EFFECT OF FOLIAR APPLICATIONS ON *TERMINALIA ARJUNA* SEEDLINGS UNDER DROUGHT AND SALT STRESSES IN EGYPT AND SUDAN

By

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Thesis
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Departement of Natural Resources
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THESIS
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Under Supervision of

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عنوان الرسالة: تأثير معاملات الرش الورقي علي شتلات الترمينااليا تحت تأثير الإجهاد المائي والملحي في مصر والسودان
المشرفون: **الأستاذة الدكتورة**: أميرة شوقى سليمان
الأستاذ الدكتور: فيصل محمد سعداوى
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قسم: الموارد الطبيعية **تاريخ منح الدرجة**: / / 2021

المستخلص العربى

لمعرفة تأثير معاملات الرش (السالسيليك أسيد ومستخلص أوراق المورينجا ومستخلص الطحالب) على تحمل شتلات الترمينااليا للملوحة أو الجفاف أجريت هذه الدراسة في مشتل قسم بحوث نباتات الزينة، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر، في مارس خلال موسمي 2016–2017/ 2017–2018، حيث أجريت على شتلات نبات تيرمينااليا أرجونا تجربتين في مواعيد ري (4، 8، 16 أيام) ومستويات ملوحة (2000، 4000، 6000 ppm). ويمكن تلخيص النتائج كالأتى: فى التجربة الأولى، حققت معاملة الري 4 أيام + مستخلص الطحالب بتركيز 7.5% أعلى نتيجة للصفات الخضرية، بينما جاءت معاملة الري 8 أيام + مستخلص الطحالب 7.5% فى المرتبة التالية مباشرة بالنسبة إلى طول النبات وسمك الساق والوزن الخضري الطازج. في التجربة الثانية، حققت معاملة 2000 ppm ملوحة + مستخلص المورينجا 10.0% أعلى نتيجة لطول النبات وطول الجذور، بينما جاءت معاملة 4000 ppm ملوحة + مستخلص الطحالب 7.5% فى المرتبة الثانية مباشرة بالنسبة إلى سمك الساق والوزن الطازج للجذور وطول الجذور، بالإضافة إلى محتوى كلوروفيل "أ" وكلوروفيل "ب" ونسبة النيتروجين والفوسفور والكالسيوم. للحصول على أفضل نتيجة يوصى باستخدام التالى : **التجربة الأولى**: الرى كل 8 أيام + الرش بمستخلص الطحالب 7.5% : أعطى أعلى نتيجة للصفات الخضرية . عند الرى كل 8 أيام سيعمل على توفير الوقت والمال والأيدى العاملة لذلك يوصى بشدة باستخدام هذه المعاملة. **التجربة الثانية**: الملوحة بتركيز 4000 جزء فى المليون + مستخلص الطحالب 7.5 % أحرزت أفضل النتائج.

الكلمات الدالة: ترمينااليا أرجونا، معاملات رى، جفاف، ملوحة، حمض السالسيليك، مستخلص المورينجا، مستخلص الطحالب

Name of Candidate: Shohra Abdel-Twab Abdel-Kader **Degree:** Ph.D.
Title of Thesis: Effect of Foliar Applications on *Terminalia arjuna* Seedlings under Drought and Salt Stresses in Egypt and Sudan
Supervisors: Prof. Dr. Amira Shawky Soliman
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Dr. Mohamed Said Abbas

Department: Natural Resources **Approval: / / 2021**

ABSTRACT

This study was carried out at the nursery of the Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt in the two seasons of 2016/2017 and 2017/2018, to investigate the effect of foliar spray of salicylic acid at 0.5, 1.0 and 1.5 mM, moringa leaf extract at 2.5, 5.0 and 10% and seaweed extract at 2.5, 5.0 and 7.5% on the tolerance of *Terminalia arjuna* seedlings to drought and salinity. The seedlings were subjected to 2 experiments: The first experiment aimed to determine the effect of foliar applications with irrigation intervals at 4, 8 and 16 days. The second experiment aimed to study the effect of foliar applications with salinity levels at 2000, 4000 and 6000 ppm NaCl. The experiments were designed as factorial in a completely randomized design. The results could be summarized as the following: In the first experiment, irrigated plants at 4 days + seaweed extract 7.5% and /or moringa leaf extract at 10% achieved the highest results for all vegetative growth characters and contents of chlorophyll a, chlorophyll b, carotenoids, total carbohydrates, N,P,K, and Ca, compared to other treatments. In the second experiment, salinity at 2000 ppm + seaweed extract at 7.5% and / or moringa leaf extract at 10.0% treatments obtained the best results of all vegetative growth characters and the contents of more chemical constituents compared to other treatments. Also, salinity at 6000 ppm NaCl + seaweed at 7.5% gave the highest proline content.

Keywords: *Terminalia arjuna*, Irrigation intervals, Drought, Salinity, Salicylic acid, Moringa extract, Seaweed extract.

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I. INTRODUCTION

***Terminalia arjuna* (Roxb) (Indian almond)** belongs to Family Combretaceae, and is commonly known as arjuna **(Hussain *et al.*, 1992)**. It has important medicinal value. The genus comprised nearly 200 species, distributed around the world, especially India and Africa (**Sharma *et al.*, 2005**).The genus *Terminalia* is the second largest genus of Combretaceae family distributed in the tropics and subtropics. About 30 species of *Terminalia* are found in Africa **(Wickens, 1973)**. The African species *Terminalia prunioides*, *Terminalia brachystemma, Terminalia gazensis, Terminalia mollis* and *Terminalia sambesiaca* **(Masoka and Eloff, 2007)**.

Stem bark is a large evergreen spreading tree growing up to 25 meters; the bark is thick, with buttressed trunk, light brown peeling bark **(Ali, 1994)**. **Leaves** are like that of guava leaves 10-25 cm long, 4-9 cm broad, oblong, a pair of gland is present on the leaf blade. **Flowers** are pale yellowish- white, 7.5 cm long spike, fruit is drupe, 2.5-5.5 cm long with five wings (**Troup, 1985**). Flowering starts after 7 years of planting, begins in April and extends to May, with the fruit ripening the following February-May, nearly a year after the appearance of the flowers **(Kramer and Kozlowki, 1979)**. **Fruits:** The fruits are 1-1.5 inch in diameter and with 5-7 longitudinal lobes. These are glabrous with 5-7 wings, woody and fibrous. Fruit is drupe and is often notched near the top**. (Ali, 1994; Mitra, 1985).**

Arjuna is propagated by seeds and stump planting (**Kumari, 1998)**. Germination takes about 50-70 days with 50-60% germination (**Hartmann *et al.*, 1997).** The plant survives in open sunny and low-rainfall areas. Seedlings are sensitive to drought and frost, but grow well if moisture is available. The tree prefers neutral soils (pH 6.5-7.0), alluvial loamy soils, which are loose, moist, fertile, and have good drainage and water holding capacity. It can also grow on saline, sodic and waterlogged sites, **(Kadambi, 1954**). **Orwa *et al.***, (**2009**) observed that seedlings of *Terminalia arjuna* are susceptible to fire, drought and frost.

The chemical constituents of Arjuna present in root bark, stem bark, leaves, seeds, and fruits. The root contains triterpenoids and glycosides, fruit contains triterpenoids and flavonoids, leaves and seeds contain flavonoids and glycosides. However, bark is considered the most important constituent from medicinal point because it contains flavonoids, glycosides, polyphenols, tannins, triterpenoids, saponins, sterols and minerals such as calcium, magnesium, zinc, copper; besides amino acids also **(Chaudhari and Mahajan, 2015; Chaudhari and Mengi, 2006)**. Bark had 34% ash content consisting entirely of pure calcium carbonate. Aqueous extract of *Terminalia arjuna* is reported to have 23% calcium salts and 16% tannins **(Anonymous, 1999; Chitlange *et al.,* 2009)**.

Terminalia arjuna has been widely used in Ayurvedic medicine for the treatment of cancer, dermatological and gynaecological complaints, heart diseases and urinary disorders. The bark is acrid, astringent and tonic, and is useful in treatment of high blood pressure and ulcers. The cancer cell growth inhibitory constituent (luteolin) has been isolated from bark, stem and leaves. Luteolin has also been shown to have specific antibacterial activity against *Neisseria gonorrhea*. It can also be used as an alexiteric, styptic, tonic and anthelmintic and it is useful in fractures, inflammation and wounds and ulcers **Orwa *et al.*, (2009)**. It has antioxidant, anti-ischemic, antihypertensive and antihypertrophic effects, which have relevance to its therapeutic potential in cardiovascular diseases. Its efficacy, mostly in patients with ischemic heart disease, hypertension and heart failure, besides its potent antibacterial and antimutagenic activities were also reported **(Kapoor, 1990; Bone, 1996; Maulik and Talwar, 2012).** It is widely planted for raising tassar silkworm and livestock fodder in India where leaves are heavily lopped. The leaves contain 9-11% crude protein and 14-20% crude fibre. Timber is locally used for carts, agricultural implements, water troughs, traps, boat building, house building, electric poles, tool-handles and jetty-piles. It is planted for shade or ornament in avenues and parks. In coffee plantations it is an excellent shade tree. **Dutta, (1995).**

Due to climate changes, drought and salinity are predicted to be widespread all over the world (**Dai, 2011**). Various environmental stresses *viz.* extreme temperatures, soil salinity, drought and flood have affected the production and cultivation of agricultural crops. Soil salinity is one of the most devastating environmental stresses, which causes major reductions in cultivated land area (**Shahbaz and Ashraf, 2013**). Abiotic stresses, such as drought and high salt stress, are thought to be the main factors adversely affecting plant growth and crop productivity, which limit global agricultural production **(An *et al.*, 2015)**.

Drought is defined as one of the most limiting factors for plant growth and yield, which causes changes at molecular and physiological level. It influences on plant primary processes such as photosynthesis and cell growth, through direct and/or secondary effects. It is one of the most important and prevalent stress factors for plants in many parts of the world, especially in arid and semiarid areas as mentioned by **Chaves *et al.* (2009).** Plants respond to water deficit according to the length and severity of water deficiency as well as plant species, age, and developmental stage (**Salehi-Lisar *et al.*, 2016**).

Redha *et al.*, (2012) revealed that the accumulation of proline in *Conocarpus lancifolius* took place after exposure of the plants to drought. **Alavi-Samani *et al.*, (2013)** manifested that water deficit reduced plant height and dry weights of *Thymus vulgaris* and *Thymus daenensis*. **Bahreininejad *et al.*, (2013)** indicated that plant height, total dry matter and chlorophyll and carotenoids contents of *Thymus daenensis* were significantly reduced under drought stress. Furthermore**, Zafar *et al.*, (2014)** on *Helianthus annuus* L., maintained that the highest chlorophyll content was related to normal irrigation. Drought stress at different growth stages led to decrease chlorophyll content in the leaves. **Koushki *et al.*, (2015)** showed that among 3 irrigation levels (6, 12 and 18 days), 6 days irrigation interval had the best effect on plant height, fresh weight, dry weight and leaf number. There was no significant difference between 6 and 12 days irrigation interval. **Tavousi *et al.*, (2015)** on pomegranate stated that irrigation deficit causes a significant decrease in crop yield compared to full irrigation. **Talebnejad and Sepaskhah,** (**2016**) informed that abiotic stresses lead towards reduction in number of branches and leaves in addition to stunted shoot growth.

Salinity is the accumulation of Na^+ and Cl^- ions in tissues of plants exposed to soils with high NaCl concentrations, which causes severe ion imbalance and excess uptake might cause inhibition to uptake of K^+ ions which is an essential element for growth and development **(James *et al.*, 2011**). Salinity limits plant growth by adversely affecting various physiological and biochemical processes like photosynthesis, antioxidant phenomena, and nitrogen metabolism **(Mehr *et al.*, 2012; and Wu *et al.*, 2014)**. It is one of the major environmental stresses that negatively impacts agricultural productivity on a global scale, accounting for 1.5 million ha agricultural land loss every year **(FAO, 2015)**. Approximately 22% of the world's agricultural land is saline **(FAO, 2017)**. A decrease in plant biomass, leaf area, and growth has been observed in different vegetable crops under salt stress **(Giuffrida *et al.*, 2013)** and **Mousavi *et al.*, (2013)** manifested that NaCl significantly inhibit the germination percentage at all salinity levels. Salinity stress is thought to result in production of reactive oxygen species (ROS) in plants causing oxidative stress **(Sharma *et al.*, 2012)**. In addition, **Shaheen *et al.* (2013); Xu and Mou, (2016)** stated that salt stress causes a nutrient imbalance due to the limited uptake of the nutrients from the soil. Nutrient availability is compromised by salinity that causes several disorders such as competitive uptake with other ions like Ca^{2+}, P and K, mobility problems within the plant and a reduced water potential.

Although germination in *Terminalia arjuna* was highly sensitive to salt stress, young plants can tolerate medium salt stress due to their ability to sustain CO_2 assimilation rate and increase water use efficiency (**Zafar *et al.*, 2019 a**). Seedlings of *Terminalia arjuna* are susceptible to fire, drought and frost (**Orwa *et al.*, 2009**). **Tomar and Gupta, (1985)** stated that *Terminalia arjuna* can tolerate salinity of

EC ranged between 7-10 mmhos/cm (4000-6000 ppm) if salinity was associated with high water table conditions.

Salicylic acid (SA), ubiquitously distributed in the plant kingdom, derives its name from the word '*Salix*', meaning willow tree in Latin (**Raskin *et al.*, 1990)**. The Greeks have been using the leaves and bark of willow trees as pain killer and anti-pyretic. Salicylic acid should be considered as a growth regulator **(Raskin, 1992)**.

It is considered to be one of the key signals in plant defense mechanisms, and its relationship with plant stress resistance. It also plays important roles in tolerance to a biotic stresses, such as those induced by salt, heat, and heavy metals **(Kang *et al.*, 2014)**. Also **Miura and Tada, (2014)** mentioned that SA plays an important role in improving the tolerance of important crops in response to a biotic stresses, like drought and salinity, the utility of SA is dependent on the concentration, the mode of application, and the stage of the plants. However, it is considered as an active antioxidant that ameliorates the adverse effect of salt salinity stress **(Hussein and Abou-Baker, 2014 and Li *et al.*, 2014).** Among the phenolic compounds, salicylic acid (SA) is a naturally occurring plant hormone acting as an endogenous signal molecule in plant resistance to environmental stresses as mentioned by **(Sofy *et al.*, 2020).**

Moringa oleifera **Howladar, (2014)** manifested that extract (MLE) contains powerful natural antioxidants, which can be used by crop producers for crop plants to improve growth and yield attributes of various crops, and to overcome environmental stresses. **Rady *et al.*, (2013)** stated that *Moringa* leaf extract contains antioxidants including proline and phytohormone such as indole acetic acid (IAA), gibberllines and cytokinins which improve plant growth, metabolism and antioxidant enzymes. **Yasmeen *et al.*, (2013)** reported the significance of MLE (moringa leaf extract) as the leaves contain a heavy amount of mineral contents including K^+ which is an excellent plant nutrient. Many reports have shown the role of MLE in improving crop resistance to salinity. **Rady *et al.*, (2015)** stated that

Moringa leaf extract also reduced uptake of the undesirable Na^+ and/or Cl^-, and enhanced shoot or leaf K^+. Also, **Yasmeen *et al.*, (2012); Yasmeen *et al.*, (2013)** and **Rehman *et al.*, (2014)** mentioned that moringa extract behaves as a plant hormone, which enhances seed germination, growth and yield of crops. MLE foliar spray improved crop performance, worked as vigorous plant growth, improved membranes stability. **Latif and Mohamed, (2016)** concluded that *Moringa* leaf extract have antioxidant compounds such as flavonoids, phenolic acids, ascorbic acid, zeatin and minerals. Therefore, MLE can be considered as a beneficial solution for crop seeds to help plants to overcome the harmful effects of environmental stress. **Desoky *et al.*, (2018)** concluded that MLE can be used as plant bio-stimulants/ nutritive means of integration under normal or abnormal conditions as an economic and natural source of mineral nutrients, phytohormones, amino acids, osmo-protectants, and antioxidants.

Seaweed extracts: Michalak and Chojnacka, **(2014)** informed that seaweed extract biochemical composition is complex (polysaccharides, minerals, vitamins, oils, fats, acids, antioxidants, pigments, hormones). **Stirk *et al.*, (2014)** reported that *Ecklonia maxima* extracts present a high potential for application in agriculture due to its high content of several plant hormones such as abscisic acid, gibberelins. Therefore, **Arioli *et al.*, (2015)** manifested that the application of liquid seaweed extracts enhanced plant growth properties through metabolic benefits, triggering disease response pathways and increasing stress tolerance. **Battacharyya *et al.*, (2015)** stated that the positive effect of seaweed extract may be due to its constituents of macro and micro nutrients as well as some growth regulators, polyamines and vitamins, which improve the nutritional status and vegetative growth. **Divya *et al.* (2015)** observed that the enhancement of germination, growth and productivity by using *Sargassum wightii* liquid fertilizer is related to the presence of high levels of several phytohormones in this extract. Furthermore, **Mathur *et al.*, (2015) and Pacholczak *et al.*, (2012**) stated that seaweed extracts are known to promote and enhance vegetables, fruits and various other crops because of their richness in growth regulators such as auxins (IAA and IBA), gibberellins and cytokinin, in addition to osmo protectant betains and micronutrients.

Díaz-Leguizamón *et al.*, (2016) declared that seaweed extracts are used as nutritional supplements, biostimulants, or biofertilizers in agriculture and horticulture to increase plant growth and yield. However, **Elansary *et al.*, (2017)** noticed that trees treated with seaweed extract gave more total growth than untreated drought-stressed trees for both rootstocks. **Hernández-Herrera *et al.*, (2018)** mentioned that seaweed can be considered a cheap, abundant, and accessible local resource along the sea coast. It represents great potential for commercial exploitation as a source of plant growth promoters and their utilization to improve growth and development. **De Vasconcelos *et al.*, (2019)** evaluated the ability of seaweed extracts in improving plant development subjected to stresses and saline environment**.**

The objectives of the study:

1. To determine the tolerance of *Terminalia arjuna* seedlings under abiotic stresses (drought and salinity).
2. To evaluate the effects of foliar applications of salicylic acid, seaweed and *Moringa olifera* leaf extracts on physiological characteristics, chemical compositions of *Terminalia arjuna* under different irrigation intervals and salinity stresses.

2. REVIEW OF LITERATURE

2-1 Effect of drought on plant growth characteristics:

Fang *et al.*, (2012) showed that under drought conditions in two species of *Salix paraqplesia* and *Hippophae rhamnoides,* height, base diameter and number of leaves were reduced. **Niu *et al.*, (2012)** on *Jatropha curcas* stated that deficit irrigation reduced plant growth and leaf development. **El-Mekawy, (2013)** on *Achillea santolina* showed that irrigation every 7 days increased number of branches/plant, plant height; fresh and dry weights of herb/plant, fresh and dry weights of roots/plant compared to irrigation every 14 and 21 days. **Emmanuel, (2014)** stated that total biomass and root dry weights of *Picralima nitida* (Apocynaceae) seedlings were lower in both water stressed and water logging conditions than well-watered conditions. Meanwhile, **Fereres *et al.*, (2014)** stated that number of leaves per plant, leaf size and leaf longevity were reduced by drought. The root growth initially increased, but reduced at a later stage because of severe drought stress. **Mohamed *et al.*, (2014)** found that long irrigation intervals significantly reduced growth parameters (plant height and number of leaves).

Assaha *et al.*, (2016) reported that water deficit markedly inhibited shoots and roots growth of huckleberry (*Solanum scabrum*) plant. The suppression of plant growth under drought stress might be attributed to the metabolic disorders induced by stress, generation of ROS (reactive oxygen species) that causes a reduction in division and elongation of cells. **Massad and Castigo, (2016)** suggested that *Combretum adenogonium*, *Vachellia xanthophloea*, and *Faidherbia albida* trees species may continue to establish under drought conditions, but if water stress is prolonged, the ranges of *V. xanthophloea* and *F. albida* may contract. Additionally, **Jafarnia *et al.*, (2018)** mentioned that the severe drought stress decreased the diameter and height growth, total biomass**. Kagambèga *et al.*, (2019)** reported that in a water deficit condition, *Acacia senegal* and *Jatropha curcas*, react by reducing their height growth and their root elongation compared to the control plants. **Zafar *et al.*, (2019 b)** on *Conocarpus erectus* and *Ficus benjamina* , revealed that all growth parameters such as plant height, stem diameter, number of leaves, and number of branches were significantly decreased under water deficit condition**.** Meanwhile, **Boumenjel *et al.,* (2020)** concluded that *Moringa* represent a promising species as an ecological solution for use in agroforestry systems, able to minimize the negative effects of drought and to rehabilitate and enhance the soil of arid zones**.**

2-2- Effect of drought on plant chemical analysis:

Chen *et al.*, (2011) reported that drought stress increased the content of pehnolic compounds (rosmarinic acid, ursolic acid and oleanolic acid) of *Prunella vulgaris* plants. **Barzegar *et al.*, (2012)** found that in almond, accumulation of proline in response to longer interval between irrigations is a general trait. **Lalinia *et al.,*** (***2012***) stated that drought stress leads to increase reactive oxygen species production in plants, resulting in decreasing of chlorophyll content. **Álvarez *et al.*, (2013)** declared that irrigation water requirements and sensitivity to water deficits of ornamental plants is a great interest to horticultural producers for planning irrigation strategies. **Afshari *et al.*, (2013)** found that net photosynthesis rate, chlorophyll index and proline content increased in response to water stress. Furthermore, **Hura *et al.*, (2013)** mentioned that increase in the cell wall of bound phenolics under drought stress is a trust worthy indicator of drought stress tolerance in plants. **Correia *et al.,* (2014)** on Eucalyptus manifested that the decrease in chlorophylls concentration as water stress increased has been considered a typical symptom of oxidative stress and may be the result of decreased pigment photo-oxidation and chlorophyll degradation. **Mohamed *et al.*, (2014)** found that total carbohydrate increased when plants were irrigated every week, compared to irrigation treatments every two or three weeks. **Maguire *et al.*, (2015)** stated that in five temperate tree species (*Acer rubrum,* *Betula papyrifera*, *Fraxinus americana*, *Quercus rubra*, and *Q. velutina*) shade and drought combined, caused total nonstructural carbohydrates (NSC) decreases in all species. Also, **Caliskan *et al.*, (2017)** on *Hypericum pruinatum* plantlets noticed that salt drought stress did not cause a significant change in phenolic compounds. On a related note, **Kumar *et al.*, (2017)** found that strong water deficit and salt stress both caused inhibition of growth, degradation of photosynthetic pigments, and increases in the levels of total phenolic compounds and antioxidant flavonoids. High salinity, in addition, induced accumulation of Na^{+} and Cl^{-} in leaves. **Tsuchida and Yakushiji, (2017)** remarked that under drought stress condition, the photosynthetic rate in Japanese apricot trees (*Prunus mume*) declined. Furthermore**, Alrashidy *et al.*, (2018)** stated a remarkable decline for both nutrients (N, P, K and Fe) and total proteins in *Moringa oleifera* and *Moringa peregrina* at drought interval of fourteen days. **Jafarnia *et al.*, (2018)** stated that the severe drought stress decreased net photosynthesis, gas exchange and proline and soluble sugar contents significantly increased.

2-3- Effect of salinity on plant growth characteristics:

Diaz-Lopez *et al.*, (2012) on Jatropha concluded that the total biomass exhibited a salt-induced decrease in the 60 mM or higher NaCl concentrations. **Hussein and Abou-Baker, (2014)** manifested that negative relationship between salt stress and plant growth characters, i.e. plant height, green leaves area and dry weight of each root, stem, leaves and shoots, which decreased as the salt concentration increased. **Badran *et al.*, (2013)** stated that soil salinity, especially at high level (0.7%) decreased plant height, number of leaves and dry weight of leaves, stem and roots of *Khaya senegalensis* seedlings. **Hanafi *et al.*, (2013)** reported that in six weed species plant height, shoot and root dry weights decreased with increasing salinity levels. **Miah, (2013)** on *Albizia procera*, *Samania saman* and *Terminalia bellirica*, revealed that germination and height performance showed good but when salinity increases survivability was decreased. Furthermore, **Karimi *et al.*, (2014)** reported a negative relationship between salinity stress and vegetative growth parameters such as leaf number, leaf area, and shoot length for pistachio rootstocks**. Ali *et al.*, (2015)** showed that increasing salinity levels significantly decreased all growth traits of *Dalbergia sisso* seedlings. **Haque *et al.*, (2016)** on *Acacia auriculiformis* seedlings noted that seawater caused reduction in shoot and root density, though plant height, leaf number and plant biomass were found to be decreased to some extent compared to control plants. **Siddique *et al.*, (2017)** on *Xylocarpus granatum* found that most of the seedlings (90%) survived at moderate salinity, and this survival percentage was decreased at higher saline conditions salinity. **Bonomelli *et al.*, (2018)** showed that treatments with salt reduced plant growth by approximately 50% of the fresh weight of all avocado plant tissues. **Fatima *et al.*, (2018)** on moringa revealed that the root, shoot length, and dry weights were significantly affected by increasing the salinity levels. **Plesa *et al.*, (2018)** on *Larix decidua* tree appeared that salinity have stronger effects on the seedlings. **Shahin *et al.*, (2018**) on *Terminalia arjuna* indicated that germination percentages were descendingly decreased with increasing salinity level (6000 and 8000 ppm), while planting the fruits in a soil mixture free from salt gave the highest germination%, **Saadawy *et al.*, (2019)** revealed that salinity levels significantly decreased growth parameters of *Taxodium distichum*, i.e. seedlings height, branches number, root length, shoot and root fresh and dry weight. **Zafar *et al.*, (2019 a**) on *Terminalia arjuna* mentioned that under high salt stress growth parameters and biomass production in leaves, stem and roots were decreased.

2-4- Effect of salinity on plant chemical analysis:

Campos *et al.*, (2012) on *Jatropha curcas* reported that the irrigation of plants with NaCl caused the highest proline levels in leaf, compared to the non-stressed ones. Conversely, the levels of total soluble sugars did not significantly differ. In these plants salinity led to chlorophyll damage. **Diaz-Lopez *et al.*, (2012)** on Jatropha concluded that salinity induced a decline in the leaf K(+) concentration. Also**, Kamal Uddin *et al.*, (2012)** on *Portulaca oleracea* noticed that Na^+ and Cl^- increased with increasing salinity, while K^+ and Ca^{2+} decreased. **Niu *et al.*, (2012)** concluded that in *Jatropha curcas* under salt leaf concentration Na was much higher than that observed in most glycophytes. Leaf concentrations of Cl were also high. **Ali *et al.*, (2013)** indicated that leaf chlorophyll content, protein, N, P, K and Ca were decreased with increasing salinity concentrations. Meanwhile, sodium, chloride and carbohydrates were gradually increased. Furthermore,**Mostajeran and Gholaminejad, (2014)** revealed that in turmeric (*Curcuma longa*) the amount of carbohydrates and reduced sugar and potassium declined as salinity increased. Meanwhile sodium and proline increased as salinity increased. **Yildiztugay *et al.*, (2014)** mentioned that, chlorine accumulation showed a significant increase in response to salinity in leaves of *Sphaerophysa kotschyana*. **Hegazi (2015**) noticed that phosphorous, sodium and calcium contents gradually increased, while a significant depression occurred in K, Mg and nitrogen content in areas with increasing seawater. However, **Karimi and Kuhbanani, (2015)** showed that salinity treatment increases Ca^{2+} in the shoot of pistachio cultivar plants. **Schiop *et al.*, (2015)** proposed that the reduction in photosynthetic pigments levels, total phenolics and total carotenoids, and the (increasing) levels of Na^+ or K^+ ions in *Picea abies* needles can be associated to the degree of salt stress affecting the plants. **Cicevan *et al.*, (2016)** reported that carotenoid levels were affected in oleander by salinity and by drought (30 days) as in many other species. Also, **Caliskan *et al.*, (2017)** noticed that salt stress increased the content of phenolic compounds. **Rezaei *et al.* (2017)** reported that salinity stress increased Na^+ content in all cultivars of *Brassica napus*. **Siddique *et al.*, (2017)** on *Xylocarpus granatum* mentioned that higher saline conditions inhibited nutrients (N, P and K) accumulation in different parts of the seedlings. **Fatima *et al.*, (2018)** observed that the uptake of K^+ and Ca^{2+} was highly affected at different salinity levels as compared to control and Na^+ ions accumulation was higher in roots rather than shoot. **Rahneshan *et al.*, (2018)** on pistachio showed that salinity increased proline content, moderate and high salinities increased the soluble sugars content.

