which gave it many advantages that made *Acacia senegal* trees have multiple characteristics based on their location. *Acacia senegal* trees were used to improve soil fertility in sandy soils and in fallow jungle systems [1]. Trees are dying due to drought and various climatic changes and has increased in recent decades [2], which is it is expected to increase further due to globalization warming and desertification, especially already different ecosystems [3].

*Acacia senegal* trees varies from coarse deep sandy soil to dry rocky soil, slightly acidic to moderately alkaline. This makes it not bear water saturation [4]. Water salinity has been defined as the condition of water characterized by a high concentration of dissolved salts [5],[6]. Salinity is one of the most significant environmental challenges limiting plant productivity; particularly in arid and semi-arid climates.

Water of different salinity is abundant in semi-arid and dry areas where the amount of rain is insufficient for use throughout the year. In Kordofan a productive land and multiple water resources were exploited at a rapid rate there was a need to prove the value of multiple water resources Salinity level for beneficial plants and crops in the early stages of germination. The genetic variation of several environmental geographic conditions and the variation of water levels, and this difference exists along the belt of the plant community and gradients in latitude, altitude and humidity [7]. The phenomenon of salinization and a decrease in arable water it is one of the major challenges facing agriculture. Expansion and increase productivity, and the use of saline water in it irrigation has become popular to counter the scarcity of fresh water and insufficient for different uses. Scientific use of salt water one of the alternatives to meet agricultural needs and water deficit [8]. Salt stress is one of the most dangerous environmental pressures that limit the growth and productivity of most plant species [9]. The ability of plants to function under low-moisture soil conditions depends on their ability to adjust acclimatization and offset the harmful effect of negative potential of water in soil and air [10].

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Recent Studies indicate significant genotype variation in physiological and morphological adaptation to stress, especially drought, in tree species. These changes in water salinity levels may lead to these imbalances for some tree species. *Acacia senegal* (L.) Willd. (Mimosaceae), where there were different types of trees gum arabic belt and varied soils in these areas.

It is necessary to study this aspect and be an extension of other studies. The objective of this paper to effect of irrigation with saline water on the growth of *Acacia senegal* seedlings in the nursery for different seed sources.

## 2. Material and methods

Seeds were collected from trees during the maturity season of tree seeds from sandy soil areas (Um-Keradem), clay soil areas (Al-Aabasia) and Gardud soil areas (Al-Rahad) table (1).

**Table 1** Different seed sources for collecting *Acacia senegal* seeds

| Provenance | Soil Type | Latitude  | Longitude | Temperature Max - Min Co | Rainfall |
|------------|-----------|-----------|-----------|--------------------------|----------|
| Al-Rahad   | Gardud    | 28o-30N   | 30o-14E   | 35 - 16                  | 320+     |
| Al-Aabasia | Clay      | 12o - 12N | 31o-17E   | 35 - 18.5                | 625+     |
| Um-Keradem | Sandy     | 13.653N   | 29.74E    | 40.5 - 14.4              | 300-350  |

A sample was taken from different water sources in a glass beaker, then the Ec meter device was used to find the value of the electrical conductivity of the samples and to find the value of the total dissolved salts, the value of the electrical conductivity was multiplied x 0.7.

**Table 2** Analysis of total dissolved salts (T.D.S) at different water levels

|    | Cl(mgl) | Na(mgl) | K(mgl) | Ca(mgl) | Mg(mgl) | T.D.S(mgl) |
|----|---------|---------|--------|---------|---------|------------|
| T1 | 106.5   | 60.3    | 5.2    | 28      | 15.8    | 533.4      |
| T2 | 85.2    | 80.7    | 28.7   | 61.6    | 90.8    | 871.5      |
| T3 | 78.2    | 99.98   | 6.1    | 88      | 56.2    | 815.5      |
| T4 | 291.1   | 451.7   | 23.3   | 385.6   | 167.6   | 2898       |

The experiment was conducted in Shikan Forest Nursery, and it is a factorial experiment in a Completely Randomized Design (CRD). The experiment includes 3 water levels (815 - 871 - 2898) ms/cm of salinity water, and addition to control (533ms/cm), 3 seed sources, 3 replicates, 2 quantities of water and 8 bags of experiment units (3x4x3x8x2=576).Seeds were planted in plastic bags of small size (20x10cm), which containing the nursery soil, where holes were made on bags in lower third of bag in order to drain the excess water from plants need so as not to lead to rotting of seeds, the seeds are irrigated with one type of water for 30days to ensure their germination.