2-5- Effect of salicylic acid SA on plant growth characteristics under stress conditions:

Salicylic acid (SA) has a remarkable influence on plant physiology as mentioned by some authors; **De Jesus, (2014)** stated that drought stress (plants watered at 15% field capacity) severely affected *Eucalyptus globulus* physiology. Foliar application of SA improved performance of plants under water stress. **Manzoor *et al.*, (2015)** mentioned that SA significantly affects root and shoot dry matter of maize under drought and salt stresses. Moreover, **Abd Al-hayany *et al.*, (2019)** on citrus seedlings reported that salicylic acid application caused an increment in number of leaves, fresh and dry weight of root system. **Husen *et al.*, (2018)** indicated that foliar application of SA improved the performance of Ethiopian mustard (*Brassica carinata*) cultivars and mitigated the damage caused by salt stress. **Moradi *et al.*, (2018)** on Moldavian balm showed that application of salicylic acid (1mM) improved germination and growth parameters at all salinity levels compared to the control. Moreover, **Abol- hasani and Roshandel, (2019)** showed discussed that SA improved seed performance in *Dracocephalum moldavica* under salt stress by reduction of detrimental effects of oxidative stress. **Souri and Tohidloo, (2019)** demonstrated that foliar application of SA increased the root fresh and dry weights of tomato.

2-6- Effect of (SA) salicylic acid on plant chemical analysis under stress conditions:

Li *et al.*, (2014) reported that SA induced salt tolerance and increased biomass of the conifer *Torreya grandis* cv. Merrillii (Family Taxaceae) by enhancing the chlorophyll content and activating the photosynthetic process. **Tingting *et al.*, (2014)** mentioned that SA induced the salt tolerance and increased the biomass of *Torreya grandis* cv. by enhancing the chlorophyll content and activity of antioxidative enzymes, activating the photosynthetic process. Moreover, **Ashraf and Jalali**, **(2015)** reported that SA had a positive affect on normal conditions and stresses in plants as it improved chlorophyll "a" content of pistachio. **Khoshbakht and Asgharei, (2018)** stated that the best ameliorative remedies of SA were obtained when Valencia orange/Bakraii seedlings were sprayed by 0.50 and 1.00 mM solutions. Application of SA increased net photosynthetic rate, proline content, greater Chlorophyll content and RWC compared with untreated plants in salt stressed plants and enhanced growth parameters. Additionally, **Manzoor *et al.*, (2015)** found that foliar application of SA significantly increased proline concentration, amino acid accumulation and chlorophyll content. **Singh *et al.*, (2015)** observed that application of SA significantly alleviated growth inhibition caused by NaCl, and was accompanied by higher photosynthetic pigments, and lower total phenolics. **Arsalan *et al.*, (2017)** stated that salicylic acid is known as an important signaling molecule that regulates plant reactions to salt stresses. It plays a critical role in the regulation of physiological functions as non-enzymatic antioxidant. Also**, Shaki *et al.*, (2018)** suggested that the exogenous SA improved the response of safflower to salinity by increasing glycine betaine, total soluble protein, carbohydrates, chlorophylls, carotenoids, flavonoid, and anthocyanin contents. **Britoa et *al.*, (2019)** estimated that olive trees treated with SA showed changes on IAA and ABA dynamics, soluble proteins and leaf P concentrations during the summer.

2-7- Effect of moringa leaf extract on plant growth characteristics under stress conditions:

Iqbal, (2014) observed that moringa leaf juice also contains micronutrients in sufficient quantities and suitable proportions that increase the growth, yield components and yield of a variety of crop. Similar effects have been observed in vegetative growth announced by **Taha *et al.*, (2015)** showed that moringa leaf extract (MLE) positively affected all growth characters, i.e. plant height, number of branches, length of roots, fresh and dry weights of branches and roots of jojoba plants. Similarly**, Zaki and Rady, (2015)** declared that *Moringa oleifera* leaf extract application increased growth characteristics (shoot length, number of leaves and plant dry weight). **Abdel Latef *et al.*, (2017)** on fenugreek (*Trigonella foenum-graecum*) manifested that foliar application of MLE ameliorated the negative impact of salinity to considerable extent by enhancing growth traits. Also, **Abd El-Mageed *et al.*, (2017)** reported that MLE-treated plants had higher growth and yield characteristics, harvest index. **Hanafy, (2017)** on *Glycine max* plants mentioned that MLE (30) was able to enhance the tolerance of the studied plant to drought stress and increase growth parameters (shoot and root length, fresh and dry weight of shoots and roots). Additionally, **Maishanu *et al.*, (2017)** indicates that cowpea plants treated with moringa extract have the highest mean of stems, number of leaves and branches, length of leaves and branches, and thickness of stem. Furthermore, **Soliman and Shannan, (2017)** on *Lagerstroemia indica*, remarked that usage of moringa leaf extract significantly improved the growth under salt stress. **Gaafar and Ewais, (2018)** mentioned that spraying pea plants with moringa extract at 4 or 6% increased significantly the vegetative growth characters, yield and its components as well as the green seed contents. **Batool *et al.*, (2020)** on moringa mentioned that foliar application of moringa leaf extract at the rate of

3% significantly improved number of branches (66%), leaves (52%), and leaflets (42%) under stress conditions.

2-8- Effect of Moringa leaf extract on plant chemical analysis under stress conditions:

(Rady *et al.*, (2013) and Zaki and Rady, (2015) maintained that MLE has the ability to reduce the adverse effect of salinity and to protect the plant against the build up of toxic ions by maintenance of the ionic homeostasis under salt stress and this makes N, P, K, Ca more available to the plant. Moreover, **Abd El-Mageed *et al.*, (2017)** on squash plants reported that MLE treated plants had higher chlorophyll fluorescence, photosynthetic pigments, soluble sugars and free proline, leaf anatomy, relative water content and membrane stability index. **Abdel Latef *et al.*, (2017)** proposed that salt-stressed *Trigonella foenum- graecum* plants were sprayed with MLE, proline content was increased, compared with stressed plants alone. Furthermore, **Elzaawely *et al.*, (2017)** concluded that the increase of free proline and soluble sugars concentrations in rocket (*Eruca vesicaria* subsp. *sativa*) plants are attributed to MLE (moringa leaf extract) applications, it maintains the chlorophyll in higher concentrations under salinity due to presence of zeatin-like cytokinin which prevents premature leaf senescence. **Hanafy. (2017)** demonstrated that MLE (30) was able to enhance photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids and total pigments) in *Glycine max* plants under drought stress. **Soliman and Shannan, (2017)** on *Lagerstroemia indica* revealed that usage of moringa leaf extract significantly improved inflorescence, as well as chemical characteristics, and decreased significantly Na under the adverse conditions of the studied sea salt stress. Additionally, **Nouman *et al.*, (2018)** on moringa tree mentioned that MLE caused improving calcium, potassium, magnesium, and phosphorous contents under 40 and 75 % field capacity. **Batool *et al.*, (2019)** on moringa seedlings suggested that foliar application of moringa leaf extract at the rate of 3%

significantly improved leaf chlorophyll a (41%) and b (71%) and total chlorophyll (49%) contents, membrane stability index (45%) and leaf phenolic contents (78%) under stress conditions. **Hassanein *et al.,* (2019)** mentioned that MO (*Moringa oleifera*), and *Moringa peregrena*, (MP) treatment led to a significant increase in anthocyanin, total carbohydrates and superoxide dismutase in basil. Alternatively, MP increased ascorbic acid oxidase actively in basil leaf.

2-9- Effect of seaweed extract on plant growth characteristics under stress conditions:

(Saa *et al.,* 2015) mentioned that seaweed extracts improved shoot growth and leaf area upon nutrient deprivation in almond tree. **Elansary *et al.*, (2016)** reported that ornamental shrubs Spiraea and Pittosporum treated with seaweed extract increased root depth as well as root weight in subjected to prolonged irrigation intervals and saline shock conditions. **Santaniello *et al.,* (2017)** suggested that pre-treatment with (ANE) *Ascophyllum nodosum* is effective to acclimate plants to the incoming stress, promoting an increased (WUE) water use efficiency and dehydration tolerance on *Arabidopsis* plants. **El Bonomelli *et al.*, (2018)** mentioned that seaweed extract reduced the effects of a biotic stress only at an early stage of avocado. **El -Sayed *et al.,* (2018)** concluded that spraying algae extract at 1.0 ml/ 6-months-old transplants of *Thuja orientalis* greatly improved growth under salinity stress. **Hashem *et al.,* (2019)** concluded that *Ulva lactuca* was found to be the best candidate to be used as a bio-fertilizer to improve canola growth, yield, and salt stress tolerance.

2-10- Effect of seaweed extract on plant chemical analysis under stress conditions:

Abbas and Akladdious, (2013) observed that plant based bio-stimulants and seaweed extracts often increase the colour of leaves by stimulating chlorophyll biosynthesis or reducing its degradation**.** This increase could be due to osmotic stress or an increase in plant hormone activities. **Chernane *et al.*, (2015)** declared that seaweed extract from *Ulva rigida* improved salt stress tolerance. The application of SWE enhanced leaf pigment (chlorophyll and carotenoids) and total phenolic content in plants under salt stress. **Elansary *et al.*, (2016)** stated that there were significant increases in proline values in SWE-treated plants grown under saline shock conditions as reported in *Spiraea nipponica* "Snowmound" and *Pittosporum eugenioides* "Variegatum". Additionally, **Godlewska *et al.*, (2016)** reported that there were significant increases in K and Ca composition in the leaves of seaweed extract (swe)-treated plants under prolonged irrigation intervals as well as saline conditions. Such effect might be attributed to the chemical composition of (swe), the positive effects of (swe) on mineral composition of treated plants had been reported in several plants, e.g., *Lepidium sativum*. **El- Bonomelli *et al.*, (2018)** on avocado revealed that seaweed extract (SWE) reduced the effects of abiotic stress and increased potassium (K) and calcium (Ca) concentrations in leaves.

2-11- Effect of drought on plant growth and chemical characteristics in Sudan

Elhag Adam, (2010) found that number of leaves of *M. oleifera* and *M. peregrina maintained* per species was significantly reduced with increasing irrigation intervals. The 8 days irrigated seedlings had the lowest values. He suggested that irrigation frequency in the nursery should not be later than 6 days for the two species. **Gasim *et al.*, (2012)** on faba bean showed that yield, as well as other traits, were reduced by drought. Drought could reduce protein content and affect its association with yield/plant. **Elhadi *et al.*, (2013)** in South of Khartoum revealed that Nine day irrigation frequency was found most suitable in traditional nursery, whereas in the modern nursery irrigation frequency of 6 days under shade 20% were found to be the most suitable. *Eucalyptus microtheca* produced the highest shoot fresh and dry weights with frequent irrigation (3 and 6 days). The performance of *Azadirachta indica* was generally very poor. **Ali *et al.*, (2015)** concluded that to obtain high yield of good quality of *Moringa oleifera*, as a forage crop, it is recommended that to be watered at not less than 75% ETc . Furthermore, **Koko, (2015)** on onion (*Allium cepa* L.) found that seed stalk length and diameter, number of florets per umbel and umbel size were reduced by water stress.

2.12- Effect of salinity on plant growth and chemical characteristics in Sudan

ElNour, (1997) stated that negative effect of high water salinity (2.4 dsm) on growth seedlings of *Casuarina equisetifolia* shoot height (cm) root length (cm), and dry weight (g) of shoots and roots as a result of salinization of potting media by continuous irrigation with high saline water (2.4ds/m). **Elbagir, (2009)** showed that both sources of *Acacia tortilis* can tolerate salinity but Port Sudan source had significantly higher survival percent, potassium content and growth values than Rufaa source. **Nasreldin, (2009)** mentioned that the germination and seedling performance of some acacia species irrigated with mixed red sea water + tap water with EC ranging from 0.4 to 10 dSm-1, but the germination failed in EC ≥ 15dSm-1.

Mukhtar, (2011) stated that increasing the level of salinity of irrigation water significantly decreased the rate of growth of *Corchorus olitorious*. Saline water with EC 4.6 dS/m and 5.5 dS/m resulted in the death of plants. **Elhag and Abdalla, (2014)** on moringa trees declared that stem height, number of leaves and root growth reduced (30% and 40%, respectively) by the highest NaCl concentration (0.8% NaCl). Na+ and Cl- concentrations increased in the different plant parts (roots, stem and leaves), whereas both K+ and Ca2+ were reduced by 24- 64% compared to control.

2.13- Effect of Salicylic acid on plant growth and chemical characteristics in Sudan

El-nour, (2014) mentioned that salinity treatment (50 Mm NaCl) significantly reduced the nitrate content in leaves and roots of cotton (*Gossypium hirsutum*) seedlings. Foliar application of salicylic acid (5 Mm) to salinized seedlings ameliorated the nitrate content in both plants and mitigated the deleterious effect of salinity. Also, **Gibril and Wasfi, (2016)** in Faculty of Agriculture, Khartoum University, reported that supplements of salicylates (salicylic acid, acetyl salicylic acid and methyl salicylates partially alleviated the depressive effects of salinity *on Zea mays*. **Abuzid, (2018)** stated that growth of two cultivars of *(Zea mays* L.) under saline conditions led to substantial decreases in all the tested parameters, and the salicylic acid is more pronounced in alleviating the adverse effects of salinity.

2-14- *Terminalia* in Africa

About 30 species of *Terminalia* are native to Africa**;** the African species of *Terminalia* are most often trees and rarely shrub-like in growth form **(Wickens, 1973).** Most of the African species of *Terminalia* are growing in various kinds of woodlands such as coastal woodlands and Miombo woodlands including Brachystegia woodlands, as well as wooded grasslands, and some are typical components in riverine forests and rain forests **(Wickens, 1973).** Most of these species of *Terminalia* have some applications in African traditional medicine and many of them are used for the treatment of infectious diseases **(Neuwinger, 2000).** Also, **(Cock, 2015)** reported that the African medicinal systems made use of native *Terminalia* species in the treatment of multiple different disorders:

Tereminalia ivorensis, *Terminalia avicennioides*, *Terminalia glaucescens* and *Terminalia macroptera*, are amongst the most useful west african species, with documented ethno-pharmacological uses for such diverse disorders as bacterial, fungal and viral diseases and infections, malaria, trypanosomias is the treatment of coughs, bloody sputum and anti-mycobacterial activity. Similarly, many Terminalia species were used by diverse ethnic and cultural groupings in Southern and Central Africa. *Terminalia bentzoe*, *T. brachystemma*, *Terminalia brownii*, *T. mollis*, *Terminalia sericea*, *Terminalia spinosa* and *Terminalia stenostachya* all have documented ethno-pharmacological uses in Southern Africa for the treatment of abdominal disorders, pain, bilharzia, cancer, coughs and colds, dysentery, diarrhoea, fever, venereal diseases, heart disorders, hypertension, jaundice, malaria, diabetes and for the treatment of bacterial, fungal and viral diseases. Indeed, the Southern African species *T. mollis* has even been linked with anti-HIV activity.

In Sudan, traditional preparations of remedies from *T. brownii* and *T. laxiflora* include soaking fresh and/or dry plant material for one day warm tap water as well as boiling the plant material in water for a few minutes to prepare decoctions, **(Muddathir *et al.,* 2013; El Ghazali *et al.,* 2003).** Despite of the frequent and various uses of *T. brownii* and *T. laxiflora* for the treatment of bacterial infections in traditional medicine, there are few studies available on their anti-microbial activities **(Opiyo *et al.,* 2011; Mbwambo *et al.,* 2007)**.

Terminalia laxiflora (Engl. & Diels) and ***T. brownii*** (Fresen) (Comretaceae) are dry savanna woodland trees occurring commonly in the Sudano- Sahelian area of Africa (**Foyet and Nana, 2013**). ***T. laxiflorais*** a common indigenous tree species in wood land and semi-humid Savannah of the Sudan. Earlier work done on the root bark of *T. laxiflora* has led to isolation of several compounds like laxiflorin, ellagic acid, trim-ethylellagic acid, tetramethyl-ellagic acid and terminolic acid **(Ekong and Idemudia, 1967).** It has multi-purpose uses with a high potential of timber production and traditional medicinal uses. In Sudan decoction of *T. Laxiflora* stem bark is used for malaria and cough treatments **(Musa *et al.,* 2011).** Women also use heartwood for fumigant ‘‘smoke bath’’. Exposure to the smoke bath is believed to relieve rheumatic pain, smoothen skin and achieve general body relaxation besides other cosmetic and medicinal beautification **(Ogbazghi and Bein, 2006).** Moreover, **Mohieldin *et al.,* (2017b) and Issa *et al.,* (2018)** revealed that *Terminalia laxiflora* (Daroat) stem and stem bark are used as antiseptics for mouthwash to prevent gingivitis and thrush in Africa. **Mohieldin *et al.,* (2017a)** revealed that the methanolic extracts of *Terminalia laxiflora* followed by *Acacia totrtilis* (bark), *Ambrosia maritima* (aerial part), *Argemone mexicana* (seed), *C. hartmannianum* (bark), *Terminalia brownii* (wood) and 50% ethanolic extract of *T. brownii* (bark) were showed an inhibitory to antibacterial activity.

Terminalia brownie **(Tuphach*, 2008)*** it is native to Kassala, Karora Hills, near Eritrean borders, Fung, Darfur, Upper Nile, Kordofan. Uses: The wood is used in the round as a local building timber, for beams and rafters. It is also used for firewood and charcoal. (**Abdalla *et al.,* 2013; Issa *et al.,* 2018**) showed that the roots of *Terminalia brownie* (Arza, Sobag), distributed in South East Blue Nile and South Kordofan, are macerated for treating cough 20, and the bark decocted for curing jaundice.

Baser and **Abeywickrama, (1995); Vasisht and Kumar, (2006)** mentioned that sudanese women use the smoke from Habil wood (*Combretum ghasalense*), Subakh (*Terminalia brownii*) and Talih (*Acacia seyal*) to fumigate their naked bodies while covering themselves with a sheet of cloth in the form of a tent. The main purpose is to impart fragrance into the skin by long exposure to the smoke of fragrant woods.

Terminalia schimperiana **(Friis and Demisse, 2020)** found that Hochst. has been used in Ethiopia, Sudan and South Sudan; and *Terminalia glaucescens* Planch. ex Benth. has been used in tropical western and parts of tropical eastern Africa.

3- MATERIALS AND METHODS

3-1. Site of experiments:

The experiment was conducted at the nursery of the Department of Ornamental Plants Researches, Horticultural Research Institute, Agricultural Research Center, Giza, Egypt, to determine the effect of foliar spray of salicylic acid, moringa leaf extract and seaweed extract on the tolerance of *Terminalia arjuna* seedlings to drought or salinity stresses. The nursery site lies at coordinations of latitude 30°01'22.5" North, longitude 31°12'31.5" East and altitude 21 m above sea level. The investigation extended over the two successive seasons of 2016/2017 and 2017/2018.

The general practices on the seed collecting, processing and germinating in *Terminalia arjuna* were validated from relevant manuals **(Bisht and Ahlawat, 1999**), whereas the fine details were retrieved from focused studies **(Naik *et al.*, 2010; Mondol, 2014)**.

3-2. Source of the fruits:

Initially, the fruits were obtained in May–June 2016 from two source localities of old-aged cultivated trees, 15–20 m height. The first was stands at the road periphery of the Zohreya Garden, Cairo. The second were ten stands in the paved facility of the Zoo Garden, Giza. The freshly fallen fully ripened fruits were picked up from the ground underneath mother trees with vigorous stems and crowns and were selected for uniformity in shape and size. The *in situ* selection neglected damaged fruits and inert matter to ensure the physical purity of the working sample.

3-3. Pre-treatments on the fruits:

A total quantity of 4650 fruits was collected, weighing 14 kg with an average of 350 fruits per kg. **Weight of Fruits per kg = № of Fruits Total ÷ № of Fruits per kg (Naik *et al.*, 2010).** The fruits were later air-dried in shade for one month then the rough fibrous rips were de-winged using a bypass pruning shear. Since the seeds of *Terminalia arjuna* are true orthodox, the fruit lot was halved; those for the 1st season were used straightforward; those for the 2nd season were stored dry in sealed gunny sacks.

The investigation sequence was carried out according to the following schedule for the two successive seasons:

In July 2016 and 2017, the fruits were pretreated by soaking in fresh water for 48 hr according to **Hossain *et al.,* (2005).** Soaking seeds in water helps in softening the seed coat, removal of inhibitors and reduce the time required for germination, **(Hartmann and Kester, 1970).**

Floating fruits were considered empty and/or unhealthy so were discarded. The water was drained off and the fruits were air-dried in shade for 24 hr to retain minimum moisture. The treated fruits were then directly sown in 10 × 20 cm polythene bags in duplicates at a depth of 2.5 cm with a mixture of sand and clay at a ratio of 1:1 v. The fruit bags were placed on the nursery ground under open conditions and monitored for seed germination. Irrigation with the nursery water was maintained daily while weeding was performed regularly. All agricultural practices necessary for seed care were done as usually grower did. The germination was recorded daily from date of sowing and continued till the germination ceased.

3-4. Seed germination:

In August 2016 and 2017, the seeds showed epigeous germination marked by the emergence of two large foliaceus cotyledons. The germination commenced in 2 weeks after sowing. The germination percentage in the first and second seasons was 63 and 58 %, respectively. **Percentage of Germination = № of germinated seeds ÷ № of fruits sown × 100. (Schelin *et al.,* 2003)**

In October 2016 and 2017, the survived seedlings reached ± 15–20 cm in height so were transplanted individually in 20 cm plastic pots filled with 5 kg of sandy soil and were given ammonium nitrate (33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48-50% K_2O) 10:20:10 fertilization 3 g per pot every month until the end of every season.

All pots were kept in the same nursery setting to minimize variation in environmental factors and observed for the plant growth and health. The irrigation with the nursery water varied according to the weather conditions; while weeding continued regularly until the time of the experiment.

3-5. Preparation of the foliar applications:

Meanwhile, the foliar applications used in the experiment were prepared according to the following procedures:

3-5-1. For the salicylic acid: one jar of powder salicylic acid ($C_7H_6O_3$), packaging size 500 g, molecular mass 138.121 g/mol, was purchased from Technogene Corp., Dokki, Egypt. 69.06, 138.12 and 207.18 mg of the powder were added to one liter of distilled water to prepare the three applications with 0.5, 1.0 and 1.5 mmol concentrations, respectively.

3-5-2. For the moringa extract: the dry leaves of *Moringa olifera* were obtained from the upper branches of more than 10-years old trees cultivated in Siwa Oasis at the Experimental Farm of the Desert Research Center. The dry leaves were ground by electrical grinder and made powder and 100 g of the powder were mixed with distilled water at a ratio of 1:10 w/v. The mixture was stirred by hand, kept in dark at room temperature for 24 hr, then filtrated using Whatman 1 filter paper thus to have a stock of 100 % concentration filtrate **(Sarmin, 2014)** and 10 ml of the filtrate was added to 400, 200 and 100 ml of distilled water to prepare the three applications with 2.5, 5 and 10 % concentrations, respectively.

3-5-3. For the seaweed extract: the commercial product “Super Blue-Green” was purchased from the selling outlet of the General Authority for Agricultural Balance Fund, Ministry of Agriculture, Giza, Egypt. The Super Blue-Green is a natural liquid fertilizer produced from blue-green algae enriched with organic acids, amino acids, vitamins, auxins and cytokinins. 25, 50 and 75 ml of the liquid were added to one liter of distilled water to prepare three applications with 2.5, 5.0 and 7.5 % concentrations, respectively.

The extract was freshly prepared one day before its foliar application. Foliar spray of salicylic acid or moringa leaf extract or seaweed extract was done manually with a hand sprayer (Vol. 20 L) in the morning between 09:00 and 11:00 a.m. every month for 8 months beginning in March and ending in October. The untreated plants (control) were sprayed with tap water.

In March 2017 and 2018, the established normal seedlings of *Terminalia arjuna* reached ± 25-30 cm in height and were used to execute two experiments:

Experiment 1: To study the effect of foliar applications with the salicylic acid, moringa extract and seaweed extract on the seedlings of *Terminalia arjuna* under drought stress condition, as irrigation with normal nursery water was applied at 4, 8 and 16 days intervals. Seedlings were irrigated to reach field capacity

Factor a – Drought stress condition:

a_1: 4 days

a_2: 8 days

a_3: 16 days

Factor b – Foliar application:

b_1: Control

b_2: Salicylic acid 0.5 mM

b_3: Salicylic acid 1.0 mM

b_4: Salicylic acid 1.5 mM

b_5: Moringa extract 2.5 %

b_6: Moringa extract 5.0 %

b_7: Moringa extract 10.0 %

b_8: Seaweed extract 2.5 %

b_9: Seaweed extract 5.0 %

b_{10}: Seaweed extract 7.5 %

Experiment 2: To study the effect of foliar applications with the salicylic acid, moringa extract and seaweed extract on the seedlings of *Terminalia arjuna* under salinity stress condition. Salinity treatments: 2000, 4000 and 6000 ppm NaCl by adding the required amount of salt 2,4 and 6 g to tap water per litre.

Salinity treatments were achieved by irrigating each seedling three times a week during 9 months start from March to end of November. The application of the different saline solutions continued till the termination of each experimental season.

Factor a – Salinity stress condition:

a_1: 2000 ppm

a_2: 4000 ppm

a3: 6000 ppm

Factor b – Foliar application:

b_1: Control

b_2: Salicylic acid 0.5 mM

b_3: Salicylic acid 1.0 mM

b_4: Salicylic acid 1.5 mM

b_5: Moringa extract 2.5 %

b_6: Moringa extract 5.0 %

b_7: Moringa extract 10.0 %

b_8: Seaweed extract 2.5 %

b_9: Seaweed extract 5.0 %

b_{10}: Seaweed extract 7.5 %

3-6. Plant measurements:

the biometric parameters were recorded in end of November 2017 and 2018 for each individual seedling.

This included: plant height; stem diameter; number of leaves and branches; root length; shoot and root fresh and dry weight.

- The plant height was measured using a tape scale from the base at soil surface to the top of the main plant stem (cm).
- The stem diameter was measured using digital calliper at the collar zone (mm).
- The number of leaves and number of branches were counted manually.
- The root length of the longest root was measured by a tape scale (cm).

The plants samples were collected at the end of the experiment and separated into fresh shoot and root weight, Roots were carefully washed to remove soil particles and both shoots and root of plants were weighed by "digital analytical scale (g). Dry the plant in an oven at 80^0 C for 48 hours until the constant weight to get dry shoot and root (g).

3-7. Chemical analysis

The determination of chemical analysis was in the Central Lab of Horticulture Research Institute as follows:

3-7-1. Determination of chlorophyll content

Chlorophyll (chl) content was measured according to **Arnon, (1949)** by homogenizing leaf samples (0.5 g) with 10 ml of acetone (80% v/v) followed by centrifuging at 9,000×g for 10 min. Absorbance was measured with a UV-vis spectrophotometer at 663 and 645 nm for chl a and chl b content, respectively. Carotenoids content was also measured spectro photometrically at wave length of 480 nm.

Chlorophyll a = {(12.7×A663) - (2.69×A645)}/10 (mg/g f.w.)

Chlorophyll b = {(22.9×A645) - (4.68×A663)}/10 (mg/g f.w.)

Carotenoids = [(A480 + 0.114 A663) - (0.638 A645) (mg/g f.w.)

3-7-2. Determination of sodium and chloride contents

At the end of the first and second experimental seasons, fresh leaf samples of leaves were separated from each experimental plant for the determination. Samples were washed several times with tap water, and then oven dried at 60ºC to a constant weight. The dried leaf samples were then ground using a porcelain mortar and a pestle. A portion of 0.3 gm of the leaf ground materials of each replicate was digested by sulfuric acid and hydrogen peroxide, according to **Evenhuis and De-Waard, (1980**). In this digested solution, sodium was determined and measured against a standard using a flame photometer Model 410 according to **Wilde *et al.,*** (**1985**). For chloride determination, 0.1 gm from the ground leaf materials of each replicate was wetted with 6 percent calcium acetate solution, ignited to 500ºC for four hours and then extracted with hot distilled water. Chloride in the extracts was determined by the silver nitrate method according to **Chapman and Pratt,** (**1961**).

3-7-3. Determination of total carbohydrates (gm/100gm dw):

A known weight (0.1 gm) of dried sample was placed in a test tube, then 1N HCl acid (10 ml.) was added. The tube was sealed and placed for 6 hours in an oven at 100^{o} C. The solution was then filtered and the filtrate was clarified by the leading and deleading method using lead acetate solution (137 gm/l.) and the excess of lead salt was precipitated using N/3 potassium oxalate solution. The extract was measured into a measuring flask (50 ml.).The combined filtrate was completed to the mark with distilled water. Total sugars were determined according to the method of **Dubois *et al.,* (1956**). The data was expressed as gm/100 gm d.w.

3-7-4. Determination of proline

Proline content in the leaves was measured following the rapid colorimetric method of **Bates *et al.,*** (**1973**). Proline was extracted from 0.5 g of dry leaf samples by grinding in 10 ml of 3% sulphosalicylic acid. The mixture was then centrifuged at 10.000 g for 10 min. Two milliliters of the supernatant was added into test tubes and 2 ml of freshly prepared acid–ninhydrin solution were also added. Tubes were incubated in a water bath at 90 °C for 30 min. The reaction was terminated in ice bath for 20 min in the dark at room temperature to allow the toluene and aqueous phases to be separated. The toluene phase was then carefully collected into test tubes and toluene fraction was read at 520 nm using spectrometer. The proline content in the sample was determined from a standard curve using analytical grade proline.

3-7-5. Determination of phenolic compounds contents:

It were colorimetrically determined using the folin reagent according to **Snell and Snell,** (**1953**) as 2g of leaves were crushed and immersed in 25 ml of 70% ethanol in brown bottles, and were then stored in dark at room temperature. After a month, ethanolic extraction was dried at room temperature, and then transported quantitatively into 5 ml of 50% isopropanol and stored in vials at 1°C. For total phenols content, a reaction mixture consisted of 1 ml extraction and 0.25 ml HCl was boiled in a water bath for 10 min, and then cooled. One ml of Folin-Denis reagent and 6 ml of 20% Na_2CO_3 were added. The mixture was completed to 10 ml with distilled water and the color density was measured at 520 nm. Tannic acid was used as a standard compound.

3-7-6. Determination of total flavonoids

Content was determined spectro-photometrically using the method of **Ordonez *et al.,*** (**2006**) based on the formation of a complex flavonoid-aluminum. An aliquot (0.5 ml) of aqueous extract was mixed with $AlCl_3$ solution (2%, 0.5 ml), then the mixture was then properly mixed and allowed to stand for 30 minutes at room temperature. The intensity of colour was measured at 420 nm after filtration if it is necessary. Total flavonoid contents were calculated as quercetin equivalent from a calibration curve and the values are presented as means of triplets analyses.

3-7-7. Determination of N, P and K :

For determination of the leaf N, P, K %, three fully expanded leaves were selected per plant. Sampled leaves were oven dried at 80°C for 72 h to the constant weight and ground in a Willey mill to reduce the material to a fineness suitable size. The ground samples were stored in airtight plastic containers for chemical analysis. Total nitrogen was determined by digesting 0.5 g dry leaf samples with 68% H_2SO_4 in Kjeldahl digestion unit until sample became colorless and titrated with 0.1 N of H_2SO_4 using selenium and sodium as catalyst. Total N was determined from the digest by stem distillation with excess NaOH according to **Yemm and Willis, (1956).** The P, K plant tissue was determined by ashing 0.2 g of the plant samples in muffle furnace at 600oC for 3 hours. The ash was cooled and dissolved in 1N hydrochloric acid and the solution passed through filter paper into 50 ml volumetric flask and was made up to the mark with distilled water. From the digest, P concentration was determined by the vanadomolybdate yellow colorimetry method using spectrophotometer according to the method described by **Humphries, (1956).** The K was determined by using flame photometer (Cornin Model 400) Nutrient accumulation in plant was evaluated using the method used by **Akanbi *et al.*, (2002)**.

3-7-8. Determination of Calcium was assayed by flame photometry using additions of NH_4 EDTA according to the method of **Greweling,** (**1961**) the standard solution used was as follows in mM:1.25 $MgSO_4$* 7 H_20; 1.25 $CaN0_3$; 12.5 KCl: and 25 EDTA to which NH_40H had been added as specified in the procedure. Dilutions made for producing standard curves were also made in the NH_4 EDTA solution. The wave-length used for Ca 24 was 422m,u and, for Mg_2 +, 285.2 m , u . Aliquots of the water extract were brought to the proper mixture by addition of an equal volume of 50 mm NH_4 EDTA. Aliquots of the acid extract were gently heated to dryness after addition of one-third volume of 30% H_20_2 and then the residue dissolved in 25 mm \NH_4 EDTA.

In general, each experiment had two factors: stress condition factor at three levels of treatments and foliar application factor at ten levels of treatments. These were completely randomized over three blocks; each of thirty experimental units of treatment combinations with three samples and one replicate per unit. Consequently, the single investigation season involved a total of 810 seedlings = 3 samples × 3 blocks × 10 foliar treatments × 3 stress treatments × 3 experiments.

Experiments were arranged as factorial in a completely randomized design.

Data were statistically analyzed using F. test via analysis of variance as described by **Snedecor and Cochran, (1989)** and means were compared by Duncan critical range at a probability level of 5% **(Duncan, 1955)** by means of SAS 1995 computer program.

4- RESULTS

Experiment 1:

4-1. Effect of foliar applications, irrigation intervals and their interaction on **Plant Height (cm)** in the 1st and 2nd seasons was significant was significant, (Table 1).

4-1.a. The irrigation intervals affected plant height significantly in both seasons. The tallest plants were a result of watering every 4 days (42.26 and 41.13 cm, respectively). Irrigating every 8 days came directly in the next grade as recorded (34.42 and 34.95 cm) in the first and second seasons, respectively. However, irrigating every 16 days recorded the lowest value in the two seasons (28.38 and 28.46 cm, respectively).

4-1.b. The effect of foliar applications in the 1st and 2nd seasons was significant. The tallest plants were a result of applying moringa exract 10.0% (37.72 and 37.86 cm, respectively) while the lowest one was observed after using control treatment (30.67 and 31.45 cm, respectively in both seasons).

4-1.c. Effect of the interaction between foliar applications and irrigation intervals was significant, the tallest plants were produced when irrigating at 4 days interval and applying treatment of moringa exract 10.0% in the 1st season and seaweed extract 7.5% in 2nd season (47.23 and 47.73 cm, respectively). In this regard 8 days interval + seaweed extract 7.5% came directly in the next grade recorded (36.07 and 39.20 cm, respectively) in each season, when compared with 16 days irrigation intervals combined with treatment of moringa exract 10.0% in 1st season and treatment seaweed extract 2.5% in 2nd season gave the shortest plants (30.17 and 30.15 cm, respectively). It should be mentioned that all plants watered at 16 days interval and having treatment (seaweed extract 7.5%) died.

Table (1): Effect of foliar applications, irrigation intervals and their interaction on plant height (cm) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	**4 days**	**8 days**	**16 days**	**Mean**
Control	37.13^{c-e}	32.13^{gm}	30.86^{km}	30.67 F
Salicylic acid 0.5 mM	38.40^{bc}	33.23^{f-m}	31.87^{h-m}	34.50 DE
Salicylic acid 1.0 mM	37.26^{cd}	34.93^{d-h}	33.37^{f-l}	35.19 CD
Salicylic acid 1.5 mM	37.26^{b}	35.05^{d-g}	33.07^{f-m}	36.41 A-C
Moringa extract 2.5%	40.53^{b}	33.87^{f-k}	31.57 $^{j-m}$	35.32 BD
Moringa extract 5.0%	46.13^{a}	34.77 $^{d-i}$	30.74 $^{l-m}$	37.21 A
Moringa extract 10.0%	47.23 ^{a}	35.77 $^{c-f}$	30.17^{m}	37.72 A
Seaweed extract 2.5%	44.97^{a}	34.37 $^{d-j}$	31.80^{i-m}	37.04 AB
Seaweed extract 5.0%	45.50^{a}	34.03 $^{e-j}$	30.33^{l-m}	36.62 A-C
Seaweed extract 7.5%	44.30^{a}	36.07 $^{c-f}$	0.00^{n}	36.79 A-C
Mean	42.26 A\	34.42 B\	28.38 C\	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	**4 days**	**8 days**	**16 days**	**Mean**
Control	36.53 $^{e-h}$	33.00 $^{i-l}$	31.11 $^{j-l}$	31.45 F
Salicylic acid 0.5 mM	37.83 $^{d-f}$	34.11^{g-j}	30.70 ^{kl}	34.21 DE
Salicylic acid 1.0 mM	41.37 ^{bc}	33.50 $^{f-i}$	31.30 $^{j-l}$	35.39 B-D
Salicylic acid 1.5 mM	43.13 ^{b}	34.91 $^{f-i}$	32.60 $^{j-l}$	36.88 AB
Moringa extract 2.5%	37.30 $^{e-g}$	33.85 $^{h-k}$	32.20 $^{i-l}$	34.45 DE
Moringa extract 5.0%	42.03 ^{bc}	35.20 $^{f-i}$	32.91 $^{i-l}$	36.71 A-C
Moringa extract 10.0%	42.43 ^{bc}	38.00 $^{d-f}$	33.15 $^{i-l}$	37.86 A
Seaweed extract 2.5%	41.00 $^{b-d}$	33.80 $^{h-k}$	30.15 ^{l}	34.98 C-E
Seaweed extract 5.0%	41.97 ^{bc}	33.90 $^{h-k}$	30.50 ^{l}	35.46 B-D
Seaweed extract 7.5%	47.73 ^{a}	39.20 $^{c-e}$	0.00^{m}	35.98 BC
Mean	41.13 A\	34.95 B\	28.46 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-2. Effect of foliar applications, irrigation intervals and their interaction on **Number of leaves/ plant** in the 1st and 2nd seasons was significant (Table 2).

4-2.a. The effect of irrigation intervals was significant in both seasons. The greatest number of leaves was a result of watering every 4 days (38.18 and 45.89 leaves, respectively) followed by 8 days intervals (30.37 and 33.24 leaves, respectively). The lowest one resulted when irrigation regime was 16 days, this number decreased simultaneously to (18.52 and 21.27 leaves, respectively).

4-2.b. Effect of foliar applications: The greatest numbers of leaves in the 1st and 2nd seasons were induced by treatments of moringa exract 10.0% and seaweed extract 2.5% (37.21 and 42.70 leaves, respectivey). Meanwhile, the lowest value in the same respect was observed when treatment control was applied (17.86 and 20.98 leaves, respectively).

4-2.c. Effect of the interaction between foliar applications and irrigation intervals in the 1st and 2nd seasons was significant. Applying treatment seaweed extract 7.5% + watering at 4 days gave rise to the greatest number of leaves (53.90 and 59.93 leaves, respectively). Plants treated with moringa extract at 10.0% in the 1st and seaweed extract 7.5% in the 2nd season + 8 days interval came in the next position for number of leaves (39.47 and 43.53 leaves, respectively). The lowest record was noticed when control + 16 days watering interval were applied (13.50 and 15.70 leaves, respectively). Plants watered at 16 days interval + seaweed extract 7.5% died.

Table (2): Effect of foliar applications, irrigation intervals and their interaction on number of leaves/ plant in two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	24.40 $^{g-l}$	15.70 ^{kl}	13.50 ^{l}	17.86 D
Salicylic acid 0.5 mM	30.73 $^{e-h}$	25.50 $^{g-k}$	14.93 ^{kl}	23.72 CD
Salicylic acid 1.0 mM	31.40 $^{d-g}$	27.40 $^{f-j}$	16.77 $^{j-l}$	25.19 C
Salicylic acid 1.5 mM	34.90 $^{c-g}$	29.97 $^{e-h}$	14.33 ^{l}	26.40 BC
Moringa extract 2.5%	33.73 $^{d-g}$	33.80 $^{d-g}$	18.50 $^{i-l}$	28.68 BC
Moringa extract 5.0%	37.83 $^{b-f}$	36.67 $^{c-f}$	20.40 $^{h-l}$	31.63 AB
Moringa extract 10.0%	45.07 $^{a-c}$	39.47 $^{b-e}$	27.10 $^{f-j}$	37.21 A
Seaweed extract 2.5%	41.80 $^{b-d}$	32.97 $^{d-g}$	31.03 $^{d-h}$	35.27 A
Seaweed extract 5.0%	48.07 ^{ab}	34.47 $^{c-g}$	28.60 $^{e-i}$	37.04 A
Seaweed extract 7.5%	53.90 ^{a}	27.80 $^{f-i}$	0.00 ^{m}	27.23 BC
Mean	38.18 A\	30.37 B\	18.52 C\	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	27.13 $^{k-m}$	20.10 ^{op}	15.70 ^{p}	20.98 F
Salicylic acid 0.5 mM	38.47 ^{fg}	24.57 ^{mn}	19.10 ^{op}	27.38 E
Salicylic acid 1.0 mM	38.67 ^{fg}	29.00 $^{j-l}$	21.00 ^{no}	29.56 E
Salicylic acid 1.5 mM	45.73 ^{cd}	32.63 $^{h-j}$	23.84 ^{mn}	34.07 D
Moringa extract 2.5%	44.23 ^{de}	34.40 $^{g-i}$	24.30 ^{mn}	34.31 CD
Moringa extract 5.0%	49.40 ^{c}	33.40 ^{hi}	24.50 ^{mn}	35.79 CD
Moringa extract 10.0%	54.83 ^{b}	35.67 ^{gh}	25.80 ^{lm}	38.77 B
Seaweed extract 2.5%	44.23 ^{de}	38.03 ^{fg}	27.70 $^{k-m}$	36.66 BC
Seaweed extract 5.0%	56.23 ^{ab}	41.07 ^{ef}	30.80 $^{i-k}$	42.70 A
Seaweed extract 7.5%	59.93 ^{a}	43.53 ^{de}	0.00 ^{q}	34.49 CD
Mean	45.89 A\	33.24 B\	21.27 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-3. Effect of foliar applications, irrigation intervals and their interaction on **stem diameter (mm)** in the 1st and 2nd seasons was significant, (Table 3)

4-3.a. The effect of irrigation intervals in the 1st and 2nd. The thichest plants were a result of watering every 4 days (7.15 and 7.11 mm, respectively) followed by 8 days irrigation intervals (6.46 and 5.92 mm, respectively). Increased to 16 days, stem diameter decreased to (4.62 mm and 4.87) in both seasons.

4-3.b. The effect of foliar applications ans 2nd season, it could be noticed that the highest values belonged to treatments of seaweed extract 5.0% in the 1st season and moringa extract 10.0% in the 2nd season (7.27, 7.30 mm, respectively). Treatment of control induced the thinnest stems (3.72 and 4.43 mm, respectively) in both seasons.

4-3.c. Effect of the interaction between foliar applications and irrigation intervals The highest values in this regard were obtained when treatment seaweed extract at 7.5% were applied in the 1st and 2nd seasons to plants watered at 4 days intervals (8.07 and 7.77 mm, respectively). Plants having treatment of seaweed extract at 7.5% + 8 days interval came in the next grade for (7.63 and 7.73 mm, respectively) in each season. The lowest record was a result of combining treatment control and 16 days interval (2.75 and 3.90 mm, respectively). Plants watered at 16 days interval and having seaweed extract 7.5% died.

Table (3): Effect of foliar applications, irrigation intervals and their interaction on stem diameter (mm) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	4.33 ^{hi}	4.06 $^{h-j}$	2.75 ^{j}	3.72 E
Salicylic acid 0.5 mM	6.46^{c-f}	5.80^{fg}	3.43 ^{ij}	5.23 D
Salicylic acid 1.0 mM	6.56^{b-f}	6.07^{d-g}	4.31 ^{hi}	5.65 CD
Salicylic acid 1.5 mM	7.00^{a-f}	6.300^{c-f}	4.86 ^{gh}	6.05 BC
Moringa extract 2.5%	7.97^{a}	6.77 $^{a-f}$	5.81 $^{e-g}$	6.85 A
Moringa extract 5.0%	7.87^{ab}	7.10 $^{a-f}$	6.28 $^{c-f}$	7.08 A
Moringa extract 10.0%	7.86ab	7.17 $^{a-e}$	5.97 $^{e-g}$	6.99 A
Seaweed extract 2.5%	7.37 $^{a-d}$	6.33^{c-f}	6.40 $^{c-f}$	6.70 AB
Seaweed extract 5.0%	8.07 ^{a}	7.33^{a-d}	6.42 $^{c-f}$	7.27 A
Seaweed extract 7.5%	8.07 ^{a}	7.63^{a-c}	0.00 ^{k}	5.23 D
Mean	7.15A\	6.46 B\	4.62 C\	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	5.40^{h-l}	4.00 $^{m-o}$	3.90 ^{no}	4.43 F
Salicylic acid 0.5 mM	6.60^{b-i}	4.70 $^{m-l}$	3.80 ^{o}	5.03 EF
Salicylic acid 1.0 mM	6.50^{b-j}	5.80 $^{f-l}$	4.70 $^{l-o}$	5.66 DE
Salicylic acid 1.5 mM	7.23^{a-e}	6.20 $^{e-k}$	5.3 $^{i-l}$	6.25 CD
Moringa extract 2.5%	7.23 $^{a-e}$	5.43 $^{g-l}$	5.23 $^{j-m}$	5.96 CD
Moringa extract 5.0%	7.43 $^{a-d}$	6.03 $^{e-k}$	5.80 $^{f-l}$	6.42 BC
Moringa extract 10.0%	8.03 ^{a}	7.43 $^{a-d}$	6.43 $^{c-j}$	7.30 A
Seaweed extract 2.5%	7.20 $^{a-e}$	5.13 $^{k-n}$	6.73^{a-g}	6.35 B-D
Seaweed extract 5.0%	7.73 $^{a-c}$	6.70 $^{b-h}$	6.80^{a-f}	7.08 AB
Seaweed extract 7.5%	7.77 ^{ab}	7.73 $^{a-c}$	0.00 ^{p}	5.17 EF
Mean	7.11 A\	5.92 B\	4.87 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-4. Effect of foliar applications, irrigation intervals and their interaction on **number of branches/ plant** in the 1st and 2nd seasons was significant, (Table 4).

4-4.a. The effect of irrigation intervals, in 1st season and 2nd seasons, the highest number of branches was a result of watering every 4 days (4.34 and 4.70 branches, respectively). Irrigating every 8 days came directly after that as recorded (3.17 and 3.77 branches, respectively). As irrigation intervals increased to 16 days the number of branches declined to (2.90 and 2.58 branches, respectively).

4-4.b. The effect of foliar applications on number of branches in the 1st and 2nd seasons the highest values were a result of using treatment of seaweed extract 2.5% (4.28 and 4.62 branches, respectively). The lowest grades were obtained when treatment control was applied (2.43 and 2.29 branches, respectively).

4-4.c. The effect of the interaction between foliar applications and irrigation intervals affected number of branches in each season was significant. The greatest number of branches resulted when treatment of seaweed extract 7.5% in the 1st season and seaweed extract 5.0% in the 2nd season + 4 days irrigation interval were applied (5.56 and 5.56 branches/ plant, respectively). Plants having treatments seaweed extract 7.5% and moringa extract 10.0% + 8 days irrigations shared in the highest grade for (3.80 and 4.97, respectively) in both seasons. The lowest value in this concern was obtained when treatment of control was combined with 16 days interval (1.83 and 1.16 branches/ plant, respectively). Plants watered at 16 days interval and having seaweed extract 7.5% died.

Table (4): Effect of foliar applications, irrigation intervals and their interaction on number of branches/ plant in the two seasons

1st season, 2016-2017 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	3.06 $^{h-m}$	2.40 ^{mn}	1.83 ^{n}	2.43 E
Salicylic acid 0.5 mM	3.13 $^{e-k}$	2.50 $^{l-n}$	3.10 $^{g-m}$	2.91 DE
Salicylic acid 1.0 mM	3.57 $^{e-k}$	2.66 l-n	2.33 ^{mn}	2.85 DE
Salicylic acid 1.5 mM	3.93 $^{d-g}$	3.00 l-n	2.77 $^{k-m}$	3.23 CD
Moringa extract 2.5%	4.40 $^{b-e}$	2.93 $^{j-m}$	3.57 $^{e-j}$	3.63 BC
Moringa extract 5.0%	4.80 $^{a-c}$	3.27 $^{f-l}$	3.80 $^{e-i}$	3.95 AB
Moringa extract 10.0%	5.23 ^{ab}	3.63 $^{e-j}$	3.87 $^{d-h}$	4.24 A
Seaweed extract 2.5%	4.60 $^{a-c}$	3.67 $^{e-j}$	3.77 $^{d-j}$	4.01 AB
Seaweed extract 5.0%	5.06 ^{ab}	3.80 $^{d-i}$	3.97 $^{c-f}$	4.28 A
Seaweed extract 7.5%	5.56 ^{a}	3.80 $^{d-i}$	0.00 ^{o}	3.12 D
Mean	4.34 A\	3.17 B\	2.90 C\	

2nd season, 2017-2018 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	3.43^{h-k}	2.26 ^{lm}	1.16^{n}	2.29 F
Salicylic acid 0.5 mM	4.00^{d-j}	3.06 $^{j-l}$	1.91^{mn}	2.99 E
Salicylic acid 1.0 mM	4.13^{d-i}	3.16 $^{i-l}$	2.26 ^{lm}	3.19 DE
Salicylic acid 1.5 mM	4.50^{c-g}	3.63 $^{g-k}$	2.70 $^{k-m}$	3.61 B-D
Moringa extract 2.5%	4.56^{b-g}	3.83^{f-j}	3.20^{i-l}	3.86 BC
Moringa extract 5.0%	4.96^{a-d}	4.23^{d-h}	3.23^{i-l}	4.14 AB
Moringa extract 10.0%	5.53^{ab}	4.97^{a-d}	3.40^{h-k}	4.63 A
Seaweed extract 2.5%	4.87^{a-e}	3.90^{e-j}	3.71^{f-j}	4.16 AB
Seaweed extract 5.0%	5.56^{a}	4.06 $^{d-i}$	4.23^{d-h}	4.62 A
Seaweed extract 7.5%	5.40^{a-c}	4.63^{a-f}	0.00 ^{o}	3.34 C-E
Mean	4.70 A\	3.77 B\	2.58 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-5. Effect of foliar applications, irrigation intervals and their interaction on **Shoot fresh weight (g/ plant)** in the 1^{st} and 2^{nd} seasons was significant (Table 5).

4-5.a. In the 1^{st} and 2^{nd} seasons the effect of irrigation intervals was significant. First grade of fresh shoots was a result of watering every 4 days (41.47 and 33.58 g/ plant, respectively). Second grade was a result of watering every 8 days (30.94 and 27.17 g, respectively). While the lightest ones were observed when irrigation at 16 days interval was applied (21.73 and 22.77 g/ plant, respectively).

4-5.b. The effect of foliar applications on shoot fresh weight: the heaviest fresh shoots resulted when treatments of seaweed extract 5.0% and moringa extract 10.0% were applied in the 1^{st} and 2^{nd} seasons (38.21 and 35.69 g/ plant, respectively). While the lowest one was a result of using treatment of control (19.39 and 16.49 g/ plant, respectively) in both seasons.

4-5.c. Effect of the interaction between foliar applications and irrigation intervals: the heaviest fresh shoots was a result of using irrigation at 4 days interval combined with treatment moringa extract 10.0% in the two seasons (51.57 and 41.77 g/ plant, respectively). Plants have seaweed extract 7.5% + 8 days intervals in both seasons shared statistically in the second grade (40.10 and 32.90 g/ plant, respectively). The lightest fresh weight was obtained when treatment control combined with watering every 16 days was used (14.77 and 10.53 g/ plant). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (5): Effect of foliar applications, irrigation intervals and their interaction on shoot fresh weight (g)/ plant in the two seasons

1st season, 2016- 2017 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	25.00^{h-k}	18.40 $^{k-m}$	14.77^{m}	19.39 E
Salicylic acid 0.5 mM	27.30 $^{g-i}$	17.50 ^{lm}	20.10 $^{j-m}$	21.63 E
Salicylic acid 1.0 mM	36.23 $^{c-f}$	26.87 $^{g-j}$	22.53 $^{i-l}$	28.54 D
Salicylic acid 1.5 mM	41.00 ^{bc}	30.20 $^{f-h}$	20.20^{j-m}	30.47 CD
Moringa extract 2.5%	42.10 ^{bc}	31.70 $^{e-h}$	28.23^{g-i}	34.01 BC
Moringa extract 5.0%	49.93^{a}	33.57 $^{d-g}$	26.43^{h-j}	36.64 AB
Moringa extract 10.0%	51.57^{a}	37.600^{c-e}	25.33^{h-j}	38.16 A
Seaweed extract 2.5%	45.10^{ab}	36.13^{c-f}	29.27^{g-i}	36.83 AB
Seaweed extract 5.0%	46.93^{ab}	37.30 $^{c-e}$	30.40^{f-h}	38.21 A
Seaweed extract 7.5%	49.50 ^{a}	40.10^{b-d}	0.00 ^{n}	29.86 D
Mean	41.47 A\	30.94 B\	21.73 C\	
2 nd season, 2017-2018 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	22.27 ^{kl}	16.67 ^{lm}	10.53 ^{m}	16.49 E
Salicylic acid 0.5 mM	29.86 $^{d-i}$	24.10 $^{h-k}$	14.90 ^{m}	22.95 D
Salicylic acid 1.0 mM	32.37 $^{b-g}$	24.00 $^{i-k}$	22.37 $^{j-l}$	26.24 CD
Salicylic acid 1.5 mM	34.10 $^{b-e}$	26.40 $^{f-k}$	34.97 $^{b-e}$	31.82 B
Moringa extract 2.5%	37.03 $^{a-c}$	29.13^{e-i}	27.10^{f-k}	31.09 B
Moringa extract 5.0%	38.23 ^{ab}	30.46 c-i	29.60^{e-i}	32.76 AB
Moringa extract 10.0%	41.77 ^{a}	32.27 $^{b-g}$	33.03 $^{b-f}$	35.69 A
Seaweed extract 2.5%	30.70 $^{c-h}$	26.73^{f-k}	29.33^{e-i}	28.92 BC
Seaweed extract 5.0%	32.93 $^{b-f}$	29.03^{e-j}	25.93^{g-k}	29.30 BC
Seaweed extract 7.5%	36.53 $^{a-d}$	32.90^{b-f}	0.00^{n}	23.14 D
Mean	33.58 A\	27.17 B\	22.77 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-6. Effect of foliar applications, irrigation intervals and their interaction on **root fresh weight (g/ plant)** in the 1st and 2nd seasons was significant, (Table 6)

4-6.a. The effect of irrigation intervals was significant. In the 1st and 2nd seasons, the highest weight was a result of watering every 4 days (33.37 and 26.34 g/ plant, respectively). Meanwhile, irrigating every 8 days recorded next grade (22.72 and 19.77 g/ plant, respectively). As irrigation intervals increased to 16 days recorded the lowest values (14.77 and 18.98 g/ plant, respectively) in both seasons.