### 2.1. Seedling growth

The number of seeds in one bag is 3 seeds, after which different treatments and amounts of water were introduced. Seedlings were irrigated with 220 ml i.e. 100% where 4 samples were taken from each seed source and were measured (height, diameter, number of leaves, number of leaves and number of dead seedlings). Seedlings were watered with different water levels daily until the end of the experiment, and duration of this experiment was 3 months. Then measurements were taken every two weeks for two months, where a measurement (root length, shoot length, branches and root diameter) was taken one month, where second measurement was taken 30 days after first measurement.

### 2.2. Survival rate

The number of live seedlings was calculated one month after entered treatments that is two months after planting the seeds, where the following equation was used to find the life or survival rate.

$$\text{Survival rate} = \frac{\text{No. liveseedlings}}{\text{No. totalseedlings}} \times 100$$

### 2.3. Biomass

36 seedlings were taken from each different source. Shoot was separated from root system, and each part was weighed separately to find wet weight. Then samples were entered into an electric oven for drying at a temperature of 60co for 24 hours, and then they were weighed to find dry weight.

### 2.4. Data analysis

After making the required laboratory measurements and estimations, the data entered into Excel was used to calculate some equations and format the data for analysis. Statistics by ANOVA using SAS software then compare means using Duncan test.

## 3. Results

**Table 3** The mean growth of *Acacia senegal* seedlings for different seed sources before irrigation with water levels (Four week old)

| Seed sources | Parameters         |                           |                    |                    |
|--------------|--------------------|---------------------------|--------------------|--------------------|
|              | Shoot Length (cm)  | Root collar diameter (mm) | No. ofLeaves       | No. ofLeaflets     |
| Al-Rahad     | 13.98 <sup>A</sup> | 1.46 <sup>A</sup>         | 11.25 <sup>A</sup> | 21.83 <sup>A</sup> |
| Al-Aabasia   | 14.5 <sup>A</sup>  | 1.59 <sup>A</sup>         | 10.31 <sup>A</sup> | 20.18 <sup>A</sup> |
| Um-Keradem   | 15.71 <sup>A</sup> | 1.57 <sup>A</sup>         | 12.06 <sup>A</sup> | 22.29 <sup>A</sup> |
| Mean         | 14.73              | 1.58                      | 11.21              | 21.79              |
| SE±          | 2.31               | 0.23                      | 2.46               | 4.91               |
| SD±          | 4                  | 0.39                      | 4.26               | 8.5                |
| CV%          | 27.16              | 24.68                     | 38                 | 39                 |

Shows that growth of *Acacia senegal* seedlings for different provenances in the fourth week before irrigation with water level, with no significant differences level (0.05) for each of length and root collar diameter, number of leaves and leaflets Table (3).

**Table 4** The mean growth of *Acacia senegal* seedlings for different seed sources (Six week old)

| Seed sources | Parameters         |                           |                    |                    |
|--------------|--------------------|---------------------------|--------------------|--------------------|
|              | Shoot Length (cm)  | Root collar diameter (mm) | No. of Leaves      | No. of Leaflets    |
| Al-Rahad     | 13.98 <sup>B</sup> | 1.46 <sup>B</sup>         | 11.25 <sup>A</sup> | 21.83 <sup>A</sup> |
| Al-Aabasia   | 14.5 <sup>AB</sup> | 1.63 <sup>A</sup>         | 10.31 <sup>A</sup> | 20.18 <sup>A</sup> |
| Um-Keradem   | 15.71 <sup>A</sup> | 1.64 <sup>A</sup>         | 12.06 <sup>A</sup> | 23.35 <sup>A</sup> |
| Mean         | 14.73              | 1.58                      | 11.21              | 21.79              |
| SE±          | 2.31               | 0.23                      | 2.46               | 4.91               |
| SD±          | 4                  | 0.39                      | 4.26               | 8.5                |
| CV%          | 27.16              | 24.68                     | 38                 | 39                 |

In the sixth week old of *Acacia senegal* seedlings growth, appeared high significant differences at level (0.005), when irrigating with water of different salinity for each of shoot length and number of leaflets, and there were significant differences for diameter and number of leaves.