4-6.b. The effect of foliar applications: the heaviest fresh roots resulted when treatment moringa extract 10.0% was used (29.18 and 26.84 g, respectively) in the 1st and 2nd seasons. The lowest records resulted when treatment control was applied (14.60 and 13.60 g, respectively).

4-6.c. The interaction between foliar applications and irrigation intervals affected root fresh weight in the 1st and 2nd seasons significantly. The heaviest root fresh weight resulted when treatment moringa extract 10.0% + 4 days irrigation interval (45.77 and 34.20 g/ plant, respectively) in both seasons. Other combinations were included also in this highest category was seaweed extract 7.5%+ 4 days irrigation intervals (40.90 and 31.93 g/ plant, respectively) in both seasons. However, plants having treatments seaweed extract 7.5% + 8 days interval came directly in the next grade (28.70 and 25.00 g/ plant, respectively) in both seasons. Records in the lowest position included plants watered every 16 days and experienced treatment control (9.63 and 8.30 g/ plant, respectively). Plants irrigated every 16 days and having seaweed extract at 7.5% died.

Table (6): Effect of foliar applications, irrigation intervals and their interaction on root fresh weight (g)/ plant in the two seasons

1st season, 2016-2017 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	20.40^{g-k}	13.76^{lm}	9.63^{m}	14.60 F
Salicylic acid 0.5 mM	25.46^{d-h}	20.70^{g-k}	16.33^{kl}	20.83 E
Salicylic acid 1.0 mM	29.40^{de}	20.46^{g-k}	14.97^{k-m}	21.61 DE
Salicylic acid 1.5 mM	31.83^{cd}	28.03^{e}	17.05^{j-l}	25.64 AC
Moringa extract 2.5%	27.63^{d-f}	20.20^{g-l}	16.73^{j-l}	21.52 DE
Moringa extract 5.0%	37.73^{bc}	24.26^{e-i}	18.87^{i-l}	26.95 AC
Moringa extract 10.0%	45.77^{a}	23.13^{e-j}	18.63^{i-l}	29.18 A
Seaweed extract 2.5%	37.75^{bc}	21.30^{f-k}	16.43^{kl}	25.16 BD
Seaweed extract 5.0%	36.83^{bc}	26.67^{d-g}	19.07^{h-l}	27.52 AB
Seaweed extract 7.5%	40.90^{ab}	28.70^{de}	0.00^{n}	23.20 CE
Mean	33.37 A\	22.72 B\\	14.77 C\	
2nd season, 2017-2018 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	17.53^{i-l}	14.97^{kl}	8.30^{m}	13.60 F
Salicylic acid 0.5 mM	20.10^{f-l}	14.60^{lm}	16.00^{j-l}	17.00 EF
Salicylic acid 1.0 mM	24.65^{c-h}	19.00^{g-l}	22.37^{d-i}	22.00 B-D
Salicylic acid 1.5 mM	26.30^{b-f}	20.67^{f-l}	28.07^{a-d}	25.01 AB
Moringa extract 2.5%	23.00^{d-i}	18.37^{h-l}	22.70^{d-i}	21.35 CD
Moringa extract 5.0%	27.23^{b-e}	18.73^{g-l}	20.60^{f-l}	22.19 B-D
Moringa extract 10.0%	34.20^{a}	21.00^{e-k}	25.33^{c-f}	26.84 A
Seaweed extract 2.5%	28.50^{a-d}	22.23^{d-j}	23.17^{d-i}	24.63 A-C
Seaweed extract 5.0%	29.63^{a-c}	23.17^{d-i}	23.27^{d-i}	25.35 AB
Seaweed extract 7.5%	31.93^{ab}	25.00^{c-g}	0.00^{n}	18.97 DE
Mean	26.34 A\	19.77 B\	18.98 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-7. Effect of foliar applications, irrigation intervals and their interaction on **shoot dry weight (g)/ plant** in the 1st and 2nd seasons was significant. (Table, 7).

4-7.a. The effect of irrigation intervals was significant: The heaviest dry shoots were a result of watering every 4 days (25.58 and 20.22 g/ plant, respectively). Moreover, irrigating every 8 days come directly in the next grade (16.75 and 15.02 g/ plant, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days the lowest values were recorded (10.91 and 12.70 g/ plant, respectively) in both seasons.

4-7.b. The effect of foliar applications on shoot dry weight: the heaviest dry shoots resulted when moringa extract 10.0% was applied (22.97 and 22.65 g/ plant, respectively) in the 1st and 2nd seasons. Furthermore, treatment control achieved the lowest record in this concern (9.73 and 8.98 g/ plant, respectively) in both seasons.

4-7.c. The interaction between foliar applications and irrigation intervals affected shoot dry weight significantly. The greatest shoot dry weight resulted when the plants treated with moringa extract at 10.0% in the 1st and seaweed extract at 7.5% in 2nd season + 4 days irrigation interval (36.90 and 28.60 g/ plant, respectively) in both seasons. Furthermore, other treatments shared in this highest grade were a result of applying treatments of seaweed extract 7.5% in the 1st season and moringa extract 10.0% in the 2nd season (35.73 and 28.33 g/ plant, respectively). Plants having treatments seaweed extract 7.5% and moringa extract 10.0 % + 8 days interval came in the second position (25.66 and 20.90 g/ plants, respectively) in both seasons. The lowest position records in plants watered every 16 days and treatment control (6.73 and 6.17 g/ plants) in both seasons. Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (7): Effect of foliar applications, irrigation intervals and their interaction on shoot dry weight (g)/ plant in the two seasons

	1st season, 2016-2017 **Irrigation Intervals**				
	Foliar applications	4 days	8 days	16 days	Mean
1	Control	13.50 $^{h-l}$	8.967 ^{lm}	6.73 ^{m}	9.73 F
2	Salicylic acid 0.5 mM	15.60 $^{g-l}$	9.66 $^{k-m}$	10.37 $^{j-m}$	11.87 EF
3	Salicylic acid 1.0 mM	20.17 $^{d-h}$	12.20 $^{i-m}$	9.33 $^{k-m}$	13.90 DE
4	Salicylic acid 1.5 mM	22.10 $^{c-g}$	16.00 $^{g-k}$	12.33 $^{i-m}$	16.78 CD
5	Moringa extract 2.5%	23.40 $^{c-f}$	17.83 $^{f-i}$	14.53 $^{h-l}$	18.59 BC
6	Moringa extract 5.0%	26.66 $^{b-d}$	18.73 $^{f-i}$	16.70 $^{f-j}$	20.70 AB
7	Moringa extract 10.0%	36.90 ^{a}	21.27 $^{d-g}$	10.73 $^{j-m}$	22.97 A
8	Seaweed extract 2.5%	28.80 ^{bc}	17.66 $^{f-i}$	14.20 $^{h-l}$	20.22 AC
9	Seaweed extract 0.50%	32.90 ^{ab}	19.50 $^{e-h}$	14.30 $^{h-l}$	22.23 AB
10	Seaweed extract 7.5%	35.73 ^{a}	25.66 $^{c-e}$	0.00 ^{n}	20.47 AC
	Mean	25.58 A\	16.75 B\	10.91 C\	
	2nd season, 2017-2018 **Irrigation Intervals**				
	Foliar applications	4 days	8 days	16 days	Mean
1	Control	12.00 $^{i-l}$	8.87 $^{k-m}$	6.17 ^{m}	8.98 F
2	Salicylic acid 0.5 mM	17.60 $^{b-h}$	11.83 $^{j-l}$	8.27 ^{lm}	12.56 E
3	Salicylic acid 1.0 mM	16.52 $^{c-i}$	13.73 $^{g-k}$	12.43 $^{i-l}$	14.23 DE
4	Salicylic acid 1.5 mM	20.37 $^{b-e}$	15.20 $^{f-j}$	16.47 $^{d-j}$	17.34 BC
5	Moringa extract 2.5%	18.87 $^{b-f}$	15.87 $^{e-j}$	15.67 $^{e-j}$	16.80 B-D
6	Moringa extract 5.0%	21.67 ^{b}	18.23 $^{b-g}$	16.90 $^{b-i}$	18.93 B
7	Moringa extract 10.0%	28.33 ^{a}	20.90 $^{b-d}$	18.73 $^{b-g}$	22.65 A
8	Seaweed extract 2.5%	15.77 $^{e-j}$	12.30 $^{i-l}$	19.37 $^{b-f}$	15.81 CD
9	Seaweed extract 5.0%	21.53 ^{bc}	15.33 $^{e-j}$	13.10 $^{h-l}$	16.65 B-D
10	Seaweed extract 7.5%	28.60 ^{a}	17.93 $^{b-h}$	0.00 ^{n}	15.84 CD
	Mean	20.22 A\	15.02 B\	12.70 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-8. Effect of foliar applications, irrigation intervals and their interaction on **root dry weight (g)/ plant** in the 1st and 2nd seasons was significant (Table 8)

4-8.a. The effect of irrigation intervals was significant: The first category of dry roots was a result of watering every 4 days (15.57 and 16.64 g/ plant, respectively). Second grade was a result of watering every 8 days (11.52 and 11.04 g/ plant, respectively). While the lightest ones were observed when irrigation at 16 days interval was applied (8.04 and 10.92 g/ plant, respectively).

4-8.b. The effect of foliar applications on root dry weight season was significant. The heaviest dry roots were a result of using treatment (moringa extract 10.0% in both seasons) (14.79 and 16.83 g/ plant, respectively). The lightest dry roots were confined to treatment control (7.43 and 7.50 g/ plant, respectively).

4-8.c. The interaction between foliar applications and irrigation intervals affected root dry weight significantly. The greatest root dry weight resulted when treatments moringa extract 10.0% in the 1st season and seaweed extract 7.5% in the 2nd season+ 4 days irrigation interval (20.20 and 24.07 g/ plant, respectively). Other treatments shared in this grade, was a result of seaweed extract 7.5% and moringa extract 10.0 % (19.60 and 22.77g/ plant, respectively) in each season. Meanwhile, plants treated with seaweed extract 5.0% or seaweed extract 7.5% + 8 days interval shared statistically and came in the second grade for (14.63 and 15.40 g/ plant, respectively) in both seasons. Records in the lowest position included plants watered every 16 days and treatment control (5.66 and 3.80 g/ plant, respectively) in 1st and 2nd seasons. Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (8): Effect of foliar applications, irrigation intervals and their interaction on root dry weight (g)/ plant in the two seasons

1st season, 2016-2017 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	9.10^{g-j}	7.533^{ij}	5.66^{j}	7.43 E
Salicylic acid 0.5 mM	11.43^{d-i}	9.93^{e-j}	8.03^{ij}	9.80 DE
Salicylic acid 1.0 mM	16.46^{a-c}	10.06^{e-j}	8.26^{ij}	11.60 BD
Salicylic acid 1.5 mM	16.70^{a-c}	13.93^{b-f}	9.60^{f-j}	13.41 AB
Moringa extract 2.5%	13.06^{c-g}	10.13^{e-i}	8.43^{h-j}	10.54 CD
Moringa extract 5.0%	16.73^{a-c}	10.73^{d-I}	9.76^{f-j}	12.41 A-C
Moringa extract 10.0%	20.20^{a}	12.83^{c-h}	11.33^{d-i}	14.79 A
Seaweed extract 2.5%	14.20^{b-e}	11.63^{d-i}	8.56^{h-j}	11.46 BD
Seaweed extract 5.0%	18.20^{ab}	14.63^{b-d}	10.70^{d-i}	14.51 A
Seaweed extract 7.5%	19.60^{a}	13.73^{c-f}	0.00^{k}	11.11 BD
Mean	15.57 A\	11.52 B\	8.04 C\	
2nd season, 2017-2018 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	10.63^{f-j}	8.07^{jk}	3.80^{kl}	7.50 E
Salicylic acid 0.5 mM	11.63^{e-j}	8.00^{jk}	8.300^{i-k}	9.31 DE
Salicylic acid 1.0 mM	13.23^{c-h}	10.03^{g-j}	13.57^{c-h}	12.28 C
Salicylic acid 1.5 mM	16.07^{b-e}	11.43^{e-j}	14.93^{b-f}	14.14 A-C
Moringa extract 2.5%	13.57^{c-h}	9.10^{h-j}	13.00^{c-h}	11.88 CD
Moringa extract 5.0%	17.57^{b-c}	10.63^{f-j}	12.77^{d-i}	13.65 BC
Moringa extract 10.0%	22.77^{a}	13.13^{c-h}	14.60^{c-g}	16.83 A
Seaweed extract 2.5%	17.27^{a-c}	12.13^{e-j}	13.60^{c-h}	14.33 A-C
Seaweed extract 5.0%	19.60^{a-b}	12.47^{e-j}	14.63^{c-g}	15.57 AB
Seaweed extract 7.5%	24.07^{a}	15.40^{b-e}	0.00^{l}	13.15 BC
Mean	16.64 A\	11.04 B\	10.92 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-9. Effect of foliar applications, irrigation intervals and their interaction on **root length (cm)** in the 1st and 2nd seasons was significant (Table 9)

4-9.a. The effect of irrigation intervals was significant: The tallest root was a result of watering every 4 days (55.39 and 43.27 cm, respectively). Meanwhile, irrigating every 8 days came directly in the next grade (42.64 and 36.08 cm, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (24.89 and 21.25 cm, respectively) in both seasons.

4-9.b. The effect of foliar applications on root length: the tallest root length resulted when treatment (seaweed extract 5.0%) was applied (50.99 and 44.78 cm, respectively) in the 1st and 2nd seasons. On the other hand, control achieved the lowest value in this concern (18.53 and 16.34 cm, respectively) in both seasons.

4-9.c. The interaction between foliar applications and intervals affected root length in the 1st and 2nd seasons significantly. The tallest root length resulted when seaweed extract 7.5% + 4 days irrigation interval (73.30 and 52.53 cm, respectively) in each seasons. However, treatments of moringa extract 10.0% in 1st season and seaweed extract 5.0% in 2nd season + 4 days intervals shared in this highest grade (66.73 and 52.17 cm, respectively). Plants having treatments seaweed extract 7.5% and seaweed extract 5.0% + 8 days interval came in the second grade for (53.16 and 46.83 cm, respectively) in both seasons. The lowest position included plants watered every 16 days + control (18.53 and 16.34 cm, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (9): Effect of foliar applications, irrigation intervals and their interaction on root length (cm) in the two seasons

1st season, 2016-2017 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	23.93^{jk}	19.26 $^{j-l}$	12.40 l	18.53 F
Salicylic acid 0.5 mM	39.40^{gh}	32.63^{hi}	17.36^{kl}	29.80 E
Salicylic acid 1.0 mM	50.23^{ef}	39.00^{gh}	22.36^{jk}	37.20 D
Salicylic acid 1.5 mM	53.20^{d-f}	38.67^{gh}	26.66 ^{ij}	39.51 CD
Moringa extract 2.5%	59.16^{b-d}	45.50^{fg}	27.20^{ij}	43.95 BC
Moringa extract 5.0%	64.63^{bc}	51.96 $^{d-f}$	32.90^{hi}	49.83 A
Moringa extract 10.0%	66.73^{ab}	51.23 $^{d-f}$	34.20^{hi}	50.72 A
Seaweed extract 2.5%	58.23^{c-e}	45.73^{fg}	37.20 ^{h}	47.05 AB
Seaweed extract 5.0%	65.10 ^{bc}	49.26^{f}	38.60^{gh}	50.99 A
Seaweed extract 7.5%	73.30 ^{a}	53.16 $^{d-f}$	0.00 ^{m}	42.15 C
Mean	55.39 A\	42.64 B\	24.89 C\	
2nd season, 2017-2018 **Irrigation Intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	23.33^{hi}	15.70 $^{j-l}$	10.10 ^{l}	16.34 E
Salicylic acid 0.5 mM	36.73^{c-e}	28.70^{f-h}	14.63^{kl}	26.68 D
Salicylic acid 1.0 mM	42.10 ^{bc}	33.40 $^{e-g}$	17.53^{i-k}	31.01 C
Salicylic acid 1.5 mM	41.90 ^{bc}	33.90^{e-g}	19.53^{i-k}	31.78 C
Moringa extract 2.5%	38.43^{c-e}	34.63^{d-g}	22.23 $^{h-j}$	31.76 C
Moringa extract 5.0%	46.63 ab	41.50 b-d	27.80 gh	38.64 B
Moringa extract 10.0%	49.30 a	41.56 b-d	32.53 e-g	41.13 AB
Seaweed extract 2.5%	49.77 a	38.50 c-e	32.66 e-g	40.31 B
Seaweed extract 5.0%	52.17 a	46.83 ab	35.43 c-f	44.78 A
Seaweed extract 7.5%	52.53 a	46.17 ab	0.00 m	32.87 C
Mean	43.27 A\	36.08 B\	21.25 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

4-10. Effect of foliar applications, irrigation intervals and their interaction on **content of chlorophyll "a" mg/g fw** in the 1st and 2nd seasons (Table 10)

4-10.a. The effect of irrigation intervals: The greatest content of chlorophyll "a" was a result of watering either every 4 days (5.01 and 4.74 mg/g fw, respectively). Furthermore, irrigating every 8 days come directly in the next grade (4.37 and 3.84 mg/g fw, respectively) in 1st and 2nd seasons. As irrigation intervals increased to 16 days recorded the lowest values (3.49 and 2.74 mg/g fw, respectively) in both seasons.

4-10.b. The effect of foliar applications on chlorophyll "a": the highest content of chlorophyll "a" resulted when treatment seaweed extarct 5.0% was applied (4.54 and 3.99 mg/g fw, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract at 7.5% achieved the lowest record in this concern (3.20 and 2.93 mg/g fw, respectively) in each seasons.

4-10.c. The interaction between foliar applications and irrigation intervals on content of chlorophyll "a" in the 1st and 2nd season. The greatest content of chlorophyll "a" resulted when the seedlings treated with seaweed extract 5.0% + 4 days irrigation interval (5.23 and 4.85 mg/g fw, respectively) was applied in both seasons. Treatment of seaweed extract 2.5% in each season + 4 days intervals shared in this highest grade (5.22 and 4.81 mg/g fw, respectively). However plants treated with seaweed extract 7.5% + 8 days interval came directly in the second grade for (4.48 and 3.94 mg/g fw, respectively) in both seasons. Records in the lowest position included plants watered every 16 days + treatment control (3.74 and 2.94 mg/g fw, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (10): Effect of foliar applications, irrigation intervals and their interaction on chlorophyll "a" content (mg/g fw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	4.88	4.22	3.74	4.28
Salicylic acid 0.5 mM	4.89	4.28	3.78	4.32
Salicylic acid 1.0 mM	4.93	4.31	3.82	4.35
Salicylic acid 1.5 mM	4.95	4.35	3.85	4.38
Moringa extract 2.5%	4.96	4.36	3.88	4.40
Moringa extract 5.0%	4.94	4.38	3.93	4.40
Moringa extract 10.0%	4.96	4.41	3.94	4.42
Seaweed extract 2.5%	5.22	4.43	3.96	4.44
Seaweed extract 5.0%	5.23	4.47	4.03	4.54
Seaweed extract 7.5%	5.13	4.48	0.00	3.20
Mean	5.01	4.37	3.49	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	4.63	3.74	2.94	3.77
Salicylic acid 0.5 mM	4.66	3.77	2.97	3.80
Salicylic acid 1.0 mM	4.67	3.83	2.91	3.80
Salicylic acid 1.5 mM	4.64	3.84	2.95	3.81
Moringa extract 2.5%	4.73	3.80	3.05	3.86
Moringa extract 5.0%	4.76	3.79	3.11	3.89
Moringa extract 10.0%	4.78	3.88	3.14	3.93
Seaweed extract 2.5%	4.81	3.91	3.15	3.96
Seaweed extract 5.0%	4.85	3.93	3.20	3.99
Seaweed extract 7.5%	4.48	3.94	0.00	2.93
Mean	4.74	3.84	2.74	

4-11. Effect of foliar applications, irrigation intervals and their interaction on **content of chlorophyll "b" (mg/g fw)** in the 1st and 2nd seasons (Table 11)

4-11.a. The effect of irrigation intervals: The highest content of chlorophyll "b" was a result of watering every 4 days (2.22 and 2.40 mg/g fw, respectively). Meanwhile, irrigating every 8 days come directly in the next grade (1.59 and 1.86 mg/g fw, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (1.03 and 0.80 mg/g fw, respectively) in both seasons.

4-11.b. The effect of foliar applications on chlorophyll "b": the highest content of chlorophyll "b" resulted when treatment of seaweed extract 5.0% was applied (1.75 and 1.78 mg/g fw, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract 7.5% achieved the lowest record in this concern (1.33 and 1.47 mg/g fw, respectively) in each seasons.

4-11.c. The interaction between foliar applications and irrigation intervals affected content of chlorophyll "b" in the 1st and 2nd seasons. The greatest content of chlorophyll "b" was a result when seaweed extract 7.5% + 4 days irrigation interval (2.35 and 2.47 mg/g fw, respectively) in each season. However, treatments of seaweed extract 5.0% in 1st season and seaweed extract 7.5% in 2nd season + 4 days intervals shared in this highest grade (2.33 and 2.47 mg/g fw, respectively). Plants having seaweed extract 5.0% + 8 days interval came in the second grade (1.67 and 1.95 mg/g fw, respectively) in each season. Records in the lowest position included plants watered every 16 days and experienced treatments salisylic acid 0.5 mm and control in each season (0.95 and 0.85 mg/g fw, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (11): Effect of foliar applications, irrigation intervals and their interaction on chlorophyll "b" content (mg/g fw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
foliar application	4 days	8 days	16 days	Mean
Control	2.17	1.52	0.95	1.55
salicylic acid 0.5 mM	2.19	1.53	0.97	1.56
salicylic acid 1.0 mM	2.00	1.56	1.13	1.56
salicylic acid 1.5 mM	2.14	1.57	1.14	1.62
moringa extract 2.5%	2.23	1.54	1.16	1.64
moringa extract 5.0%	2.26	1.61	1.24	1.70
moringa extract 10.0%	2.28	1.64	1.26	1.73
seaweed extract 2.5%	2.29	1.60	1.22	1.70
seaweed extract 5.0%	2.33	1.67	1.25	1.75
seaweed extract 7.5%	2.35	1.65	0.00	1.33
Mean	2.22	1.59	1.03	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	2.33	1.77	0.87	1.66
Salicylic acid 0.5 mM	2.36	1.78	0.85	1.66
Salicylic acid 1.0 mM	2.38	1.83	0.88	1.70
Salicylic acid 1.5 mM	2.31	1.80	0.86	1.66
Moringa extract 2.5%	2.38	1.84	0.85	1.69
Moringa extract 5.0%	2.42	1.86	0.87	1.72
Moringa extract 10.0%	2.44	1.87	0.91	1.74
Seaweed extract 2.5%	2.49	1.92	0.94	1.78
Seaweed extract 5.0%	2.43	1.95	0.96	1.78
Seaweed extract 7.5%	2.47	1.94	0.00	1.47
Mean	2.40	1.86	0.80	

4-12. Effect of foliar applications, irrigation intervals and their interaction on **carotenoids content (mg/g fw)** in the 1st and 2nd seasons (Table 12)

4-12.a. The effect of irrigation intervals: The highest carotenoids content was a result of watering every 4 days (1.71 and 1.95 mg/g fw, respectively). Moreover, irrigating every 8 days came directly in the next grade (1.23 and 1.32 mg/g fw, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (0.85 and 0.69 mg/g fw, respectively) in both seasons.

4-12.b. The effect of foliar applications: the highest carotenoids content resulted when treatment of seaweed extract 5.0% was applied (1.37 and 1.40 mg/g fw, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract 7.5% achieved the lowest record in this concern (1.03 and 1.10 mg/g fw, respectively) in each seasons.

4-12.c. The interaction between foliar applications and irrigation intervals on carotenoids content in the 1st and 2nd seasons. The highest carotenoids content resulted when treatments of seaweed extract 7.5% and moringa extract 10.0% + 4 days irrigation interval (1.81 and 1.99 mg/g fw, respectively) in each season, in addition to other treatments, the most prominent of which were treatment of seaweed extract 2.5% in the 1st season and seaweed extract 5.0% in the 2nd season plus 4 days irrigation intervals (1.77 and 1.98 mg/g fw, respectively). Plants having treatment seaweed extract 5.0%+ 8 days interval have the next grade (1.31 and 1.39 mg/g fw, respectively) in each season. Records in the lowest position included plants watered every 16 days and experienced control (0.86 and 0.72 mg/g fw, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (12): Effect of foliar applications, irrigation intervals and their interaction on carotenoids content (mg/g fw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	1.66	1.14	0.86	1.22
Salicylic acid 0.5 mM	1.67	1.17	0.86	1.23
Salicylic acid 1.0 mM	1.69	1.18	0.88	1.25
Salicylic acid 1.5 mM	1.57	1.24	0.92	1.24
Moringa extract 2.5%	1.68	1.26	0.96	1.30
Moringa extract 5.0%	1.72	1.23	1.00	1.32
Moringa extract 10.0%	1.74	1.25	0.95	1.31
Seaweed extract 2.5%	1.77	1.27	0.99	1.34
Seaweed extract 5.0%	1.75	1.31	1.05	1.37
Seaweed extract 7.5%	1.81	1.29	0.00	1.03
Mean	1.71	1.23	0.85	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	1.88	1.25	0.72	1.28
Salicylic acid 0.5 mM	1.95	1.27	0.74	1.32
Salicylic acid 1.0 mM	1.93	1.24	0.73	1.30
Salicylic acid 1.5 mM	1.96	1.29	0.77	1.34
Moringa extract 2.5%	1.94	1.32	0.74	1.33
Moringa extract 5.0%	1.97	1.35	0.76	1.36
Moringa extract 10.0%	1.99	1.37	0.84	1.40
Seaweed extract 2.5%	1.96	1.34	0.79	1.36
Seaweed extract 5.0%	1.98	1.39	0.84	1.40
Seaweed extract 7.5%	1.92	1.38	0.00	1.10
Mean	1.95	1.32	0.69	

4-13. Effect of foliar applications, irrigation intervals and their interaction on **total carbohydrate %** in the 1st and 2nd seasons (Table 13)

4-13.a. The effect of irrigation intervals: The highest total carbohydrate% was a result of watering every 4 days (24.06 and 25.78 % dw, respectively). Meanwhile, irrigating every 8 days come directly in the next grade (20.73 and 21.26 % dw, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (14.48 and 12.97 % dw, respectively) in both seasons.