Among the results, Um keradem seedlings recorded the highest shoot length (15.71 cm) and root collar diameter (1.64 mm) compared to other seed sources, while Al-Rahad recorded the least significant difference in seedlings length (13.98 cm) as well in root collar diameter (1.46 mm) table (4).

**Table 5** Effect of water saline level on *Acacia senegal* seedlings for three seed sources (Six week old seedlings).

| Water levels | Parameters         |                           |                    |                    |
|--------------|--------------------|---------------------------|--------------------|--------------------|
|              | Shoot Length (cm)  | Root collar diameter (mm) | No. ofLeaves       | No. ofLeaflets     |
| T1           | 13.68 <sup>B</sup> | 1.51 <sup>BC</sup>        | 11.58 <sup>A</sup> | 22.58 <sup>A</sup> |
| T2           | 16.12 <sup>A</sup> | 1.64 <sup>AB</sup>        | 12.47 <sup>A</sup> | 24.55 <sup>A</sup> |
| T3           | 15.81 <sup>A</sup> | 1.72 <sup>A</sup>         | 11.69 <sup>A</sup> | 22.61 <sup>A</sup> |
| T4           | 13.31 <sup>B</sup> | 1.44 <sup>C</sup>         | 9.08 <sup>B</sup>  | 17.41 <sup>B</sup> |
| SE±          | 2                  | 0.19                      | 2.13               | 4.25               |
| SD±          | 4                  | 0.39                      | 4.26               | 8.5                |
| CV%          | 27.17              | 24.94                     | 37.98              | 39.01              |

T1: Normal water; T2: Nursery water; T3: Pump water1; T4: Pump water2

Table (5) which shows the mean growth of *Acacia senegal* seedlings and the effect of different salinity water levels in the sixth week old, where we find the results of seedling length with significant differences, and nursery and pump1 had the highest height (16.12 and 15.81cm) respectively. Pump 1 recorded the largest root collar diameter compared to the other water levels (1.72 mm), while pump 2 recorded the lowest root collar diameter (1.44 cm). The pump2 recorded the lowest value number of seedling (9.08 and 17.41), respectively, while the other water levels were more numerous for leaves and leaflets and there were no significant differences between them, nursery (12.47 and 24.55), pump1 (11.69 and 22.61) and normal water (11.58 and 22.58) respectively.

**Table 6** The mean growth of *Acacia senegal* seedlings for different seed sources (Eight week old)

| Seed sources | Parameters         |                           |                    |                    |
|--------------|--------------------|---------------------------|--------------------|--------------------|
|              | Shoot Length (cm)  | Root collar diameter (mm) | No. of Leaves      | No. ofLeaflets     |
| Al-Rahad     | 16.69 <sup>A</sup> | 1.81 <sup>B</sup>         | 15.18 <sup>A</sup> | 29.85 <sup>A</sup> |
| Al-Aabasia   | 16.2 <sup>A</sup>  | 1.7 <sup>B</sup>          | 13.22 <sup>A</sup> | 25.75 <sup>A</sup> |
| Um-Keradem   | 17.25 <sup>A</sup> | 1.99 <sup>A</sup>         | 13.52 <sup>A</sup> | 26.7 <sup>A</sup>  |
| Mean         | 16.71              | 1.83                      | 13.97              | 27.43              |
| SE±          | 2.94               | 0.25                      | 3.76               | 7.47               |
| SD±          | 5.09               | 0.43                      | 6.51               | 12.93              |
| CV%          | 30.46              | 23.5                      | 46.59              | 47.14              |

The eight week old of *Acacia senegal* growth from different seed sources, there were no significant differences in shoot length and number of leaves and leaflets for seedlings, while there were high significant differences for root collar diameter level (0.005).

Table (6), Um-Kredem showed the largest value for root collar diameter (1.99 mm), and Al-Rahad and Al-Abbasiya were recorded lowest value (1.81 and 1.70 mm), respectively.

**Table 7** Effect of water saline level on *Acacia senegal* seedlings for three seed sources (Eight week old seedlings)

| Water level | Parameters          |                           |                    |                    |
|-------------|---------------------|---------------------------|--------------------|--------------------|
|             | Shoot Length (cm)   | Root collar diameter (mm) | No. of Leaves      | No. of Leaflets    |
| T1          | 16.36 <sup>AB</sup> | 1.82 <sup>AB</sup>        | 13.11 <sup>A</sup> | 25.69 <sup>A</sup> |
| T2          | 17.95 <sup>A</sup>  | 1.92 <sup>A</sup>         | 15.25 <sup>A</sup> | 30.05 <sup>A</sup> |
| T3          | 17.5 <sup>AB</sup>  | 1.91 <sup>A</sup>         | 14.41 <sup>A</sup> | 28.19 <sup>A</sup> |
| T4          | 15.05 <sup>B</sup>  | 1.69 <sup>B</sup>         | 13.13 <sup>A</sup> | 25.8 <sup>A</sup>  |
| Mean        | 16.72               | 1.84                      | 13.98              | 27.43              |
| SE±         | 2.55                | 0.22                      | 3.26               | 6.47               |
| SD±         | 5.09                | 0.43                      | 6.51               | 12.93              |
| CV%         | 30.46               | 23.5                      | 46.59              | 47.14              |

T1: Normal water; T2: Nursery water; T3: Pump water1; T4: Pump water2

In water of different salinity at eighth week old, the nursery showed the longest shoot length (17.95 cm) and the largest value of the root collar diameter (1.92 mm) and pump 2 recorded the lowest length (15.05 cm) and root collar diameter (1.69 mm) Table (7).

**Table 8** The mean growth of *Acacia senegal* seedlings for different seed sources (Tenth week old)

| Seed sources | Parameters         |                           |                    |                    |
|--------------|--------------------|---------------------------|--------------------|--------------------|
|              | Shoot Length (cm)  | Root collar diameter (mm) | No. of Leaves      | No. of Leaflets    |
| Al-Rahad     | 19.04 <sup>A</sup> | 2.02 <sup>A</sup>         | 15.5 <sup>A</sup>  | 30.41 <sup>A</sup> |
| Al-Aabasia   | 17.58 <sup>A</sup> | 1.93 <sup>A</sup>         | 14.68 <sup>A</sup> | 29.18 <sup>A</sup> |
| Um-Keradem   | 18.07 <sup>A</sup> | 2.07 <sup>A</sup>         | 13.58 <sup>A</sup> | 26.83 <sup>A</sup> |
| Mean         | 18.23              | 2.01                      | 14.59              | 28.81              |
| SE±          | 2.94               | 0.27                      | 4.55               | 9.12               |
| SD±          | 5.1                | 0.47                      | 7.88               | 15.79              |
| CV%          | 28                 | 23.42                     | 53.98              | 54.83              |

Similar letters in the columns there are no significant differences

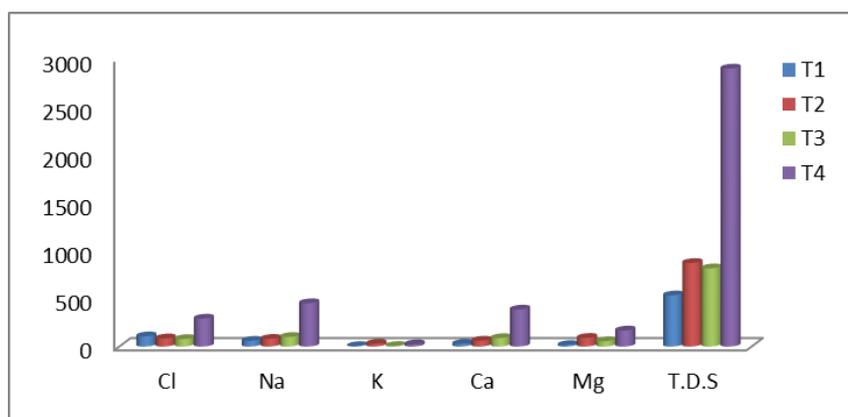
**Figure 1** Analysis of dissolved salts at different of water levels

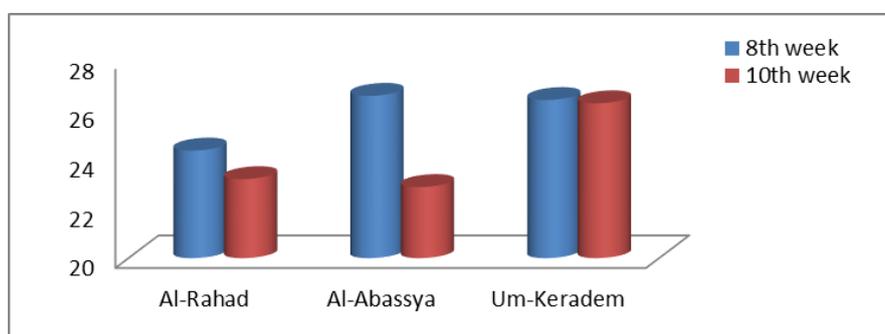
Table (8) in the tenth week old of *Acacia senegal* seedlings growth, there were no significant differences level (0.05) for each of length, root collar diameter, leaves and leaflets (Appendix .4).