4-13.b. The effect of foliar applications on total carbohydrate%: the highest total carbohydrate % resulted when seaweed extract 2.5% was applied (21.47 and 21.34 % dw, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract 7.5% achieved the lowest record in this concern (15.64 and 16.78 % dw, respectively) in both seasons.

4-13.c. The interaction between foliar applications and irrigation intervals on taotal carbohydrate%. The greatest carbohydrate% resulted when moringa extract 10.0% in 1st season and seaweed extract 7.5% in 2nd season + 4 days irrigation interval (25.50 and 27.20 % dw, respectively), Other treatment seaweed extract 2.5% in each season combined with 4 days irrigation intervals shared in the highest position (25.34 and 26.80 % dw, respectively). Furthermore, plants having seaweed extract 2.5% in the 1st season and seaweed extract 7.5% in 2nd season + 8 days intervals came in the next grade for (21.97 and 23.13 % dw, respectively). The plants watered every 16 days and control have the lowest values (14.51 and 13.25 % dw). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (13): Effect of foliar applications, irrigation intervals and their interaction on total carbohydrates% (dw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	22.00	18.30	14.51	18.27
Salicylic acid 0.5 mM	22.80	19.40	15.50	19.23
Salicylic acid 1.0 mM	23.36	19.75	15.25	19.45
Salicylic acid 1.5 mM	23.91	21.50	16.35	20.59
Moringa extract 2.5%	23.37	20.22	15.63	19.74
Moringa extract 5.0%	24.45	21.40	16.60	20.82
Moringa extract 10.0%	25.50	21.89	16.42	21.27
Seaweed extract 2.5%	25.34	21.97	17.10	21.47
Seaweed extract 5.0%	24.86	20.94	17.48	21.09
Seaweed extract 7.5%	25.00	21.93	0.00	15.64
Mean	24.06	20.73	14.48	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	24.10	19.41	13.25	18.92
Salicylic acid 0.5 mM	24.67	20.34	14.74	19.92
Salicylic acid 1.0 mM	24.68	20.74	14.20	19.87
Salicylic acid 1.5 mM	25.51	20.56	15.38	20.48
Moringa extract 2.5%	25.84	21.22	14.88	20.65
Moringa extract 5.0%	26.00	21.46	13.38	20.28
Moringa extract 10.0%	26.34	21.00	15.40	20.91
Seaweed extract 2.5%	26.80	22.41	14.82	21.34
Seaweed extract 5.0%	26.68	22.30	13.67	20.88
Seaweed extract 7.5%	27.20	23.13	0.00	16.78
Mean	25.78	21.26	12.97	

4-14. Effect of foliar applications, irrigation intervals and their interaction on **flavonoids content (mg/100 g dw)** in the 1st and 2nd seasons (Table 14)

4-14.a. The effect of irrigation intervals: The highest flavonoids content was a result of watering either every 8 days (5.33 and 5.35 mg/100 g dw, respectively). Moreover, irrigating every 16 days come directly in the next grade (3.40 and 3.34 mg/100 g dw, respectively) in 1st and 2nd season. As irrigation intervals decreased to 4 days recorded the lowest values (2.77 and 2.75 mg/100 g dw), respectively) in both seasons.

4-14.b. The effect of foliar applications: the highest flavonoids content resulted when seaweed extract 5.0% was applied (4.13 and 4.11 mg/100 g dw, respectively) in the 1st and 2nd seasons. Meanwhile, seaweed extrct 7.5% achieved the lowest record in this concern (2.85 and 2.82 mg/100 g dw, respectively) in each season.

4-14.c. The interaction between foliar applications and irrigation intervals on flavonoids content. The greatest flavonoids content resulted when seaweed extract 7.5% in in the 1st season and seaweed extract 5.0% in 2nd season + 8 days irrigation intervals and (5.62 and 5.60 mg/100 g dw, respectively). Next grade was a result of applying 16 days irrigation intervals + seaweed extract 5.0% in each season (3.95 and 3.88 mg/100 g dw, respectively). Meanwhile, records in the lowest position included plants watered every 4 days + control (2.74 and 2.51 mg/100 g dw). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (14): Effect of foliar applications, irrigation intervals and their interaction on flavonoids content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	2.74	5.06	3.56	3.79
Salicylic acid 0.5 mM	2.75	5.13	3.64	3.84
Salicylic acid 1.0 mM	2.61	5.12	3.68	3.80
Salicylic acid 1.5 mM	2.67	5.30	3.77	3.91
Moringa extract 2.5%	2.75	5.28	3.78	3.94
Moringa extract 5.0%	2.77	5.36	3.86	4.00
Moringa extract 10.0%	2.83	5.41	3.82	4.02
Seaweed extract 2.5%	2.80	5.48	3.91	4.06
Seaweed extract 5.0%	2.88	5.55	3.95	4.13
Seaweed extract 7.5%	2.93	5.62	0.00	2.85
Mean	2.77	5.33	3.40	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	2.51	5.12	3.54	3.72
Salicylic acid 0.5 mM	2.64	5.14	3.58	3.79
Salicylic acid 1.0 mM	2.66	5.22	3.63	3.84
Salicylic acid 1.5 mM	2.72	5.20	3.66	3.86
Moringa extract 2.5%	2.77	5.31	3.70	3.93
Moringa extract 5.0%	2.75	5.36	3.77	3.96
Moringa extract 10.0%	2.80	5.45	3.85	4.03
Seaweed extract 2.5%	2.84	5.56	3.81	4.07
Seaweed extract 5.0%	2.86	5.60	3.88	4.11
Seaweed extract 7.5%	2.93	5.54	0.00	2.82
Mean	2.75	5.35	3.34	

4-15. Effect of foliar applications, irrigation intervals and their interaction on **proline content (mg/100 g dw)** in the 1st and 2nd seasons (Table 15)

4-15.a. The effect of irrigation intervals was significant: The highest proline content was a result of watering every 16 days (70.13 and 55.35 mg/100 g dw, respectively). Meanwhile, irrigating every 8 days came directly in the next grade (56.24 and 52.79 mg/100 g dw, respectively) in 1st and 2nd season. As irrigation intervals decreased to 4 days recorded the lowest values (38.55 and 39.29 mg/100 g dw, respectively) in each season.

4-15.b. The effect of foliar applications: the highest proline content resulted when moringa extract 10.0% in the 1st season and salicylic acid 1.5mM in the 2nd season were applied (70.33 and 61.36 mg/100 g dw, respectively). Furthermore, seaweed extract 7.5% in the 1st season and moringa extract 2.5% in the 2nd season achieved the lowest record in this concern (41.63 and 34.83 mg/100 g dw, respectively).

4-15.c. The interaction between foliar applications and irrigation intervals on proline content in the 1st and 2nd seasons. The greatest proline content (mg/100 g dw) resulted when salicylic acid 1.5 mM + 16 days irrigation interval (96.40 and 75.41 mg/100 g dw, respectively) in each season. Meanwhile, 8 days irrigation intervals + moringa extract 10.0% in the 1st season and seaweed extract 7.5% in the 2nd season (78.78 and 68.41 mg/100 g dw, respectively). Records in the lowest position included plants watered every 4 days and experienced treatments seaweed extract 2.5% in 1st season and moringa extract 2.5% in the 2nd season (30.80 and 27.23 mg/100 g dw). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (15): Effect of foliar applications, irrigation intervals and their interaction on proline content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
foliar application	4 days	8 days	16 days	Mean
Control	33.72	43.40	63.38	46.83
salicylic acid 0.5 mM	36.00	48.60	81.40	55.33
salicylic acid 1.0 mM	35.80	52.60	78.90	55.77
salicylic acid 1.5 mM	44.30	63.50	96.40	68.07
moringa extract 2.5%	31.50	40.30	53.60	41.80
moringa extract 5.0%	34.00	55.70	76.64	55.45
moringa extract 10.0%	38.70	78.78	93.20	70.23
seaweed extract 2.5%	30.80	51.20	68.52	50.17
seaweed extract 5.0%	47.30	56.81	89.23	64.45
seaweed extract 7.5%	53.40	71.50	0.00	41.63
Mean	38.55	56.24	70.13	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	27.40	37.15	53.10	39.22
Salicylic acid 0.5 mM	30.10	48.25	58.24	45.53
Salicylic acid 1.0 mM	46.70	61.34	66.80	58.28
Salicylic acid 1.5 mM	42.18	66.50	75.41	61.36
Moringa extract 2.5%	27.23	34.61	42.64	34.83
Moringa extract 5.0%	38.60	44.57	54.80	45.99
Moringa extract 10.0%	48.25	58.34	72.00	59.53
Seaweed extract 2.5%	37.82	47.23	56.84	47.30
Seaweed extract 5.0%	42.70	61.54	73.68	59.31
Seaweed extract 7.5%	51.95	68.41	0.00	40.12
Mean	39.29	52.79	55.35	

4-16. Effect of foliar applications, irrigation intervals and their interaction on **phenolics content (mg/100 g dw)** in the 1st and 2nd seasons (Table 16)

4-16.a. The effect of irrigation intervals: The highest phenolics content were a result of watering either every 8 days (17.44 and 16.04 mg/100 g dw, respectively). Furthermore, irrigating every 16 days come directly in the next grade (13.26 and 12.46 mg/100 g dw, respectively) in 1st and 2nd season. As irrigation intervals deceased to 4 days recorded the lowest values (12.75 and 12.34 mg/100 g dw, respectively) in each season.

4-16.b. The effect of foliar applications: the highest phenolics content resulted when treatments of seaweed extract 2.5% and seaweed extract 5.0% were applied (15.16 and 14.23 mg/100 g dw, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract 7.5% achieved the lowest record in this concern (10.25 and 9.60 mg/100 g dw, respectively) in both seasons.

4-16.c. the interaction between foliar applications and irrigation intervals on phenolics content in the 1st and 2nd seasons. The greatest phenolics content resulted when treatments seaweed extract 7.5% and seaweed extract 5.0% + 8 days irrigation intervals (17.82. and 16.24 mg/100 g dw, respectively) in each season. Second grade was a result of applying seaweed extract 5.0% and seaweed extract 2.5% (14.83 and 13.93 mg/100 g dw, respectively) in each season. Records in the lowest position included plants watering every 4 days + treatments salicylic acid 0.5mM and control (12.53 and 12.11 mg/100 g dw). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (16): Effect of foliar applications, irrigation intervals and their interaction on phenolics content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	12.68	17.38	14.51	14.86
Salicylic acid 0.5 mM	12.53	17.76	14.66	14.98
Salicylic acid 1.0 mM	12.57	17.65	14.68	14.97
Salicylic acid 1.5 mM	12.65	16.85	14.76	14.75
Moringa extract 2.5%	12.78	16.98	14.72	14.83
Moringa extract 5.0%	12.71	17.20	14.77	14.89
Moringa extract 10.0%	12.83	17.38	14.82	15.01
Seaweed extract 2.5%	12.88	17.76	14.85	15.16
Seaweed extract 5.0%	12.94	17.65	14.83	15.14
Seaweed extract 7.5%	12.93	17.82	0.00	10.25
Mean	12.75	17.44	13.26	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	12.11	15.84	13.74	13.90
Salicylic acid 0.5 mM	12.18	15.87	13.76	13.94
Salicylic acid 1.0 mM	12.25	15.96	13.80	14.00
Salicylic acid 1.5 mM	12.21	15.93	13.85	14.00
Moringa extract 2.5%	12.30	15.98	13.84	14.04
Moringa extract 5.0%	12.36	16.07	13.87	14.10
Moringa extract 10.0%	12.38	16.13	13.90	14.14
Seaweed extract 2.5%	12.47	16.16	13.93	14.19
Seaweed extract 5.0%	12.52	16.24	13.94	14.23
Seaweed extract 7.5%	12.61	16.20	0.00	9.60
Mean	12.34	16.04	12.46	

(4-17)- Effect of foliar applications, irrigation intervals and their interaction on N% dw in the 1st and 2nd seasons (Table 17)

4-17.a. Effect of irrigation intervals: The highest N% was a result of watering every 4 days (1.30 and 1.19 %, respectively) in both seasons. It was observed that irrigating every 8 days came directly in the next grade (0.81% and 0.87%). While N% decreased to 0.52% and 0.55 %, respectively when irrigation was at 16 days interval.

4-17.b. Effect of foliar applications: In the 1st and 2nd seasons the highest N% resulted when treatment seaweed extract 2.5% and seaweed extract 5.0% were applied (1.02 and 1.04%). The lowest one was a result of using control (0.68 and 0.72%).

4-17.c. Effect of the interaction between foliar applications and irrigation intervals: In the 1st and 2nd seasons, the highest N% was a result of using irrigation at 4 days interval combined with treatment seaweed extract 7.5% (1.53 and 1.44 %, respectively). Other treatments seaweed extract 5.0% combined with 4 days irriation intervals shared in the highest position (1.47 and 1.42 %, respectively) in each season. Furthermore, 8 days irrigations came directly in the second grade+ seaweed 7.5 % in 1st season and seaweed extract 2.5% in the 2nd season (0.95 and 0.97%, respectively). The lowest percentage was obtained when control combined with watering every 16 days were used (0.41 and 0.49%, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (17): Effect of foliar applications, irrigation intervals and their interaction on N% dw in the two seasons

1st season, 2016-2017				
	Irrigation intervals			
Foliar applications	4 days	8 days	16 days	Mean
Control	0.98	0.64	0.41	0.68
Salicylic acid 0.5 mM	1.11	0.70	0.48	0.76
Salicylic acid 1.0 mM	1.15	0.75	0.53	0.81
Salicylic acid 1.5 mM	1.23	0.71	0.55	0.83
Moringa extract 2.5%	1.30	0.77	0.61	0.89
Moringa extract 5.0%	1.33	0.83	0.67	0.94
Moringa extract 10.0%	1.40	0.90	0.64	0.98
Seaweed extract 2.5%	1.45	0.91	0.70	1.02
Seaweed extract 5.0%	1.47	0.94	0.62	1.01
Seaweed extract 7.5%	1.53	0.95	0.00	0.83
Mean	1.30	0.81	0.52	
2nd season, 2017-2018				
	Irrigation intervals			
Foliar applications	4 days	8 days	16 days	Mean
Control	0.91	0.77	0.49	0.72
Salicylic acid 0.5 mM	0.97	0.81	0.51	0.76
Salicylic acid 1.0 mM	0.97	0.84	0.56	0.79
Salicylic acid 1.5 mM	1.12	0.79	0.55	0.82
Moringa extract 2.5%	1.18	0.88	0.66	0.91
Moringa extract 5.0%	1.21	0.92	0.62	0.92
Moringa extract 10.0%	1.27	0.90	0.67	0.95
Seaweed extract 2.5%	1.37	0.97	0.70	1.01
Seaweed extract 5.0%	1.42	0.91	0.78	1.04
Seaweed extract 7.5%	1.44	0.94	0.00	0.79
Mean	1.19	0.87	0.55	

4-18. Effect of foliar applications, irrigation intervals and their interaction on **P% dw** in the 1st and 2nd seasons (Table 18)

4-18.a. The effect of irrigation intervals: The greatest P% was a result of watering every 4 days (0.39 and 0.43 %, respectively). Meanwhile, irrigating every 8 days come directly in the next grade (0.26 and 0.30 %, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (0.10 and 0.13 %, respectively) in both seasons.

4-18.b. The effect of foliar applications on shoot dry weight: the greatest P% resulted when seaweed extract 5.0% was applied (0.29 and 0.34 %, respectively) in the 1st and 2nd seasons. Meanwhile, treatment control achieved the lowest record in this concern (0.22 and 0.23 %, respectively) in both seasons.

4-18.c. The interaction between foliar applications and irrigation intervals on P% in the 1st and 2nd season. The greatest P% resulted from seaweed extract 7.5% + 4 days irrigation intervals (0.49 and 0.52 %) in each seasons. However, treatment of seaweed extract 5.0% + 4 days irrigation intervals shared in the highest position (0.45 and 0.50%, respectively). While, plants having treatments seaweed extract 5.0% and seaweed extract 7.5% in 1st season (0.29 % for each treatments) and seaweed extract 7.5% in the 2nd season (0.35 %) + 8 days interval came in the second position. Records in the lowest position included plants watered every 16 days + control (0.08 and 0.09 %). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (18): Effect of foliar applications, irrigation intervals and their interaction on P% dw in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	0.34	0.23	0.08	0.22
Salicylic acid 0.5 mM	0.34	0.26	0.09	0.23
Salicylic acid 1.0 mM	0.35	0.25	0.10	0.23
Salicylic acid 1.5 mM	0.36	0.24	0.11	0.24
Moringa extract 2.5%	0.37	0.26	0.11	0.25
Moringa extract 5.0%	0.38	0.27	0.12	0.26
Moringa extract 10.0%	0.40	0.28	0.13	0.27
Seaweed extract 2.5%	0.42	0.28	0.12	0.28
Seaweed extract 5.0%	0.45	0.29	0.14	0.29
Seaweed extract 7.5%	0.49	0.29	0.00	0.26
Mean	0.39	0.26	0.10	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	0.36	0.23	0.09	0.23
Salicylic acid 0.5 mM	0.39	0.26	0.11	0.25
Salicylic acid 1.0 mM	0.37	0.28	0.13	0.26
Salicylic acid 1.5 mM	0.38	0.29	0.14	0.27
Moringa extract 2.5%	0.41	0.30	0.15	0.29
Moringa extract 5.0%	0.45	0.33	0.16	0.31
Moringa extract 10.0%	0.44	0.31	0.17	0.31
Seaweed extract 2.5%	0.47	0.34	0.18	0.33
Seaweed extract 5.0%	0.50	0.33	0.19	0.34
Seaweed extract 7.5%	0.52	0.35	0.00	0.29
Mean	0.43	0.30	0.13	

4-19. Effect of foliar applications, irrigation intervals and their interaction on **K% dw** in the 1st and 2nd seasons. (Table, 19)

4-19.a. The effect of irrigation intervals: The highest K% was a result of watering either every 4 days (2.34 and 2.41 %, respectively). Moreover, irrigating every 8 days came directly in the next grade (1.75 and 1.71 %, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (1.29 and 1.21 %, respectively) in each season.

4-19.b. The effect of foliar applications on shoot dry weight: The heaviest K% resulted when treatment of seaweed extract 5.0% was applied (1.92 and 1.89 %, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract at 7.5% achieved the lowest record in this concern (1.41 and 1.45 %, respectively) in each season.

4-19.c. The interaction between foliar applications and irrigation intervals on K% in the 1st and 2nd season. The greatest K% resulted from seaweed extract 7.5% + 4 days irrigation interval (2.41 and 2.56 %, respectively) in each seasons. Other treatments seaweed extract 5.0% shared in the highest position in each season (2.40 and 2.52%, respectively). However, plants having seaweed extract 7.5% + 8 days interval came directly in the second grade (1.83 and 1.78 %, respectively) in each season. Records in the lowest position included plants watered every 16 days and experienced control (1.32 and 1.26 %, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (19). Effect of foliar applications, irrigation intervals and their interaction on K% in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	2.25	1.67	1.32	1.75
Salicylic acid 0.5 mM	2.28	1.68	1.36	1.77
Salicylic acid 1.0 mM	2.30	1.70	1.34	1.78
Salicylic acid 1.5 mM	2.32	1.73	1.38	1.81
Moringa extract 2.5%	2.34	1.74	1.42	1.83
Moringa extract 5.0%	2.37	1.78	1.44	1.86
Moringa extract 10.0%	2.36	1.77	1.50	1.88
Seaweed extract 2.5%	2.38	1.80	1.53	1.90
Seaweed extract 5.0%	2.40	1.81	1.56	1.92
Seaweed extract 7.5%	2.41	1.83	0.00	1.41
Mean	2.34	1.75	1.29	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	2.21	1.64	1.26	1.70
Salicylic acid 0.5 mM	2.32	1.66	1.29	1.76
Salicylic acid 1.0 mM	2.33	1.67	1.30	1.77
Salicylic acid 1.5 mM	2.37	1.69	1.33	1.80
Moringa extract 2.5%	2.39	1.72	1.37	1.83
Moringa extract 5.0%	2.43	1.70	1.38	1.84
Moringa extract 10.0%	2.45	1.73	1.36	1.85
Seaweed extract 2.5%	2.50	1.73	1.40	1.88
Seaweed extract 5.0%	2.52	1.75	1.41	1.89
Seaweed extract 7.5%	2.56	1.78	0.00	1.45
Mean	2.41	1.71	1.21	

4-20. Effect of foliar applications, irrigation intervals and their interaction on **Ca% dw** in the 1st and 2nd seasons. (Table, 20)

4-20.a. The effect of irrigation intervals: The highest Ca% was a result of watering every 4 days (3.22 and 3.30 %, respectively). Meanwhile, irrigating every 8 days came directly in the next grade (2.14 and 2.28 %, respectively) in 1st and 2nd season. As irrigation intervals increased to 16 days recorded the lowest values (1.24 and 1.51 %, respectively) in each season.

4-20.b. The effect of foliar applications on shoot dry weight: the highest Ca% resulted when treatment seaweed extract 5.0% was applied (2.30 and 2.54 %, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extrct 7.5% achieved the lowest record in this concern (1.84 and 1.96 %, respectively) in each season.

4-20.c. The interaction between foliar applications and irrigation intervals on Ca%. The greatest Ca% resulted when seaweed extract 7.5% + 4 days irrigation interval (3.36 and 3.47 %) in each season. Other values shared also in this highest grade were seaweed extract 5.0% (3.33 and 3.44 %, respectively) in 1st and 2nd seasons. However, plants having treatments seaweed extract 5.0% in the 1st season and seaweed 7.5% in the 2nd season + 8 days intervals shared statistically in the next grade for (2.18 and 2.41 %, respectively) in each season. Records in the lowest position included plants watered every 16 days and control (1.35 and 1.57 %, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (20): Effect of foliar applications, irrigation intervals and their interaction on Ca% dw in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	3.11	2.06	1.35	2.17
Salicylic acid 0.5 mM	3.14	2.10	1.37	2.20
Salicylic acid 1.0 mM	3.17	2.13	1.38	2.23
Salicylic acid 1.5 mM	3.15	2.15	1.33	2.21
Moringa extract 2.5%	3.20	2.16	1.35	2.24
Moringa extract 5.0%	3.25	2.14	1.39	2.26
Moringa extract 10.0%	3.27	2.15	1.41	2.28
Seaweed extract 2.5%	3.26	2.15	1.40	2.27
Seaweed extract 5.0%	3.33	2.18	1.38	2.30
Seaweed extract 7.5%	3.36	2.17	0.00	1.84
Mean	3.22	2.14	1.24	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	3.14	2.13	1.57	2.28
Salicylic acid 0.5 mM	3.18	2.17	1.58	2.31
Salicylic acid 1.0 mM	3.20	2.22	1.62	2.35
Salicylic acid 1.5 mM	3.25	2.25	1.66	2.39
Moringa extract 2.5%	3.27	2.26	1.64	2.39
Moringa extract 5.0%	3.31	2.30	1.71	2.44
Moringa extract 10.0%	3.36	2.34	1.74	2.48
Seaweed extract 2.5%	3.42	2.36	1.76	2.51
Seaweed extract 5.0%	3.44	2.37	1.80	2.54
Seaweed extract 7.5%	3.47	2.41	0.00	1.96
Mean	3.30	2.28	1.51	

4-21. Effect of foliar applications, irrigation intervals and their interaction on **Na% dw** in the 1st and 2nd seasons. (Table, 21)

4-21.a. The effect of irrigation intervals: The highest Na% was a result of watering every 16 days (5.56 and 6.63 %, respectively). Meanwhile, irrigating every 8 days came directly in the next grade (4.53 and 6.05 %, respectively) in 1st and 2nd seasons. When intervals decreased to 4 days recorded the lowest values (3.53 and 4.48 %, respectively) in both seasons.

4-21.b. The effect of foliar applications on Na: the highest Na% resulted when treatments control in the 1st season and salicylic 0.5mM in the 2nd season were applied (5.12 and 6.30 %, respectively). Furthermore, seaweed extract 7.5% achieved the lowest record in this concern (2.58 and 3.28 %, respectively) in both seasons.

4-21.c. The interaction between foliar applications and irrigation intervals on Na% in the 1st and 2nd season. The greatest Na% resulted when treatments control in 1st season and salicylic acid 0.5mM in 2nd season + 16 days irrigation interval (6.78 and 7.61%, respectively) in each season. Other values came in the second grade was a result of 8 days irrigation intervals + control in each season (4.70 and 6.34 %, respectively). Meanwhile, records in the lowest position included plants watered every 4 days + seaweed extract 7.5% (3.21 and 4.13 %, respecttively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (21): Effect of foliar applications, irrigation intervals and their interaction on Na% dw in the two seasons

1st season, 2016-2017 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	3.88	4.70	6.78	5.12
Salicylic acid 0.5 mM	3.86	4.56	6.56	4.99
Salicylic acid 1.0 mM	3.77	4.67	6.37	4.94
Salicylic acid 1.5 mM	3.49	4.46	6.25	4.73
Moringa extract 2.5%	3.51	4.32	6.11	4.65
Moringa extract 5.0%	3.40	4.00	5.97	4.46
Moringa extract 10.0%	3.44	4.73	5.95	4.71
Seaweed extract 2.5%	3.36	4.65	5.83	4.61
Seaweed extract 5.0%	3.35	4.66	5.74	4.58
Seaweed extract 7.5%	3.21	4.52	0.00	2.58
Mean	3.53	4.53	5.56	
2nd season, 2017-2018 **Irrigation intervals**				
Foliar applications	4 days	8 days	16 days	Mean
Control	4.77	6.34	7.56	6.22
Salicylic acid 0.5 mM	4.96	6.33	7.61	6.30
Salicylic acid 1.0 mM	4.60	6.28	7.40	6.09
Salicylic acid 1.5 mM	4.57	6.17	7.44	6.06
Moringa extract 2.5%	4.48	6.21	7.36	6.02
Moringa extract 5.0%	4.36	5.86	7.34	5.85
Moringa extract 10.0%	4.40	5.93	7.25	5.86
Seaweed extract 2.5%	4.28	5.88	7.18	5.78
Seaweed extract 5.0%	4.25	5.76	7.14	5.72
Seaweed extract 7.5%	4.13	5.71	0.00	3.28
Mean	4.48	6.05	6.63	

4-22. Effect of foliar applications, irrigation intervals and their interaction on **chloride content (mg/100 g dw)** in the 1st and 2nd seasons. (Table, 22)

4-22.a. The effect of irrigation intervals: The highest Cl % was a result of watering every 16 days (2.97 and 3.07 mg/100 g dw, respectively). Meanwhile, irrigating every 8 days came directly in the next grade (2.79 and 2.74 mg/100 g dw, respectively) in 1st and 2nd season. When irrigation intervals decreased to 4 days recorded the lowest values (2.48 and 2.29 mg/100 g dw, respectively) in each season.

4-22.b. The effect of foliar applications on Cl content: The highest Cl % resulted when treatments salicylic acid 0.5% and control were used (3.07 and 3.04 mg/100 g dw, respectively) in the 1st and 2nd seasons. Furthermore, seaweed extract 7.5% achieved the lowest record in this concern (1.57 and 1.54 mg/100 g dw, respectively) in each season.