**Table 9** Effect of water saline level on *Acacia senegal* seedlings for three seed sources (Ten week old seedlings)

| Water level | Parameters         |                           |                    |                    |
|-------------|--------------------|---------------------------|--------------------|--------------------|
|             | Shoot Length (cm)  | Root collar diameter (mm) | No. of Leaves      | No. of Leaflets    |
| T1          | 16.83 <sup>A</sup> | 2.1 <sup>A</sup>          | 12.83 <sup>A</sup> | 25.5 <sup>A</sup>  |
| T2          | 19.37 <sup>A</sup> | 1.95 <sup>A</sup>         | 14.8 <sup>A</sup>  | 29.02 <sup>A</sup> |
| T3          | 18.86 <sup>A</sup> | 2.01 <sup>A</sup>         | 15.36 <sup>A</sup> | 30.52 <sup>A</sup> |
| T4          | 17.86 <sup>A</sup> | 1.97 <sup>A</sup>         | 15.36 <sup>A</sup> | 30.19 <sup>A</sup> |
| Mean        | 18.23              | 2.01                      | 14.59              | 28.81              |
| SE±         | 2.55               | 0.24                      | 3.94               | 7.89               |
| SD±         | 5.1                | 0.47                      | 7.88               | 15.79              |
| CV%         | 28                 | 23.42                     | 53.98              | 54.83              |

T1: Normal water; T2: Nursery water; T3: Pump water1; T4: Pump water2

Table (9) the mean growth of *Acacia senegal* seedlings, there were no significant different between different water levels (0.05).



**Figure 2** Mean root length of *Acacia Senegal* seedlings for different seed sources at 8<sup>th</sup> 10<sup>th</sup> weeks old

From the results of the destructive sampling of different seed sources and saline water levels, there were no significant differences between them in the 8<sup>th</sup> and 10<sup>th</sup> weeks old Figure (1) and Figure (2).

**Table 10** The biomass characteristics of *Acacia senegal* seedlings from different seed sources

| Seed sources | Parameters         |                    |                    |                    |                    |                    |
|--------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|              | Wet shoot(g)       | Dry shoot(g)       | W-D shoot          | Wet root           | Dry root           | W-D root           |
| Al-Rahad     | 0.669 <sup>A</sup> | 0.32 <sup>A</sup>  | 0.349 <sup>A</sup> | 0.508 <sup>A</sup> | 0.268 <sup>A</sup> | 0.24 <sup>A</sup>  |
| Al-Aabasia   | 7.413 <sup>A</sup> | 0.344 <sup>A</sup> | 7.068 <sup>A</sup> | 0.503 <sup>A</sup> | 0.245 <sup>A</sup> | 0.258 <sup>A</sup> |
| Um-Keradem   | 0.674 <sup>A</sup> | 0.325 <sup>A</sup> | 0.349 <sup>A</sup> | 0.475 <sup>A</sup> | 0.253 <sup>A</sup> | 0.223 <sup>A</sup> |
| Mean         | 2.918              | 0.329              | 2.588              | 0.493              | 0.255              | 0.24               |
| SE±          | 7.72               | 0.08               | 7.72               | 0.14               | 0.08               | 0.07               |
| SD±          | 13.37              | 0.13               | 13.37              | 0.24               | 0.13               | 0.12               |
| CV%          | 458.21             | 40.33              | 516.44             | 48.76              | 49.58              | 48.59              |

Similar letters in the columns there are no significant differences

**Table 11** The biomass characteristics of *Acacia senegal* seedlings from different saline water

| Water levels | Parameters         |                    |                    |                    |                    |                    |
|--------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|              | Wet shoot(g)       | Dry shoot(g)       | (W-D) shoot        | Wet root           | Dry root           | (W-D) root         |
| T1           | 0.557 <sup>A</sup> | 0.264 <sup>A</sup> | 0.292 <sup>A</sup> | 0.337 <sup>A</sup> | 0.171 <sup>A</sup> | 0.166 <sup>A</sup> |
| T2           | 0.728 <sup>A</sup> | 0.342 <sup>A</sup> | 0.386 <sup>A</sup> | 0.513 <sup>A</sup> | 0.271 <sup>A</sup> | 0.242 <sup>A</sup> |
| T3           | 0.738 <sup>A</sup> | 0.363 <sup>A</sup> | 0.374 <sup>A</sup> | 0.564 <sup>A</sup> | 0.281 <sup>A</sup> | 0.283 <sup>A</sup> |
| T4           | 9.652 <sup>A</sup> | 0.348 <sup>A</sup> | 9.303 <sup>A</sup> | 0.567 <sup>A</sup> | 0.297 <sup>A</sup> | 0.27 <sup>A</sup>  |
| Mean         | 2.918              | 0.329              | 2.588              | 0.495              | 0.255              | 0.24               |
| SE±          | 6.69               | 0.07               | 6.69               | 0.12               | 0.07               | 0.06               |
| SD±          | 13.37              | 0.13               | 13.37              | 0.24               | 0.13               | 0.12               |
| CV%          | 458.21             | 40.33              | 516.44             | 48.76              | 49.58              | 48.59              |

Similar letters in the columns there are no significant differences

Table (10 and 11) there were no significant differences in all measuring of biomass of *Acacia senegal* seedlings.

#### 4. Discussion

The seeds that seem important in the production of these trees from gum bear many of the qualities that mother tree was exposed, which have direct contributions to increasing local and national income, while these trees are widely spread in Sudan in different areas within the Gum Arabic zoon. Plants in arid regions are usually exposed to a series of drought stresses where rainfall is variable and discontinuous and recurring drought cycles naturally occur. However, trees follow different approaches to survival through mechanisms of drought avoidance, tolerance and adaptation to salt water levels [11].

From the results of *Acacia senegal* seedlings whose seeds were collected from different sources (Al-abassya, Al-Rahad and Um-Keradem), soil, climate, environment and rainfall within the gum arabic zoon, and to subjected to water levels of different salinity. The measurement of seedlings began in the fourth week old, where the differences were few when watering with one level of irrigation, but when the levels of irrigation were varied and there was a clear superiority in the seed sources for the seedlings, Um-Keradem showed the length and thickness of the seedlings and it continued until the tenth week old. This corresponds to germination speed shown by quality of these seeds, which enables it to establish in different water levels salinity. The seedlings continue to grow during stages from fourth to the tenth week old with differences in the different growth characteristics by watering them with different water sources of salinity.

Salinity is one of the most important a biotic factors affecting plant growth and productivity. The negative effects of salt on plant growth were initially associated with the component of osmotic stress caused by reduced soil water potential, thus restricting root water uptake[12].This is consistent with the study by continuing to the foundation stage and adapting it to the different salinity influences.

Excess salinity in water is considered one of the water stresses for plants, and the degree of tolerance to salinity varies from one plant to another and adapts, but it may face some problems at the beginning of growth, such as stomata, low rate of photosynthesis and eventually death, and this corresponds to [13], [14] .

Water levels gave the best growth performance after seedling establishing (ten weeks old). This confirms that seedlings at the beginning of growth were subject to many external and internal factors that affect them and may lead to their death or weakening and were difficult to establish in the natural growth. Water levels whose salinity ranges between (533.4 to 2898 ms/cm) can be used for irrigation, especially for *Acacia senegal* seedlings with a ph between (7.1-8.4), and to reduce losses, it is possible to rely on less salinity levels.

#### 5. Conclusion

This work was done by using different water levels to irrigate one-month-old seedlings from different seed sources. The response to salt water stress at general level was good with appearance of significant differences at beginning of

experiment and these differences disappeared at end of experiment. This indicates that *Acacia senegal* seedlings were more tolerant of salt water stress to the level of 2898 ms/cm total dissolved salts (T.D.S), can be used for irrigation, especially for *Acacia senegal* seedlings with a ph between (7.1-8.4), and to reduce losses, it is possible to rely on less salinity levels.

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## Compliance with ethical standards

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### Disclosure of conflict of interest

All authors agree to publish for this article; the first author he collected data and conducted the experiments, the second and third author's analyzed and prepared the article for publication.

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