4-22.c. The interaction between foliar applications and irrigation intervals on Cl content (mg/100 g dw) in the 1st and 2nd season. The highest Cl resulted when treatments of control + 16 days irrigation intervals and (3.50 and 3.66 mg/100 g dw, respectively) in each season. Plants having treatments salicylic acid 0.5% and conrol+ 8 days irrigation intervals came in the second position (3.10 and 2.99 mg/100 g dw, respectively) in both seasons. Records in the lowest position included plants watered every 4 days and seaweed extract 7.5% (2.20 and 2.10 mg/100 g dw, respectively). Plants irrigated every 16 days and having seaweed extract 7.5% died.

Table (22): Effect of foliar applications, irrigation intervals and their interaction on Cl % dw in the two seasons

1st season, 2016-2017				
	Irrigation intervals			
Foliar applications	4 days	8 days	16 days	Mean
Control	2.64	3.00	3.50	3.05
Salicylic acid 0.5 mM	2.70	3.10	3.40	3.07
Salicylic acid 1.0 mM	2.63	2.87	3.17	2.89
Salicylic acid 1.5 mM	2.44	2.77	3.21	2.81
Moringa extract 2.5%	2.47	2.74	3.25	2.82
Moringa extract 5.0%	2.51	2.88	3.33	2.91
Moringa extract 10.0%	2.65	2.84	3.31	2.93
Seaweed extract 2.5%	2.31	2.65	3.30	2.75
Seaweed extract 5.0%	2.25	2.56	3.23	2.68
Seaweed extract 7.5%	2.20	2.51	0.00	1.57
Mean	2.48	2.79	2.97	
2nd season, 2017-2018				
	Irrigation intervals			
Foliar applications	4 days	8 days	16 days	Mean
Control	2.46	2.99	3.66	3.04
Salicylic acid 0.5 mM	2.51	2.87	3.59	2.99
Salicylic acid 1.0 mM	2.38	2.71	3.36	2.82
Salicylic acid 1.5 mM	2.14	2.64	3.27	2.68
Moringa extract 2.5%	2.30	2.74	3.20	2.75
Moringa extract 5.0%	2.28	2.80	3.33	2.80
Moringa extract 10.0%	2.36	2.77	3.49	2.87
Seaweed extract 2.5%	2.22	2.80	3.51	2.84
Seaweed extract 5.0%	2.16	2.58	3.28	2.67
Seaweed extract 7.5%	2.10	2.53	0.00	1.54
Mean	2.29	2.74	3.07	

Experiment 2:

(4-23): Effect of foliar applications, salinity levels and their interaction on **plant height (cm)** in the 1st and 2nd seasons (Table 23)

4-23.a. The effect of salinity levels was significant in the 1st and 2nd seasons. The tallest plants were a result of applying salinity at 2000 ppm (39.80 and 39.75 cm, respectively). Although salinity increased to 4000 ppm the plant height recorded the second grade directly (36.50 and 39.00 cm, respectively). Meanwhile, 6000 ppm salinity gave the shortest plant (32.86 and 33.55 cm, respectively) in both seasons.

4-23.b. The effect of foliar applications in the 1st and 2nd seasons was significant. The tallest plants were a result of applying treatment of moringa extract at 10.0% (39.70 and 41.74 cm, respectively) in both seasons. The shortest plants resulted from control (33.37 and 33.70 cm, respectively).

4-23.c. Effect of the interaction between foliar applications and salinity levels affected plant height significantly in the both seasons. Applying moringa extract 10.0% combined with 2000 ppm salinity gave rise to the tallest plants (43.90 and 43.70 cm, respectively) in both seasons. Other treatments shared in the highest position from seaweed extract 7.5% + 2000 ppm 43.53 and 43.47 cm, respectively) in both seasons. However, the second grade was produced when using 4000 ppm salinity level and applying moringa extract 10.0% and seaweed extract 7.5% in 1st and 2nd seasons (40.73 and 43.13 cm, respectively). The shortest plants were a result of using salinity at 6000 combined with treatment control in 1st season and seaweed extract 5.0% in the 2nd season (31.31 and 31.06 cm, respectively).

Table (23): Effect of foliar applications, salinity levels and their interaction on plant height (cm) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	35.73 $^{g-k}$	33.07 $^{k-o}$	31.31 ^{o}	33.37 G
Salicylic acid 0.5 mM	36.4^{f-j}	34.50 $^{j-n}$	31.47 ^{o}	34.12 FG
Salicylic acid 1.0 mM	38.03^{d-h}	34.55 $^{j-n}$	32.43 ^{n}	35.00 EF
Salicylic acid 1.5 mM	39.13^{c-e}	35.23 $^{i-m}$	32.38 ^{n}	35.58 EF
Moringa extract 2.5%	40.30^{cd}	35.56^{h-l}	32.77 $^{m-o}$	36.21 DE
Moringa extract 5.0%	43.30 ^{ab}	37.23 $^{e-i}$	32.90^{l-o}	37.81 BC
Moringa extract 10.0%	43.90 ^{a}	40.73 ^{bc}	34.47 $^{j-n}$	39.70 A
Seaweed extract 2.5%	38.00 $^{d-h}$	37.23 $^{e-i}$	33.62 $^{k-o}$	36.28 C-E
Seaweed extract 5.0%	39.70 $^{c-e}$	38.30^{c-g}	33.93^{j-o}	37.31 C-E
Seaweed extract 7.5%	43.53 ^{a}	38.63^{c-f}	33.40^{k-o}	38.52 AB
Mean	39.80 A\	36.50 B\	32.86 C\	

2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	35.77^{ij}	34.10^{jk}	31.31^{n}	33.70 E
Salicylic acid 0.5 mM	38.23^{f-h}	36.17^{i}	32.17^{mn}	35.46 D
Salicylic acid 1.0 mM	39.83^{c-f}	36.64^{hi}	32.35^{l-n}	36.27 D
Salicylic acid 1.5 mM	32.23^{f-h}	37.03^{g-i}	31.30 ^{n}	35.52 D
Moringa extract 2.5%	36.90^{gh}	39.81^{c-f}	31.95 ^{n}	36.22 D
Moringa extract 5.0%	42.40^{ab}	41.47 ^{bc}	38.87^{ef}	40.98 AB
Moringa extract 10.0%	43.70 ^{a}	42.53^{ab}	39.00 $^{d-f}$	41.74 A
Seaweed extract 2.5%	38.56^{e-g}	39.30 $^{d-f}$	31.06 ^{n}	36.31 D
Seaweed extract 5.0%	40.63^{cd}	40.00 $^{c-e}$	33.73^{k-m}	38.10 C
Seaweed extract 7.5%	43.47 ^{a}	43.13 ^{a}	33.96 $^{j-l}$	40.14 B
Mean	39.75 A\	39.00 B\	33.55 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-24): Effect of foliar applications, salinity levels and their interaction on **number of leaves/ plant** in the 1st and 2nd seasons (Table 24)

4-24.a. The effect of salinity levels was significant in the 1st and 2nd seasons; the highest number of leaves was a result of using 2000 ppm salinity (42.58 and 43.63 leaves/ plant, respectively). As salinity level increased to 4000 ppm, this number decreased simultaneously to 32.56 and 36.74 leaves/ plant, respectively, while the lowest one resulted when salinity level rose to 6000 ppm (25.03 and 28.26 leaves/ plant, respectively) in each season.

4-24.b. Effect of foliar applications: The significantly highest number of leaves in the 1st and 2nd seasons was induced by treatment of moringa extract 10.0% (44.84 and 44.10 leaves/ plant, respectively). The lowest value in the same respect was observed when control was applied (18.98 and 16.41 leaves/ plant, respectively) in both seasons.

4-24.c. Effect of the interaction between foliar applications and salinity levels: affected number of leaves significantly. Applying 2000 ppm salinity combined with seaweed extract 7.5% in the 1st season and moringa extract 10.0% in the 2nd season gave rise to the greatest number of leaves (49.57 and 53.73 leaves/ plant, respectively). Other treatments shared in the highest position at salinity 2000 ppm and applying moringa extract 10.0 % (49.23 and 53.73 leaves/ plant, respectively) in each season. Furthermore, Salinity 4000 ppm+ moringa extract 10.0% and seaweed extract 7.5% shared statistically in the second grade in the 1st and 2nd seasons (44.17 and 43.90 leaves/ plant, respectively). The lowest record was noticed when control plus 6000 ppm salinity were applied (13.57 and 9.30 leaves, respectively) in both seasons.

Table (24). Effect of foliar applications, salinity levels and their interaction on number of leaves/ plant in the two seasons

1st season, 2016-2017				
	Salinity levels (ppm)			
Foliar applications	2000	4000	6000	Mean
Control	26.03^{g-k}	17.47^{jk}	13.57^{k}	18.98 D
Salicylic acid 0.5 mM	32.40^{c-j}	28.17^{f-j}	22.67^{i-k}	27.71 CD
Salicylic acid 1.0 mM	41.90^{b-g}	29.13^{e-k}	24.50^{i-k}	31.84 BC
Salicylic acid 1.5 mM	45.80^{a-d}	35.90^{b-i}	22.83^{i-k}	34.84 BC
Moringa extract 2.5%	43.73^{a-f}	30.13^{c-j}	23.63^{i-k}	32.50 BC
Moringa extract 5.0%	46.07^{a-c}	41.30^{b-h}	33.07^{b-i}	40.14 AB
Moringa extract 10.0%	49.23^{ab}	44.17^{a-f}	31.23^{c-j}	44.84 A
Seaweed extract 2.5%	35.73^{b-i}	29.30^{d-k}	25.00^{h-k}	30.01 C
Seaweed extract 5.0%	45.40^{a-e}	34.23^{b-i}	28.13^{f-k}	35.92 A-C
Seaweed extract 7.5%	49.57^{a}	36.00^{b-i}	25.80^{g-k}	37.12 A-C
Mean	42.58 A\	32.56 B\	25.03 C\	

2nd season, 2017-2018				
	Salinity levels (ppm)			
Foliar applications	2000	4000	6000	Mean
Control	23.30^{k-m}	16.33^{mn}	9.30^{n}	16.41 D
Salicylic acid 0.5 mM	42.40^{a-g}	34.63^{e-k}	27.83^{j-m}	34.96 BC
Salicylic acid 1.0 mM	46.23^{a-d}	40.80^{b-i}	31.57^{g-l}	39.53 AB
Salicylic acid 1.5 mM	46.23^{a-d}	43.23^{a-f}	30.73^{h-l}	40.17 AB
Moringa extract 2.5%	35.80^{c-j}	29.17^{j-l}	22.13^{lm}	29.00 C
Moringa extract 5.0%	48.73^{ab}	37.17^{c-j}	30.50^{i-l}	38.87 AB
Moringa extract 10.0%	53.73^{a}	43.73^{a-f}	34.83^{d-k}	44.10 A
Seaweed extract 2.5%	42.33^{a-g}	36.23^{c-j}	26.23^{j-m}	34.93 BC
Seaweed extract 5.0%	46.77^{a-c}	42.13^{b-h}	37.27^{c-j}	42.00 A
Seaweed extract 7.5%	50.83^{ab}	43.90^{a-e}	32.30^{f-l}	42.34 A
Mean	43.63 A\	36.74 B\	28.26 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-25): Effect of foliar applications, salinity levels and their interaction on **stem diameter (mm)** in the 1^{st} and 2^{nd} seasons (Table 25)

4-25.a. Effect of salinity levels: In the 1^{st} and 2^{nd} seasons the effect of was significant. The thichest plants was a result of applying 2000 ppm salinity (6.31 and 7.30 mm, respectively), as salinity levels increased to 4000 ppm, stem diameter was decreased (5.67 and 6.54 mm, respectively). When watering intervals increased to 16 days, stem diameter decreased to (4.92 and 5.93 mm, respectively).

4-25.b. The effect of foliar applications on stem diameter in the 1^{st} and 2^{nd} seasons was significant. The highest values belonged to treatment of moringa extract 10.0% (6.41 and 7.28 mm, respectively). However, control induced the thinnest stems (4.44 and 5.44 mm, respectively) in each seasons.

4-25.c. Effect of the interaction between foliar applications and salinity levels: This interaction affected stem diameter in the 1^{st} and 2^{nd} seasons significantly. However, it could be noticed that the highest values in this regard were obtained when treatment seaweed extract 7.5% was applied to plants subjected to 2000 ppm salinity (7.17 and 8.17 mm, respectively). Other treatments shared in the highest position was a result of applying 2000 ppm salinity + moringa extract 10.0% (7.07 and 7.93 mm, respectively). The second grade record in the same question was a result of combining moringa extract 10.0% with 4000 ppm salinity (6.40 and 7.27 mm, rspectively). Meanwhile, the lowest record was a result of combining control with 6000 ppm salinity (4.00 and 5.00 mm, respectively).

Table (25): Effect of foliar applications, salinity levels and their interaction on stem diameter (mm) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	5.00 c-g	4.33 ij	4.00 J	4.44 F
Salicylic acid 0.5 mM	5.40 c-f	4.70 i-k	4.10 i-l	4.73 EF
Salicylic acid 1.0 mM	5.87 b-f	5.40 e-i	4.40 hi	5.22 DE
Salicylic acid 1.5 mM	6.10 b-e	5.60 d-h	4.40 hi	5.46 CD
Moringa extract 2.5%	6.40 a-f	6.03 bc	5.40 e-l	5.94 A-C
Moringa extract 5.0%	6.90 a-c	6.30 b-e	5.73 d-g	6.31 A
Moringa extract 10.0%	7.07 ab	6.40 a-f	5.77 d-g	6.41 A
Seaweed extract 2.5%	6.43 a-d	5.80 d-g	4.60 f-g	5.61 B-D
Seaweed extract 5.0%	6.97 ab	6.27 b-f	5.37 e-i	6.13 AB
Seaweed extract 7.5%	7.17 a	6.00 c-f	5.20 fg	6.09 A-C
Mean	6.31 A\	5.67 B\	4.92 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	6.00 d-f	5.33 ef	5.00 hi	5.44 F
Salicylic acid 0.5 mM	6.40 c-k	5.70 d--g	5.10 gh	5.73 EF
Salicylic acid 1.0 mM	6.97 b-f	6.40 c-k	5.40 ef	6.22 ED
Salicylic acid 1.5 mM	7.10 b-e	6.23 c-e	5.70 d-f	6.34 CD
Moringa extract 2.5%	7.40 ad	6.70 b-j	6.40 b-j	6.83 A-C
Moringa extract 5.0%	7.90 ab	7.10 b-e	6.73 b-k	7.24 A
Moringa extract 10.0%	7.93 ab	7.27 a-f	6.43 b-i	7.28 A
Seaweed extract 2.5%	7.26 a-f	6.80 b-h	5.60 d-g	6.55 B-D
Seaweed extract 5.0%	7.86 ac	7.27 a-f	6.47 b-j	7.13 AB
Seaweed extract 7.5%	8.17 a	6.80 b-h	6.20 c-k	7.02 AB
Mean	7.30 A\	6.54 B\	5.93 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-26): Effect of foliar applications, salinity levels and their interaction on **number of branches/ plant** in the 1st and 2nd seasons (Table 26)

4-26.a. the effect of salinity levels was significant. The highest records belonged to salinity levels of 2000 ppm (5.20 and 5.28 branches/ plant, respectively) in the 1st and 2nd seasons. Second grade was a result of salinity 4000 ppm (4.53 and 4.25 branches/ plant, respectively). The lowest records belonged to salinity levels of 6000 ppm (3.63 and 3.14 branches/ plant, respectively in both seasons.

4-26.b. The effect of foliar applications was significant. The highest values were a result of using treatments seaweed extract 7.5% in the 1st season and moringa extract 10.0% in the 2nd season (5.21 and 5.58 branches/plant, respectively). The lowest records in the same question resulted when control was used (2.61 and 2.73 branches/ plant, respectively).

4-26.c. Effect of the interaction between foliar applications and salinity levels affected number of branches in the 1st and 2nd seasons significantly. It could be noticed that the highest number of branches resulted when treatments seaweed extract 5.0% and moringa extract 10.0% combined with 2000 ppm salinity were applied (6.00 and 6.60 branches/ plant, respectively). Other treatments shared in the highest position were a result of applying 2000 ppm salinity + seaweed extract 7.5% and moringa extract 5.0 % (5.83 and 5.80 branches/ plant, respectively) in each season. Moreover, 4000 ppm salinity+ seaweed extract 7.5% and moringa extract 10.0% came in the second grade (5.63 and 5.83 branches/ plant, respectively) in each season. The lowest value in this concern was obtained when control was combined with 6000 ppm salinity (1.83 and 1.57 branches/ plant, respectively).

Table (26): Effect of foliar applications, salinity levels and their interaction on number of branches in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.50 ^{n}	2.50 ^{p}	1.83 ^{q}	2.61 D
Salicylic acid 0.5 mM	5.00 ^{e}	4.13 ^{ij}	3.33 ^{o}	4.15 C
Salicylic acid 1.0 mM	5.17 ^{d}	4.43 g	3.67 ^{mn}	4.42 C
Salicylic acid 1.5 mM	5.17 ^{d}	4.37 ^{gh}	3.50 ^{n}	4.34 C
Moringa extract 2.5%	5.17 ^{d}	4.63 ^{f}	3.83 ^{kl}	4.54 BC
Moringa extract 5.0%	5.83 ^{b}	5.00 ^{e}	4.27 ^{hi}	5.00 AB
Moringa extract 10.0%	5.80 ^{b}	5.17 ^{d}	4.27 ^{hi}	5.01 AB
Seaweed extract 2.5%	4.50 ^{fg}	4.37 ^{gh}	3.77 ^{lm}	4.14 C
Seaweed extract 5.0%	6.00 ^{a}	5.30 ^{d}	4.00 ^{jk}	5.10 A
Seaweed extract 7.5%	5.83 ^{ab}	5.63 ^{c}	4.27 ^{hi}	5.21 A
Mean	5.20 A\	4.53 B\	3.63 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	4.13 ^{gh}	2.50 ^{j}	1.57 ^{k}	2.73 E
Salicylic acid 0.5 mM	4.43 $^{f-h}$	3.50 ^{i}	2.40 ^{j}	3.44 D
Salicylic acid 1.0 mM	5.13 $^{c-e}$	4.27 ^{gh}	2.83 ^{j}	4.04 CD
Salicylic acid 1.5 mM	5.63 ^{bc}	4.50 $^{f-h}$	2.90 ^{j}	4.34 BC
Moringa extract 2.5%	5.40 $^{a-d}$	4.27 ^{gh}	3.50 ^{i}	4.35 BC
Moringa extract 5.0%	5.80 ^{b}	4.50 $^{f-h}$	4.33 ^{gh}	4.98 AB
Moringa extract 10.0%	6.60 ^{a}	5.83 ^{b}	4.00 ^{hi}	5.58 A
Seaweed extract 2.5%	4.47 $^{f-h}$	4.27 ^{gh}	2.77 ^{j}	3.87 CD
Seaweed extract 5.0%	4.90 $^{d-f}$	4.77 $^{e-g}$	3.87 ^{j}	4.44 BC
Seaweed extract 7.5%	5.33 $^{b-d}$	4.50 $^{f-h}$	3.67 ^{j}	4.46 BC
Mean	5.28 A\	4.25 B\	3.14 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-27): Effect of foliar applications, salinity levels and their interaction on **shoot fresh weight (g)** in the 1st and 2nd seasons (Table 27)

4-27.a. The effect of salinity levels was significant. The heaviest fresh shoot was a result of using 2000 ppm salinity (35.72 and 35.55 g/ plant, respectively) in the 1st and 2nd seasons. Next grade was a result belonged to salinity levels 4000 ppm (30.10 and 29.44 g/ plant, respectively). While the lightest ones were observed when salinity at 6000 ppm was applied (23.04 and 22.42 g/ plant, respectively) in both seasons.

4-27.b. The effect of foliar applications was significant. The heaviest fresh shoots resulted when treatment moring extract 10.0% was applied in the both seasons (36.81 and 35.71 g/ plant, respectively). While the lowest one was a result of using control (16.49 and 18.68 g/ plant, respectively) in the 1st and 2nd seasons.

4-27.c. Effect of the interaction between foliar applications and salinity levels affected shoot fresh weight significantly. The highest fresh shoots was a result of using 2000 ppm salinity combined with seaweed extract 7.5% in the 1st season and seaweed extract 5.0% in the 2nd season (45.50 and 43.13 g/ plant, respectively). Other treatments shared in the highest position were a result of applying 2000 ppm salinity + seaweed extract 5.0% in the 1st season and seaweed extract 7.5% in the 2nd season (42.30 and 42.10 g/ plant, respectively). However, Salinity 4000 ppm + moringa extract 10.0% came directly in the second grade (37.77 and 38.60 g/ plant, respectively). However, the lightest fresh weight was obtained when control combined with 6000 ppm salinity was used (11.97 and 13.30 g/ plant, respectively) in each seasons.

Table (27): Effect of foliar applications, salinity levels and their interaction on shoot fresh weight (g) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	20.17^{k-m}	17.53^{l-n}	11.97^{n}	16.49 F
Salicylic acid 0.5 mM	26.80^{g-j}	23.53^{i-l}	16.17^{mn}	22.13 E
Salicylic acid 1.0 mM	27.00^{g-j}	25.53^{i-k}	20.87^{j-m}	24.43 E
Salicylic acid 1.5 mM	34.83^{c-f}	26.10^{h-k}	25.00^{i-k}	28.64 D
Moringa extract 2.5%	39.17^{a-d}	28.77^{f-i}	24.27^{i-k}	30.63 CD
Moringa extract 5.0%	40.77^{a-c}	33.00^{d-g}	28.03^{g-i}	33.90 A-C
Moringa extract 10.0%	40.60^{a-c}	37.77^{c-f}	32.27^{e-h}	36.81 A
Seaweed extract 2.5%	40.37^{a-c}	34.67^{c-f}	23.23^{i-l}	32.72 BC
Seaweed extract 5.0%	42.30^{ab}	37.43^{b-e}	25.37^{i-k}	35.00 AB
Seaweed extract 7.5%	45.50^{a}	37.00^{b-e}	23.97^{i-l}	35.45 AB
Mean	35.72 A\	30.10 B\	23.04 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	24.27^{g-i}	18.37^{ij}	13.30^{j}	18.68 E
Salicylic acid 0.5 mM	32.83^{c-f}	24.73^{f-i}	18.23^{ij}	25.37 D
Salicylic acid 1.0 mM	34.70^{b-e}	28.43^{d-h}	21.93^{hi}	28.35 CD
Salicylic acid 1.5 mM	36.57^{a-d}	32.10^{c-g}	22.83^{hi}	30.57 BC
Moringa extract 2.5%	39.39^{a-c}	28.97^{d-h}	21.67^{h-j}	29.91 B-D
Moringa extract 5.0%	40.33^{a-c}	38.13^{a-c}	23.00^{hi}	33.81 AB
Moringa extract 10.0%	39.97^{a-c}	38.60^{a-c}	28.77^{d-h}	35.71 A
Seaweed extract 2.5%	42.00^{ab}	24.47^{g-i}	21.77^{hi}	29.33 B-D
Seaweed extract 5.0%	43.13^{a}	28.27^{d-h}	25.83^{f-i}	32.48 A-C
Seaweed extract 7.5%	42.10^{ab}	32.70^{c-f}	27.23^{e-h}	34.01 AB
Mean	37.55 A\	29.44 B\	22.42 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-28): Effect of foliar applications, salinity levels and their interaction on **roots fresh weight (g)/ plant** in the 1st and 2nd seasons (Table 28)

4-28.a. In the 1st and 2nd seasons the effect of salinity levels was significant, the highest weights were a result of using 2000 ppm salinity (25.23 and 28.44 g/ plant, respectively). The second grade was a result of using salinity of 4000 ppm (21.93 and 21.57 g/ plant, respectively). The lowest root fresh weights were a result of using salinity level of 6000 ppm (15.57 and 16.50 g/ plant, respectively).

4-28.b. The effect of foliar applications in both seasons was significant. The heaviest fresh roots resulted when treatment of seaweed extract 7.5% was used (26.37 and 29.42 g/ plant, respectively). The lowest records resulted when control was applied (12.19 and 13.00 g/ plant, respectively) in the 1st nd 2nd seasons.

4-28.c. The interaction between foliar applications and salinity levels was significant in the 1st and 2nd seasons. The greatest root fresh weight resulted when moringa extract 10.0% and seaweed extract 7.5% combined with 2000 ppm salinity (32.43 and 37.13 g/ plant, respectively) were used. Other treatments shared in the highest position were a result of applying 2000 ppm salinity + seaweed extract 7.5% in the 1st season and seaweed extract 5.0% in the 2nd season (31.47 and 35.97 g/ plant, respectively). Records in the second grade was a result of applying salinity 4000 ppm and treatment of seaweed extract 7.5% (28.47 and 27.23 g/ plant, respectively). The lowest position included plants subjected to 6000 ppm salinity and experienced control (8.73 and 7.83 g/ plant, respectively) in each season.

Table (28). Effect of foliar applications, salinity levels and their interaction on root fresh weight (g) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	16.33^{h-l}	14.42^{lm}	8.73^{m}	12.19 E
Salicylic acid 0.5 mM	17.93^{g-l}	15.30^{j-m}	11.20^{lm}	14.81 DE
Salicylic acid 1.0 mM	20.13^{d-k}	19.17^{f-k}	13.53^{k-m}	17.58 CD
Salicylic acid 1.5 mM	26.03^{a-f}	21.00^{d-k}	15.20^{k-m}	20.74 BC
Moringa extract 2.5%	24.00^{b-h}	22.13^{d-j}	16.37^{i-m}	20.80 BC
Moringa extract 5.0%	27.43^{a-e}	24.50^{b-g}	17.77^{g-l}	23.20 AB
Moringa extract 10.0%	32.43^{a}	25.73^{a-f}	17.03^{g-l}	25.06 AB
Seaweed extract 2.5%	25.73^{a-f}	23.60^{c-i}	14.23^{k-m}	21.29 BC
Seaweed extract 5.0%	30.83^{a-c}	28.12^{a-d}	19.57^{f-k}	26.17 A
Seaweed extract 7.5%	31.47^{ab}	28.47^{a-d}	19.30^{f-k}	26.37 A
Mean	25.23 A\	21.93 B\	15.27 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	17.33^{h-j}	13.80^{i-k}	7.83^{k}	13.00 E
Salicylic acid 0.5 mM	23.30^{c-h}	18.97^{f-j}	15.70^{h-k}	19.39 D
Salicylic acid 1.0 mM	26.00^{c-g}	19.48^{e-j}	17.13^{h-j}	20.98 CD
Salicylic acid 1.5 mM	27.70^{b-e}	23.47^{c-h}	17.80^{g-j}	22.96 B-D
Moringa extract 2.5%	26.27^{c-g}	20.10^{e-j}	12.43^{jk}	19.67 D
Moringa extract 5.0%	28.83^{a-d}	21.67^{d-i}	17.43^{h-j}	22.61 B-D
Moringa extract 10.0%	31.13^{a-c}	23.70^{c-h}	19.23^{f-j}	24.72 A-C
Seaweed extract 2.5%	31.00^{a-c}	21.60^{d-i}	13.63^{i-k}	22.17 CD
Seaweed extract 5.0%	35.97^{ab}	26.00^{c-g}	20.00^{e-j}	27.39 AB
Seaweed extract 7.5%	37.13^{a}	27.23^{c-f}	23.90^{c-h}	29.42 A
Mean	28.44 A\	21.57 B\	16.50 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-29): Effect of foliar applications, salinity levels and their interaction on **shoot dry weight (g) / plant** in the 1st and 2nd seasons (Table 29)

4-29.a. The effect of salinity levels was significant in the 1st and 2nd seasons, the heaviest dry shoots was a result of applying 2000 ppm salinity (22.35 and 23.94 g/ plant, respectively). Furthermore second grade was obtained when plants were subjected to 4000 ppm salinity (17.55 and 17.83 g/ plant, respectively). The lightest dry shoots were a result of applying salinity 6000 ppm (13.42 and 12.93 g/ plant, respectively).

4-29.b. The effect of foliar applications in the 1st and 2nd seasons was significant. The heaviest dry shoots resulted when treatment moringa extract 10.0% were applied (22.93 and 22.79 g/ plant, respectively). Control achieved the lowest record in this concern (10.87 and 10.50 g/ plant, respectively) in both seasons.

4-29.c. The interaction between foliar applications and salinity levels affected shoot dry weight significantly. The greatest values were obtained when plants were subjected to 2000 ppm salinity combined with seaweed extract 7.5% and seaweed extract 5.0% (30.17 and 30.83 g/ plant, respectively) in both seasons. Other treatments shared in the highest position were a result of applying 2000 ppm salinity + moringa extract 10.0% in the 1st season and seaweed extract 2.5% in the 2nd season (27.50 and 28.17 g/ plant, respectively). However, Salinity 4000 ppm+ seaweed extract 7.5% in the 1st season and moringa extract 10.0% in the 2nd season came directly in the second grade (23.63 and 24.40 g/ plant, respectively). The lightest dry shoots were induced by using control for plants + 6000 ppm salinity (7.85 and 7.93 g/ plant, respectively).

Table (29): Effect of foliar applications, salinity levels and their interaction on shoot dry weight (g)/ plant in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	13.70^{h-j}	11.17 $^{i-k}$	7.85^{k}	10.87 E
Salicylic acid 0.5 mM	15.37^{g-i}	10.87^{i-k}	8.73 ^{jk}	11.69 E
Salicylic acid 1.0 mM	16.50 $^{f-h}$	13.80 $^{h-j}$	11.17^{i-k}	13.89 E
Salicylic acid 1.5 mM	21.17^{c-f}	16.30^{f-h}	13.90^{hi}	17.19 D
Moringa extract 2.5%	21.47^{c-f}	17.83^{f-h}	14.53^{g-i}	17.91 CD
Moringa extract 5.0%	27.27 ^{ab}	19.27 $^{c-g}$	15.83^{g-i}	20.72 A-C
Moringa extract 10.0%	27.50 ^{ab}	23.17 $^{b-e}$	18.23^{e-h}	22.93 A
Seaweed extract 2.5%	24.10^{bc}	18.63^{d-h}	14.63^{g-i}	19.12 B-D
Seaweed extract 5.0%	26.87^{ab}	21.30^{c-f}	15.80 $^{g-i}$	21.39 AB
Seaweed extract 7.5%	30.17 ^{a}	23.63^{b-d}	13.63 $^{h-j}$	22.44 A
Mean	22.35 A\	17.55 B\	13.42 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	13.53^{h-l}	10.03 ^{lm}	7.93^{m}	10.50 F
Salicylic acid 0.5 mM	17.53^{e-i}	12.33 $^{i-m}$	10.66^{lm}	13.48 EF
Salicylic acid 1.0 mM	20.17^{d-g}	16.40^{f-j}	10.80^{k-m}	15.76 ED
Salicylic acid 1.5 mM	22.83^{b-e}	21.57^{d-f}	14.33 $^{h-l}$	19.54 BC
Moringa extract 2.5%	24.62^{b-d}	16.03^{g-k}	12.63 $^{i-m}$	17.76 CD
Moringa extract 5.0%	26.97^{a-c}	23.57 $^{b-d}$	12.00 $^{j-m}$	20.78 A-C
Moringa extract 10.0%	27.20 ^{ab}	24.40 $^{b-d}$	16.77 $^{f-j}$	22.79 A
Seaweed extract 2.5%	28.17^{ab}	13.93^{h-l}	12.77 $^{j-m}$	18.02 CD
Seaweed extract 5.0%	30.83 ^{a}	18.03^{e-h}	15.20^{g-l}	21.36 AB
Seaweed extract 7.5%	27.80 ^{ab}	21.73 $^{c-f}$	17.00 $^{f-j}$	22.18 AB
Mean	23.94 A\	17.83 B\	12.93 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-30): Effect of foliar applications, salinity levels and their interaction on **roots dry weight (g/plant)** in the 1st and 2nd seasons (Table 30)

4-30.a. In the 1st and 2nd seasons the effect of salinity levels was significant. The heaviest dry roots were a result of applying 2000 ppm salinity (13.52 and 15.78 g/ plant, respectively). 4000 ppm Salinity came directly in the second grade (11.56 and 11.82 g/ plant, respectively). The lightest dry roots were a result of applying 6000 ppm salinity (8.44 and 9.19 g/ plant, respectively) in both seasons.

4-30.b. The effect of foliar applications in the 1st and 2nd seasons was significant. The heaviest dry roots were a result of using moringa extract 10.0% and seaweed extract 7.5% (14.02 and 16.60 g/ plant, respectively). The lightest dry roots were confined to control (6.08 and 6.53 g/ plant, respectively) in both seasons.

4-30.c. the interaction between foliar applications and salinity levels affected root dry weight significantly. The heaviest dry roots were produced when plants having 2000 ppm salinity were subjected to moringa extract 10.0% in the 1st season and seaweed extract 7.5% in the 2nd season (16.53 and 19.77 g/ plant, respectively), other treatments shared in the highest position were a result of applying 2000 ppm salinity + seaweed extract 7.5% and seaweed extract 5.0% in each season (15.60 18.63 g/ plant, respectively). The next value in the same regard was obtained when applying 4000 ppm salinity + moringa extract 10.0% and seaweed extract 7.5% (14.70 and 16.77 g/ plant, respectively) in each season. The least record in the same concern was observed when control was combined with 6000 ppm salinity (3.03 and 3.77 g, respectively) in both seasons.

Table (30): Effect of foliar applications, salinity levels and their interaction on root dry weight (g)/ plant in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	9.23^{g-l}	6.00^{lm}	3.03^{m}	6.08 E
Salicylic acid 0.5 mM	11.67 $^{b-k}$	9.33^{g-l}	7.13^{k-m}	9.48 D
Salicylic acid 1.0 mM	12.47 $^{a-j}$	10.43 $^{c-l}$	8.63 $^{i-l}$	10.51 DC
Salicylic acid 1.5 mM	13.77 $^{a-g}$	12.43 $^{a-j}$	8.83 $^{h-l}$	11.68 A-D
Moringa extract 2.5%	13.13^{b-i}	11.33^{b-k}	8.50 $^{i-l}$	11.00 B-D
Moringa extract 5.0%	15.13^{a-c}	13.87^{a-g}	9.47^{f-l}	12.82 A-C
Moringa extract 10.0%	16.53 ^{a}	14.70^{a-d}	10.83^{c-k}	14.02 A
Seaweed extract 2.5%	14.37^{a-e}	11.43^{b-k}	8.03 $^{j-l}$	11.24 B-D
Seaweed extract 5.0%	13.57 $^{a-h}$	12.00^{a-j}	9.83^{e-l}	11.75 A-D
Seaweed extract 7.5%	15.60 ^{ab}	14.27 $^{a-f}$	10.27^{e-l}	13.31 AB
Mean	13.52 A\	11.56 B\	8.44 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	9.13^{g-j}	6.70 ^{ij}	3.77 ^{j}	6.53 D
Salicylic acid 0.5 mM	14.00^{a-g}	9.83^{f-i}	8.41^{g-j}	10.8 C
Salicylic acid 1.0 mM	15.27^{a-g}	11.03^{d-i}	9.60^{f-i}	11.93 BC
Salicylic acid 1.5 mM	15.40 $^{a-f}$	12.30 $^{c-i}$	9.77^{f-i}	12.59 BC
Moringa extract 2.5%	15.30^{a-f}	10.77^{e-i}	7.45^{h-j}	11.17 BC
Moringa extract 5.0%	15.77^{a-e}	12.93^{b-h}	9.80^{f-i}	12.83 BC
Moringa extract 10.0%	17.00 $^{a-c}$	13.63 $^{a-g}$	10.93^{d-i}	13.86 A-C
Seaweed extract 2.5%	17.01^{a-c}	10.633 $^{e-i}$	7.00 ^{ij}	11.55 BC
Seaweed extract 5.0%	18.63^{ab}	13.77 $^{a-g}$	10.40 $^{e-i}$	14.37 AB
Seaweed extract 7.5%	19.77 ^{a}	16.77 $^{a-d}$	13.77 $^{a-f}$	16.60 A
Mean	15.78 A\	11.82 B\	9.19 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-31): Effect of foliar applications, salinity levels and their interaction on **root length (cm)** in the 1st and 2nd seasons (Table 31)

4-31.a. The effect of salinity levels was significant in the 1st and 2nd seasons. The longest root was a result of using 2000 ppm salinity (39.59 and 40.34 cm, respectively). Moreover, at the 4000 ppm salinity the roots decreased to (33.12 and 32.86 cm, respectively). The shortest roots were a result of applying 6000 ppm salinity (24.60 and 22.94 cm, respectively) in both seasons.

4-31.b. The effect of foliar applications in the 1st and 2nd seasons was significant. The longest roots belonged to plants subjected to seaweed extract 7.5% in both seasons (40.13 and 42.88 cm, respectively). The shortest one resulted when control was used (13.23 and 15.22 cm, respectively).

4-31.c. The interaction between foliar applications and salinity levels affected root length in the 1st and 2nd seasons significantly. The longest roots were produced by plants having treatment of moringa extract 10.0% combined with 2000 ppm salinity (49.10 and 51.20 cm, respectively), Other treatments shared in the highest position were a result of applying 2000 ppm salinity +seaweed extract 7.5% in the 1st season and moringa extract 5.0% in the 2nd season (45.60 and 49.93 cm, respectively). Salinity 4000 ppm+ seaweed extract 7.5% in each seaons came directly in the second grade (42.50 and 45.10 cm, respectively). The shortest roots resulted when control combined with 6000 ppm salinity was used (7.17 and 8.17cm, respectively).

Table (31): Effect of foliar applications, salinity levels and their interaction on root length (cm) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	19.30 $^{j-l}$	13.33 ^{lm}	7.17^{m}	13.23 F
Salicylic acid 0.5 mM	32.43^{d-h}	25.00^{h-k}	18.43^{kl}	25.39 E
Salicylic acid 1.0 mM	39.17^{b-e}	28.56^{g-i}	21.60 $^{i-k}$	29.71 DE
Salicylic acid 1.5 mM	38.40^{b-e}	33.43 $^{d-g}$	22.40 $^{i-k}$	31.41 CD
Moringa extract 2.5%	39.83^{b-d}	33.10^{d-g}	26.13^{g-j}	33.02 CD
Moringa extract 5.0%	45.30^{a-c}	38.53^{b-e}	31.57^{e-h}	38.46 AB
Moringa extract 10.0%	49.10 ^{a}	39.27^{b-e}	30.67^{f-h}	39.61 A
Seaweed extract 2.5%	42.40^{a-c}	37.73^{c-f}	25.47 $^{h-k}$	35.17 BC
Seaweed extract 5.0%	44.50^{a-c}	39.73^{b-d}	30.63^{f-h}	38.35 AB
Seaweed extract 7.5%	45.60^{ab}	42.50^{a-c}	32.30^{d-h}	40.13 A
Mean	39.59 A\	33.12 B\	24.60 C\	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	22.17 j-m	15.60 ^{mn}	8.17^{n}	15.22 D
Salicylic acid 0.5 mM	29.40^{g-k}	24.10 $^{j-l}$	15.17 ^{mn}	22.85 C
Salicylic acid 1.0 mM	32.77^{f-i}	26.47 $^{h-k}$	17.53 ^{lm}	25.69 C
Salicylic acid 1.5 mM	43.00^{b-d}	29.80 $^{g-j}$	18.17 ^{lm}	30.38 B
Moringa extract 2.5%	40.00^{d-f}	32.53 $^{f-i}$	21.63^{k-m}	31.48 B
Moringa extract 5.0%	49.93^{ab}	39.00 $^{d-f}$	26.77^{h-k}	38.52 A
Moringa extract 10.0%	51.20 ^{a}	41.70 $^{c-e}$	28.13^{g-k}	40.34 A
Seaweed extract 2.5%	41.73^{c-e}	32.73 $^{f-i}$	25.43 $^{i-l}$	33.30 B
Seaweed extract 5.0%	44.73^{a-d}	41.60 $^{c-e}$	33.90^{e-h}	40.18 A
Seaweed extract 7.5%	48.77^{a-c}	45.10 $^{a-d}$	34.90^{e-g}	42.88 A
Mean	40.34 A\	32.86 B\	22.94 C\	

Means with the same letter in the same column are not significantly different according to Duncan's multiple range test

(4-32): Effect of foliar applications, salinity levels and their interaction on **chlorophyll "a" content (mg/g fw)** in the 1st and 2nd seasons (Table 32)

4-32.a. Effect of salinity levels: In the 1st and 2nd seasons the greatest content was a result of using 2000 ppm salinity (5.22 and 5.24 mg/ g fw, respectively). At the higher percent of salinity 4000 ppm this content decreased to 4.38 and 4.52 mg/g fw, respectively. On the other hand, the lowest content resulted when salinity at 6000 ppm was adopted (3.47 and 3.76 mg/g fw, respectively) in both seasons.

4-32.b. Effect of foliar applications: In the two season seaweed extract 7.5% achieved the highest content of chlorophyll "a" (4.45 and 4.64 mg/g FW, respectively), while control induced the lowest one (4.23 and 4.40 mg/g fw, respectively).

4-32.c. Effect of the interaction between foliar applications and salinity levels: salinity at 2000 ppm + seaweed extract 7.5% in the two seasons gave rise to the the highest chlorophyll "a" content (5.29 and 5.35 mg/g fw, respecively). Other combinations were included also in this highest category, was treatment of moringa extract 5.0 % and seaweed extract 5.0% in both seasons (5.28 and 5.34 mg/g fw, respectively) combined with 2000 ppm salinity. While salinity at 4000 ppm + seaweed extract 7.5% came directly in the second grade (4.48 and 4.62 mg/g fw, respectively). The lowest one was observed when control was applied to plants having 6000 ppm salinity (3.35 and 3.63 mg/g fw, respectively) in both seasons.

Table (32): Effect of foliar applications, salinity levels and their interaction on chlorophyll "a" content (mg/g fw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	5.10	4.24	3.35	4.23
Salicylic acid 0.5 mM	5.15	4.28	3.39	4.27
Salicylic acid 1.0 mM	5.17	4.33	3.44	4.31
Salicylic acid 1.5 mM	5.21	4.38	3.48	4.36
Moringa extract 2.5%	5.26	4.37	3.42	4.35
Moringa extract 5.0%	5.28	4.40	3.46	4.38
Moringa extract 10.0%	5.22	4.43	3.51	4.39
Seaweed extract 2.5%	5.27	4.42	3.53	4.41
Seaweed extract 5.0%	5.25	4.47	3.54	4.42
Seaweed extract 7.5%	5.29	4.48	3.58	4.45
Mean	5.22	4.38	3.47	
2nd season **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	5.10	4.46	3.63	4.40
Salicylic acid 0.5 mM	5.15	4.48	3.64	4.42
Salicylic acid 1.0 mM	5.17	4.49	3.68	4.45
Salicylic acid 1.5 mM	5.21	4.41	3.72	4.45
Moringa extract 2.5%	5.22	4.53	3.74	4.50
Moringa extract 5.0%	5.26	4.55	3.77	4.53
Moringa extract 10.0%	5.28	4.57	3.74	4.53
Seaweed extract 2.5%	5.32	4.50	3.84	4.55
Seaweed extract 5.0%	5.34	4.57	3.86	4.59
Seaweed extract 7.5%	5.35	4.62	3.94	4.64
Mean	5.24	4.52	3.76	

(4-33): Effect of foliar applications, salinity levels and their interaction on **chlorophyll "b" content (mg/g fw)** in the 1st and 2nd seasons (Table 33)

4-33.a. Effect of salinity levels: In the 1st and 2nd seasons the highest content was a result of salinity levels 2000 ppm (3.19 and 2.95 mg/g fw, respectively), applying salinity at 4000 ppm gave rise to the next grade of chlorophyll "b" content (2.29 and 2.33 mg/g fw, respectively). While doing the same with 6000 ppm salinity resulted in the lowest record in the same regard (1.23 and 1.14 mg/g FWfw, respectively) in both seasons.

4-33.b. Effect of foliar applications: In the 1st and 2nd seasons seaweed extract 7.5% achieved the highest content of chlorophyll "b" (2.34 and 2.34 mg/g fw, respectively). While control induced the lowest one (2.13 and 1.97 mg/g fw, respectively) in both seasons.

4-33.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons salinity at 2000 ppm + treatments seaweed extract 5.0% and seaweed extract 7.5% gave rise to the the highest chlorophyll "b" content (3.34 and 3.09 mg/g fw, respectively). Other combinations were also have the highest category which was treatment seaweed extract 7.5% in the 1st season and seaweed extract 5.0% in the 2nd season (3.32 and 3.04 mg/g fw, respectively) combined with 2000 ppm salinity. On the other hand, Salinity 4000 ppm + seaweed extract 7.5% came directly in the second grade (2.39 and 2.51 mg/g fw, respectively). While salinity at 6000 ppm+ control resulted in the lowest content (1.15 and 0.93 mg/g fw, respectively) in each season.

Table (33): Effect of foliar applications, salinity levels and their interaction on chlorophyll "b" content (mg/g fw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.07	2.16	1.15	2.13
Salicylic acid 0.5 mM	3.09	2.19	1.18	2.15
Salicylic acid 1.0 mM	3.11	2.24	1.16	2.17
Salicylic acid 1.5 mM	3.14	2.25	1.23	2.21
Moringa extract 2.5%	3.15	2.23	1.24	2.21
Moringa extract 5.0%	3.19	2.36	1.25	2.27
Moringa extract 10.0%	3.21	2.38	1.22	2.27
Seaweed extract 2.5%	3.26	2.34	1.28	2.29
Seaweed extract 5.0%	3.34	2.37	1.27	2.33
Seaweed extract 7.5%	3.32	2.39	1.32	2.34
Mean	3.19	2.29	1.23	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	2.84	2.15	0.93	1.97
Salicylic acid 0.5 mM	2.88	2.23	0.98	2.03
Salicylic acid 1.0 mM	2.89	2.27	1.00	2.05
Salicylic acid 1.5 mM	2.93	2.25	1.10	2.09
Moringa extract 2.5%	2.94	2.30	1.14	2.13
Moringa extract 5.0%	2.95	2.37	1.17	2.16
Moringa extract 10.0%	2.93	2.34	1.20	2.16
Seaweed extract 2.5%	2.97	2.42	1.25	2.21
Seaweed extract 5.0%	3.04	2.44	1.26	2.25
Seaweed extract 7.5%	3.09	2.51	1.37	2.32
Mean	2.95	2.33	1.14	

(4-34): Effect of foliar applications, salinity levels and their interaction on **carotenoids content (mg/g fw)** in the 1st and 2nd seasons (Table 34)

4-34.a. Effect of salinity levels: In the 1st season as salinity levels 2000 ppm gave the highest content (2.35 and 2.46 mg/g fw, respectively). While, applying 4000 ppm salinity this content decreased simultaneously to 1.86 and 1.86 mg/g fw, respectively in both seaons. But as salinity increased to 6000 ppm gave the lowest value (1.36 and 1.30 mg/g fw, respectively)

4-34.b. Effect of foliar applications: In the 1st and 2nd seasons applying seaweed extract 7.5% gave the highest carotenoids content (1.95 and 1.98 mg/g fw, respectively). While adopting control induced the lowest value (1.76 and 1.74 mg/g fw, respectively).

4-34.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons using seaweed extract 7.5% + 2000 ppm salinity level resulted in the highest record of carotenoids content (2.44 and 2.56 mg/g fw, respectivly), in addition to treatments seaweed extract 5.0% in each season + 2000 ppm salinity (2.43 and 2.55 mg/g, respectively. On the other hand, salinity at 4000 ppm combined with seaweed extract 7.5% and seaweed extract 5.0%) gave rise to the next value in the same regard (1.96 and 1.98 mg/g wf, respectively). While control + 6000 ppm salinity resulted in the lowest record (1.25 and 1.12 mg/g fw, respectively) in both seasons.

Table (34): Effect of foliar applications, salinity levels and their interaction on carotenoids content (mg/g fw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	2.26	1.77	1.25	1.76
Salicylic acid 0.5 mM	2.28	1.78	1.29	1.78
Salicylic acid 1.0 mM	2.33	1.84	1.34	1.84
Salicylic acid 1.5 mM	2.34	1.83	1.36	1.84
Moringa extract 2.5%	2.31	1.79	1.32	1.81
Moringa extract 5.0%	2.37	1.88	1.37	1.87
Moringa extract 10.0%	2.35	1.85	1.38	1.86
Seaweed extract 2.5%	2.41	1.91	1.39	1.90
Seaweed extract 5.0%	2.43	1.94	1.41	1.93
Seaweed extract 7.5%	2.44	1.96	1.44	1.95
Mean	2.35	1.86	1.36	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	2.36	1.75	1.12	1.74
Salicylic acid 0.5 mM	2.39	1.74	1.18	1.77
Salicylic acid 1.0 mM	2.44	1.79	1.23	1.82
Salicylic acid 1.5 mM	2.42	1.82	1.25	1.83
Moringa extract 2.5%	2.45	1.85	1.28	1.86
Moringa extract 5.0%	2.47	1.87	1.34	1.89
Moringa extract 10.0%	2.48	1.92	1.36	1.92
Seaweed extract 2.5%	2.51	1.96	1.37	1.95
Seaweed extract 5.0%	2.55	1.98	1.41	1.98
Seaweed extract 7.5%	2.56	1.95	1.43	1.98
Mean	2.46	1.86	1.30	

(4-35): Effect of foliar applications, salinity levels and their interaction on **total carbohydrate% (dw)** in the 1st and 2nd seasons (Table 35)

4-35.a. Effect of salinity levels: In the 1st and 2nd seasons salinity level (2000 ppm) induced the highest percentage of total carbohydrates (23.29 and 19.34 % dw), while salinity at 6000 ppm gave rise to the next grade of percentage (18.31 and 16.28 % dw,). While 6000 ppm salinity induced the lowest one (15.28 and 13.43% dw, respectively) in both seasons.

4-35.b. Effect of foliar applications: In the 1st and 2nd seasons the highest percentage belonged to seaweed extract 7.5% (20.27 and 17.63 % dw, respectively) while control induced the lowest one (17.12 and 15.03 % dw, respectively).

4-35.c. Effect of the interaction between foliar applications and salinity levels: the highest percentage in this regard was obtained when treatment seaweed extract 7.5% were applied to plants subjected to 2000 ppm salinity (25.50 and 20.75 % dw, respectively) in both seasons. Other treatments of seaweed extract at 2.5% in the 1st season and seaweed extract at 5.0% in the 2nd season combined with 2000 ppm salinity levels shared in the highest position (24.63 and 20.54 % dw, respectively). However, salinity at 4000 ppm + seaweed extract 5.0% and seaweed extract 2.5% came directly in the second grade (19.98 and 17.71% dw, respectively) in the 1st and 2nd seasons. The lowest record in the same question was a result of combining control and 6000 ppm salinity (13.80 and 11.84%% dw, respectively).

Tables (35): Effect of foliar applications, salinity levels and their interaction on total carbohydrate% (dw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	21.00	16.56	13.80	17.12
Salicylic acid 0.5 mM	22.12	17.85	14.50	18.16
Salicylic acid 1.0 mM	21.88	17.95	14.84	18.22
Salicylic acid 1.5 mM	22.40	17.80	14.70	18.30
Moringa extract 2.5%	23.66	17.32	15.60	18.86
Moringa extract 5.0%	23.87	18.74	15.98	19.53
Moringa extract 10.0%	23.85	18.24	15.45	19.18
Seaweed extract 2.5%	24.63	19.40	16.32	20.12
Seaweed extract 5.0%	24.00	19.98	15.62	19.87
Seaweed extract 7.5%	25.50	19.30	16.00	20.27
Mean	23.29	18.31	15.28	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	18.66	14.59	11.84	15.03
Salicylic acid 0.5 mM	18.30	15.00	12.30	15.20
Salicylic acid 1.0 mM	18.58	15.64	12.34	15.52
Salicylic acid 1.5 mM	18.90	16.10	13.41	16.14
Moringa extract 2.5%	19.20	16.30	13.70	16.40
Moringa extract 5.0%	19.64	16.10	13.20	16.31
Moringa extract 10.0%	19.00	16.88	14.44	16.77
Seaweed extract 2.5%	19.84	17.71	14.80	17.45
Seaweed extract 5.0%	20.54	16.90	13.67	17.04
Seaweed extract 7.5%	20.75	17.53	14.60	17.63
Mean	19.34	16.28	13.43	

(4-36): Effect of foliar applications, salinity levels and their interaction on **flavonoids content (mg/100 g dw)** in the 1st and 2nd seasons (Table 36).

4-36.a. Effect of salinity levels: In the 1st and 2nd seasons the greatest content was a result of using 4000 ppm salinity (5.32 and 5.99 mg/100 g dw, respectively). At 2000 ppm salinity level, the lowest value was observed (3.20 and 3.80 mg/100 g dw, respectively).

4-36.b. Effect of foliar applications: The greatest content in the 1st and 2nd seasons was induced by treatment of seaweed extract 5.0% and seaweed extract 7.5% (4.41 and 5.09 mg/100 g dw, respectively). The lowest value in the same respect was observed when control was applied (4.06 and 4.57 mg/100 g dw, respectively).

4-36.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons it could be noticed that the highest percentage in this regard was obtained when applying seaweed extract 7.5% + 4000 ppm salinity in each seasons (5.47 and 6.34 mg/100 g dw, respectively). Other combinations shared in the highest value were treatments moringa extract 5.0% in the 1st season and seaweed extract 5.0% in the 2nd season (5.44 and 6.25 mg/g dw, respectively) combined with 4000 ppm salinity. Furthermore, treatment 6000+ seaweed extract 7.5% (4.47 and 4.88 mg/100 g dw, respectively) gave rise to the second position. The lowest record was noticed when control plus 2000 ppm salinity were applied (3.04 and 3.57 mg/100 g dw).

Table (36): Effect of foliar applications, salinity levels and their interaction on flavonoids content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.04	5.14	4.00	4.06
Salicylic acid 0.5 mM	3.11	5.17	4.10	4.13
Salicylic acid 1.0 mM	3.14	5.25	4.14	4.18
Salicylic acid 1.5 mM	3.15	5.27	4.23	4.22
Moringa extract 2.5%	3.18	5.37	4.20	4.25
Moringa extract 5.0%	3.21	5.39	4.28	4.29
Moringa extract 10.0%	3.25	5.44	4.31	4.33
Seaweed extract 2.5%	3.28	5.34	4.40	4.34
Seaweed extract 5.0%	3.38	5.40	4.44	4.41
Seaweed extract 7.5%	3.25	5.47	4.47	4.40
Mean	3.20	5.32	4.26	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.57	5.71	4.42	4.57
Salicylic acid 0.5 mM	3.63	5.78	4.48	4.63
Salicylic acid 1.0 mM	3.66	5.84	4.54	4.68
Salicylic acid 1.5 mM	3.74	5.83	4.51	4.69
Moringa extract 2.5%	3.81	5.92	4.63	4.79
Moringa extract 5.0%	3.78	6.00	4.66	4.81
Moringa extract 10.0%	3.88	6.13	4.72	4.91
Seaweed extract 2.5%	3.92	6.14	4.77	4.94
Seaweed extract 5.0%	3.97	6.25	4.81	5.01
Seaweed extract 7.5%	4.06	6.34	4.88	5.09
Mean	3.80	5.99	4.64	

(4-37): Effect of foliar applications, salinity levels and their interaction on **proline content (mg/100 g dw)** in the 1st and 2nd seasons (Table 37)

4-37.a. Effect of salinity levels: In the 1st and 2nd seasons the highest contents belonged to salinity levels 6000 ppm (144.08 and 148.00 mg/100 g dw, respectively). As salinity level was 4000 ppm the proline content came in the second position (125.18 and 87.49 mg/100 g dw), finally at 2000 ppm the percent decrease to 74.56 and 58.37 mg/100 g dw, respectively in both seasons.

4-37.b. Effect of foliar applications: In the 1st and 2nd seasons the highest content was a result of using seaweed extract 7.5% (134.87 and 118.59 mg/100 g dw, respectively), while the lowest content in the same question resulted when control was used (80.50 and 76.88 mg/100 g dw).

4-37.c. Effect of the interaction between foliar applications and salinity levels: In the two season the greatest proline content resulted when seaweed extract 7.5% + 6000 ppm salinity was applied (165.30 and 173.00 mg/100 g dw, respectively). Other combinations shared in the highest category were treatments moringa extract 10.0% in the 1st season and seaweed extract 5.0% in the 2nd d season combined with 6000 ppm salinity (154.50 and 162.50 mg/100 g dw, respectively). However, next grade was a result of applying 4000 ppm + seaweed extract 7.5% in the 1st season and seaweed extract 5.0% in the 2nd season (142.63 and 108.30 mg/100 g dw, respectively. The lowest content in this concern was obtained when control was combined with 2000 ppm salinity (37.1 and 43.50 mg/100 g dw) in both seasons.

Table (37): Effect of foliar applications, salinity levels and their interaction on proline content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	37.81	90.30	113.40	80.50
Salicylic acid 0.5 mM	44.50	105.40	125.00	91.63
Salicylic acid 1.0 mM	57.60	128.40	144.30	110.10
Salicylic acid 1.5 mM	72.00	132.70	147.20	117.30
Moringa extract 2.5%	78.70	124.60	135.60	112.97
Moringa extract 5.0%	88.60	136.50	148.10	124.40
Moringa extract 10.0%	91.30	130.80	154.50	125.53
Seaweed extract 2.5%	83.70	122.50	153.40	119.87
Seaweed extract 5.0%	94.71	138.00	154.00	128.90
Seaweed extract 7.5%	96.67	142.63	165.30	134.87
Mean	74.56	125.18	144.08	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	43.50	65.74	121.40	76.88
Salicylic acid 0.5 mM	57.30	73.50	138.76	89.85
Salicylic acid 1.0 mM	52.40	71.10	144.70	89.40
Salicylic acid 1.5 mM	61.66	78.20	135.61	91.82
Moringa extract 2.5%	47.80	73.50	146.80	89.37
Moringa extract 5.0%	55.67	84.41	153.00	97.69
Moringa extract 10.0%	58.80	97.00	155.97	103.92
Seaweed extract 2.5%	64.10	105.60	148.25	105.98
Seaweed extract 5.0%	68.00	117.56	162.50	116.02
Seaweed extract 7.5%	74.48	108.30	173.00	118.59
Mean	58.37	87.49	148.00	

(4-38): Effect of foliar applications, salinity levels and their interaction on **phenolics content (mg/100 g dw)** in the 1st and 2nd seasons (Table 38)

4-38.a. Effect of salinity levels: In the 1st and 2nd seasons the highest content was a result of using salinity at 4000 ppm, while the lowest was obtained when adopting salinity at 2000 ppm, (16.67 and 17.28 mg/100 g dw, respectively). However, this value declined the lowest grade when salinity at 2000 ppm was adopted (13.33 and 13.50 mg/100 g dw, respectively).

4-38.b. Effect of foliar applications: In the 1st and 2nd seasons the greatest phenolics content was a result of applying seaweed extract 7.5% (15.19 and 15.47 mg/100 g dw, respectively), while the lowest one was observed after using control (14.64 and 14.92 mg/100 g dw, respectively) for each treatment.

4-38.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons the highest content was obtained when using 4000 ppm salinity level and applying treatments seaweed extract 5.0% and seaweed extract 7.5% (16.84 and 17.66 mg/100 g dw, respectively). Other treatments shared in the highest category were seaweed extract 2.5% and seaweed extract 5.0% (16.83 and 17.66 mg/100 g dw, respectively) in each season combined with 4000 ppm salinity. Next grade was a result of using 6000 ppm + seaweed extract 7.5% in 1st season and seaweed extract 5.0% in 2nd season (15.10 in both tratments). Finally, salinity at 2000 ppm combined with treatment control gave rise to the lowest content (12.88 and 13.20 mg/100 g dw, respectively) in each season.

Table (38): Effect of foliar applications, salinity levels and their interaction on phenolics content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	12.88	16.40	14.64	14.64
Salicylic acid 0.5 mM	13.10	16.47	14.72	14.76
Salicylic acid 1.0 mM	13.17	16.61	14.74	14.84
Salicylic acid 1.5 mM	13.24	16.66	14.84	14.91
Moringa extract 2.5%	13.26	16.57	14.87	14.90
Moringa extract 5.0%	13.38	16.77	14.88	15.01
Moringa extract 10.0%	13.48	16.80	15.00	15.09
Seaweed extract 2.5%	13.60	16.83	14.93	15.12
Seaweed extract 5.0%	13.54	16.84	14.97	15.12
Seaweed extract 7.5%	13.67	16.79	15.10	15.19
Mean	13.33	16.67	14.87	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	13.20	16.87	14.70	14.92
Salicylic acid 0.5 mM	13.33	16.95	14.77	15.02
Salicylic acid 1.0 mM	13.35	16.90	14.58	14.94
Salicylic acid 1.5 mM	13.47	17.10	14.63	15.07
Moringa extract 2.5%	13.53	17.31	14.81	15.22
Moringa extract 5.0%	13.49	17.36	14.86	15.24
Moringa extract 10.0%	13.58	17.44	14.78	15.27
Seaweed extract 2.5%	13.66	17.58	14.90	15.38
Seaweed extract 5.0%	13.68	17.59	15.10	15.46
Seaweed extract 7.5%	13.74	17.66	15.00	15.47
Mean	13.50	17.28	14.81	

(4-39): Effect of foliar applications, salinity levels and their interaction on **N% dw** in the 1st and 2nd seasons (Table 39)

4-39.a. Effect of salinity levels: In the 1st and 2nd seasons the highest N% was a result of using 2000 ppm salinity (1.11 and 1.30 %, respectively). Salinity at 4000 ppm came directly in the second grade (0.85 and 0.78 %). while the lowest one was observed when salinity at 6000 ppm was applied (0.59 and 0.64%, respectively) in both seasons.

4-39.b. Effect of foliar applications: In the 1st and 2nd seasons the highest N% resulted when seaweed extract 7.5% was applied (1.08 and 1.14%, respectively). The lowest one was a result of using control (0.71 and 0.71%, respectively).

4-39.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons the highest N% was a result of using 2000 ppm salinity combined with seaweed extract 7.5% (1.64 and 1.73%, respectively). Other combinations shared in the highest value were treatments seaweed extract 5.0% in each season (146 and 1.60, respectively) + 2000 ppm salinity. Furthermore, salinity 4000 ppm + seaweed extract 7.5% came directly in the second grade (0.97 and 0.91 %, respectively). The lowest percentage was obtained when control combined with 6000 ppm salinity were used (0.51 and 0.50%, respectively).

Table (39):Effect of foliar applications, salinity levels and their interaction on N% dw in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	0.90	0.72	0.51	0.71
Salicylic acid 0.5 mM	0.91	0.76	0.53	0.73
Salicylic acid 1.0 mM	0.93	0.83	0.55	0.77
Salicylic acid 1.5 mM	1.00	0.88	0.54	0.81
Moringa extract 2.5%	0.92	0.84	0.64	0.80
Moringa extract 5.0%	0.98	0.81	0.58	0.79
Moringa extract 10.0%	1.12	0.80	0.60	0.84
Seaweed extract 2.5%	1.24	0.93	0.66	0.94
Seaweed extract 5.0%	1.46	0.95	0.67	1.03
Seaweed extract 7.5%	1.64	0.97	0.64	1.08
Mean	1.11	0.85	0.59	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	0.96	0.66	0.50	0.71
Salicylic acid 0.5 mM	0.97	0.68	0.53	0.73
Salicylic acid 1.0 mM	1.04	0.67	0.59	0.77
Salicylic acid 1.5 mM	1.10	0.73	0.57	0.80
Moringa extract 2.5%	1.22	0.78	0.66	0.89
Moringa extract 5.0%	1.35	0.80	0.65	0.93
Moringa extract 10.0%	1.46	0.84	0.70	1.00
Seaweed extract 2.5%	1.55	0.81	0.68	1.01
Seaweed extract 5.0%	1.60	0.88	0.73	1.07
Seaweed extract 7.5%	1.73	0.91	0.77	1.14
Mean	1.30	0.78	0.64	

(4-40): Effect of foliar applications, salinity levels and their interaction on **P% dw** in the 1st and 2nd seasons (Table 40)

4-40.a. Effect of salinity levels: In the 1st and 2nd seasons the highest P% was a result of using 2000 ppm salinity (0.49 and 0.58 %, respectively). As salinity level increase to 4000 ppm, the P% came directly in the second grade (0.38 and 0.46 %, respectively). While the lowest one was observed when salinity at 6000 ppm was applied (0.26 and 0.31 %, respectively).

4-40.b. Effect of foliar applications: In the 1st and 2nd seasons the highest P% resulted when seaweed extract 7.5% was applied (0.45 and 0.52%). The lowest one was a result of using treatments control (0.34 and 0.38%, respectively) in each season.

4-40.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons the highest P% was the outcome of using 2000 ppm salinity combined with seaweed extract 7.5% (0.60 and 0.66 %, respectively). Other records shared also in this highest grade which resulted from treatment seaweed extract 5.0% in each season 0.53 and 0.63 %, respectively) combined with 2000 ppm salinity. Salinity 4000 ppm + seaweed extract 7.5% came directly in the second grade (0.44 and 0.51 %, respectively). The lowest percentage was obtained when control combined with 6000 ppm salinity were used (0.19 and 0.24%, respectively).

Table (40): Effect of foliar applications, salinity levels and their interaction on P% dw in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	0.48	0.34	0.19	0.34
Salicylic acid 0.5 mM	0.46	0.35	0.22	0.34
Salicylic acid 1.0 mM	0.47	0.36	0.23	0.35
Salicylic acid 1.5 mM	0.44	0.38	0.20	0.34
Moringa extract 2.5%	0.48	0.36	0.26	0.37
Moringa extract 5.0%	0.47	0.37	0.27	0.37
Moringa extract 10.0%	0.49	0.40	0.29	0.39
Seaweed extract 2.5%	0.52	0.41	0.30	0.41
Seaweed extract 5.0%	0.53	0.43	0.28	0.41
Seaweed extract 7.5%	0.60	0.44	0.31	0.45
Mean	0.49	0.38	0.26	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	0.51	0.40	0.24	0.38
Salicylic acid 0.5 mM	0.53	0.42	0.27	0.41
Salicylic acid 1.0 mM	0.56	0.44	0.28	0.43
Salicylic acid 1.5 mM	0.55	0.41	0.30	0.42
Moringa extract 2.5%	0.58	0.46	0.29	0.44
Moringa extract 5.0%	0.54	0.49	0.33	0.45
Moringa extract 10.0%	0.58	0.47	0.32	0.46
Seaweed extract 2.5%	0.62	0.48	0.35	0.48
Seaweed extract 5.0%	0.63	0.51	0.36	0.50
Seaweed extract 7.5%	0.66	0.51	0.38	0.52
Mean	0.58	0.46	0.31	

(4-41): Effect of foliar applications, salinity levels and their interaction on **K% dw** in the 1st and 2nd seasons (Table 61)

4-41.a. Effect of salinity levels: In the 1st and 2nd seasons the highest K% was a result of applying 2000 ppm salinity (2.39 and 2.38 %, respectively). Salinity 4000 ppm came directly in the second grade (1.85 and 1.88 %, respectively). Otherwise, the lowest K% was a result of applying salinity at 6000 ppm (1.52 and 1.38%, respectively).

4-41.b. Effect of foliar applications: In the 1st and 2nd seasons, the highest K% resulted when treatment (seaweed extract 7.5% and seaweed extract 5.0%) (2.03 and 1.94%, respectively). Meanwhile, control achieved the lowest record in this concern (1.83 and 1.80%, respectively) in both seasons.

4-41.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons the greatest value was obtained when plants were subjected to 2000 ppm salinity combined with seaweed extract 7.5% (2.49 and 2.46 %, respectively). Other records shared also in this highest grade, the most prominent of which resulted from treatment 2000 ppm salinity + seaweed extract 5.0% in each season (2.45 and 2.45 %, respectively). In the second grade salinity 4000 ppm came directly combined with treatments (seaweed extract 7.5% and seaweed extract 5.0%) (1.94 and 1.93 %, respectively). The lowest K% was induced by using control for plants undergoing 6000 ppm salinity (1.41 and 1.29%, respectively).

Table (41): Effect of foliar applications, salinity levels and their interaction on K% dw in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	2.34	1.75	1.41	1.83
Salicylic acid 0.5 mM	2.35	1.80	1.44	1.86
Salicylic acid 1.0 mM	2.37	1.83	1.47	1.89
Salicylic acid 1.5 mM	2.34	1.84	1.48	1.89
Moringa extract 2.5%	2.30	1.78	1.45	1.84
Moringa extract 5.0%	2.39	1.85	1.53	1.92
Moringa extract 10.0%	2.41	1.88	1.55	1.95
Seaweed extract 2.5%	2.44	1.89	1.59	1.97
Seaweed extract 5.0%	2.45	1.92	1.63	2.00
Seaweed extract 7.5%	2.49	1.94	1.66	2.03
Mean	2.39	1.85	1.52	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	2.29	1.83	1.29	1.80
Salicylic acid 0.5 mM	2.33	1.85	1.32	1.83
Salicylic acid 1.0 mM	2.36	1.86	1.35	1.86
Salicylic acid 1.5 mM	2.34	1.83	1.38	1.85
Moringa extract 2.5%	2.37	1.89	1.36	1.87
Moringa extract 5.0%	2.39	1.88	1.39	1.89
Moringa extract 10.0%	2.44	1.90	1.41	1.92
Seaweed extract 2.5%	2.41	1.91	1.44	1.92
Seaweed extract 5.0%	2.45	1.93	1.45	1.94
Seaweed extract 7.5%	2.46	1.90	1.42	1.93
Mean	2.38	1.88	1.38	

(4-42): Effect of foliar applications, salinity levels and their interaction on **Ca% dw** in the 1st and 2nd seasons (Table 42)

4-42.a. Effect of salinity levels: In the 1st and 2nd seasons, the greatest Ca% was a result of using 2000 ppm salinity (3.41 and 3.79 %, respectively). Salinity at 4000 ppm came directly in the second grade (2.78 and 2.68 %, respectively). As salinity level rose to 6000 ppm, this number decreased consecutively to 2.01 and 2.13%, respectively.

4-42.b. Effect of foliar applications: the greatest Ca% in the 1st and 2nd seasons was induced by seaweed extract 7.5% (2.87 and 3.01%, respectively). The lowest percentage in the same respect was observed when control was applied (2.60 and 2.72%, respecttively) in both seasons.

4-42.c. Effect of the interaction between foliar applications and salinity levels: applying seaweed extract 5.0% in the 1st and 2nd seasons +2000 ppm salinity gave rise to the greatest Ca% (3.48 and 3.98 %, respectively). Other interactions shared in this highest position were induced by treatment salinity at 2000 ppm combined with seaweed extract 7.5% in the 1st and 2nd seasons (3.47 and 3.88 %, respectively). However, salinity at 4000 ppm + seaweed extract 7.5% came directly in the second grade (2.91 and 2.84%, respectively). The lowest record was noticed when control plus 6000 ppm salinity were applied (1.85 and 1.91%, respectively) in both seasons.

Table (42): Effect of foliar applications, salinity levels and their interaction on Ca% dw in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.33	2.63	1.85	2.60
Salicylic acid 0.5 mM	3.35	2.66	1.88	2.63
Salicylic acid 1.0 mM	3.38	2.70	1.90	2.66
Salicylic acid 1.5 mM	3.41	2.74	1.95	2.70
Moringa extract 2.5%	3.43	2.75	1.96	2.71
Moringa extract 5.0%	3.39	2.83	1.96	2.73
Moringa extract 10.0%	3.44	2.84	2.06	2.78
Seaweed extract 2.5%	3.44	2.86	2.12	2.81
Seaweed extract 5.0%	3.48	2.83	2.17	2.83
Seaweed extract 7.5%	3.47	2.91	2.24	2.87
Mean	3.41	2.78	2.01	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.66	2.58	1.91	2.72
Salicylic acid 0.5 mM	3.67	2.55	1.95	2.72
Salicylic acid 1.0 mM	3.72	2.62	1.96	2.77
Salicylic acid 1.5 mM	3.74	2.65	2.13	2.84
Moringa extract 2.5%	3.79	2.66	2.16	2.87
Moringa extract 5.0%	3.83	2.63	2.17	2.88
Moringa extract 10.0%	3.85	2.72	2.24	2.94
Seaweed extract 2.5%	3.87	2.77	2.25	2.96
Seaweed extract 5.0%	3.92	2.78	2.22	2.97
Seaweed extract 7.5%	3.88	2.84	2.30	3.01
Mean	3.79	2.68	2.13	

(4-43): Effect of foliar applications, salinity levels and their interaction on **Na% dw** in the 1st and 2nd seasons (Table 43)

4-43.a. Effect of salinity levels: In the 1st and 2nd seasons the highest percenages were a result of using 6000 ppm salinity (6.81 and 7.49 %, respectively). As salinity level decrease to 2000 ppm it gave the lowest percentage (4.64 and 5.32%, respectively).

4-43.b. Effect of foliar applications: In the 1st and 2nd seasons the highest Na% resulted when control was used (6.00 and 6.69%, respectively). The lowest percenage resulted when seaweed extract at 7.5% was applied (5.41 and 6.22%, respectively).

4-43.c. Effect of the interaction between foliar applications and salinity levels: In the 1st and 2nd seasons the greatest Na% resulted when control combined with 6000 ppm salinity was used (7.31 and 7.80%, respectively). Other treatment shared in this highest position was induced by salicylic acid at 0.5 mM in each season (7.15 and 7.66 %, respectively). Next grade was a result of using 4000 ppm + control (5.84 and 6.74%, respectively). Percenage in the lowest position include plants subjected to 2000 ppm salinity and experienced seaweed extract 7.5% (4.41 and 5.11%, respectively) in each seasons.

Table (43): Effect of foliar applications, salinity levels and their interaction on Na% dw in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	4.86	5.84	7.31	6.00
Salicylic acid 0.5 mM	4.77	5.72	7.15	5.88
Salicylic acid 1.0 mM	4.78	5.78	7.04	5.87
Salicylic acid 1.5 mM	4.74	5.70	6.88	5.77
Moringa extract 2.5%	4.49	5.66	6.78	5.64
Moringa extract 5.0%	4.66	5.55	6.74	5.65
Moringa extract 10.0%	4.63	5.61	6.65	5.63
Seaweed extract 2.5%	4.57	5.53	6.61	5.57
Seaweed extract 5.0%	4.52	5.47	6.50	5.50
Seaweed extract 7.5%	4.41	5.35	6.47	5.41
Mean	4.64	5.62	6.81	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	5.52	6.74	7.80	6.69
Salicylic acid 0.5 mM	5.42	6.72	7.66	6.60
Salicylic acid 1.0 mM	5.39	6.64	7.63	6.55
Salicylic acid 1.5 mM	5.44	6.67	7.51	6.54
Moringa extract 2.5%	5.38	6.53	7.55	6.49
Moringa extract 5.0%	5.30	6.45	7.48	6.41
Moringa extract 10.0%	5.26	6.52	7.40	6.39
Seaweed extract 2.5%	5.23	6.37	7.36	6.32
Seaweed extract 5.0%	5.17	6.41	7.24	6.27
Seaweed extract 7.5%	5.11	6.34	7.22	6.22
Mean	5.32	6.54	7.49	

(4-44): Effect of foliar applications, salinity levels and their interaction on **chloride content (mg/100 g dw)** in the 1st and 2nd seasons (Table 44)

4-44.a. Effect of salinity levels: In the 1st season as long as salinity level increased to 6000 ppm, chloride content increased to to 4.60 and 4.20 mg/100 mg/100g dw, respectively) (the highest value). However, this declined when salinity level decreased to to 2000 ppm (2.90 and 2.93 mg/100 g dw, respectively).

4-44.b. Effect of foliar applications: In the 1st and 2nd seasons the highest content was a result of applying control (4.23 and 3.89 mg/100 g dw, respectively). The lowest one was observed after using the seaweed extract 7.5% (3.33 and 3.19 mg/100 g dw, respectively).

4-44.c. Effect of the interaction between foliar applications and salinity levels: In the 1st season the highest content was produced when using 6000 ppm salinity level and applying treatment control (5.44 and 4.56 mg/100 g dw, respectively). Using 4000 ppm + control came directly in the second grade (3.93 and 3.87 mg/100g/dw, respectively). However, applying salinity at 2000 ppm combined with moringa extract 0.5 % in the 1st season and seaweed extract 7.5% in the 2nd season gave the lowest content (2.61 and 2.53 mg/100 g dw, respectively)

Table (44): Effect of foliar applications, salinity levels and their interaction on chloride content (mg/100 g dw) in the two seasons

1st season, 2016-2017 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.32	3.93	5.44	4.23
Salicylic acid 0.5 mM	3.17	3.84	5.20	4.07
Salicylic acid 1.0 mM	2.93	3.80	5.00	3.91
Salicylic acid 1.5 mM	2.91	3.45	4.15	3.50
Moringa extract 2.5%	2.85	3.49	4.41	3.58
Moringa extract 5.0%	2.61	3.55	4.56	3.57
Moringa extract 10.0%	2.68	3.74	4.78	3.73
Seaweed extract 2.5%	2.92	3.34	4.33	3.53
Seaweed extract 5.0%	2.87	3.26	4.12	3.42
Seaweed extract 7.5%	2.78	3.23	3.98	3.33
Mean	2.90	3.56	4.60	
2nd season, 2017-2018 **Salinity levels (ppm)**				
Foliar applications	2000	4000	6000	Mean
Control	3.23	3.87	4.56	3.89
Salicylic acid 0.5 mM	3.18	3.84	4.49	3.84
Salicylic acid 1.0 mM	2.88	3.56	4.00	3.48
Salicylic acid 1.5 mM	2.86	3.71	4.44	3.67
Moringa extract 2.5%	3.10	3.50	4.12	3.57
Moringa extract 5.0%	2.99	3.66	4.00	3.55
Moringa extract 10.0%	2.96	3.57	4.25	3.59
Seaweed extract 2.5%	2.82	3.58	4.44	3.61
Seaweed extract 5.0%	2.75	3.42	3.88	3.35
Seaweed extract 7.5%	2.53	3.24	3.80	3.19
Mean	2.93	3.60	4.20	

5-Discussion

This study was carried out at the nursery of the Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt in March of the two seasons, 2016-2017 and 2017-2018. Transplants of *Terminalia arjuna* were subjected to 2 experiments aiming to investigate the effect of foliar applications with salicylic acid, moringa leaf extract and seaweed extract combined with irrigation intervals and salinity levels on the tolerance of *Terminalia arjuna* seedlings.

Results of this study were in accordance with the findings of some of authors as demonstrated in the following discussion:

5-1- Effect of salicylic acid (SA) on plants

Results showed significant effect for foliar application of salicylic acid on *Terminalia* seedlings. These findings were similar to those reported by **Kang *et al.*, (2014)** who indicated that SA resulting in increased chlorophyll content and improved seedlings growth. **Miura and Tada, (2014)** mentioned that SA plays an important role in improving the tolerance of important crops as response to abiotic stresses like drought and salinity. The utility of SA is dependent on the concentration, the mode of application, and the stage of the plants. However, **Manzoor *et al.*, (2015)** found that foliar application of SA significantly increased amino acid accumulation and shoot dry matter in maize.

Effect of salicylic acid (SA) under drought and salt stresses:

5-1-a. Under Drought

The interaction between irrigation intervals and salicylic acid treatments was significant compared with control treatment for studied traits for plant height, shoot fresh weight and root fresh weight, in addition to chlorophyll "a" and chlorophyll "b".

These results are in parallel with **Kang *et al.*, (2012)** who found that SA induced growth and drought tolerance in wheat plants. **Rao *et al.*, (2012)** noticed that salicylic acid can play a role in reducing the effect of drought in maize. **Zamaninejad *et al.*, (2013)** stated that salicylic acid at 140 mg/l increased plant height of corn under drought conditions. Furthermore, **De Jesus, (2014)** stated that foliar application of SA improved performance of *Eucalyptus globulus* under drought stress. **Heydarian *et al.*, (2014**) on *Capparis spinosa*, showed that salicylic acid have more effect on germination characteristics under drought stress. **Kabiri *et al.*, (2014)** manifested that salicylic acid could protect *Nigella sativa* plants against drought stress through increasing soluble sugar contents and photosynthetic pigments (chlorophyll *a*, *b*, total chlorophyll, and carotenoids). Moreover, **Abbaspour and Ehsanpour, (2016)** concluded that SA increased drought tolerance of *Artemisia aucheri* by increasing biosynthesis of phenolic compounds, increased content of soluble carbohydrates.

5-1-b. Under salinity

Results indicated that the interaction between salicylic acid (1.5 mM) and salinity levels gave the highest values of plant height, number of leaves, chlorophyll "a" , chlorophyll "b", and carotenoids.

Simaei *et al.*, (2012) explained that exogenous SA application has obtained a particular attention because it induces protective effects on plants under salinity. Also, **Badran *et al.*, (2013)** on *Khaya senegalensis* seedlings stated that salicylic acid at 200 ppm was effective in alleviating the harmful effects of salinity and improved all traits. **Li *et al.*, (2014)** reported that SA induced salt tolerance of the conifer *Torreya grandis* cv. Merrillii (Family Taxaceae). **Jamali *et al.*, (2015)** informed that the foliar treatment of salicylic acid reduced the deleterious effect of salinity stress and recorded the highest values in all measured physical fruit quality traits. This may be due to its role as antioxidant and anti-diseases substances which keep plant healthy, vigor and consequently increased its productivity, fruit traits and quality. **Husen *et al.*, (2018)** stated that foliar application of SA improved the performance of Ethiopian mustard (*Brassica carinata*) cultivars and mitigated the damage caused by salt stress.

5-2- Effect of seaweed extract (SWE) on plants

There was a significant increase in all studied traits of seedlings and its components by using a foliar application of seaweed extract (7.5%) and seaweed extract 5.0% concerning number of leaves (59.93 leaves), root length (73.30 cm), chlorophyll "b" content (2.47 mg/g f.w.) with using , and carotenoids content (1.98 mg/g f.w.).

These results confirm those of **Godlewska and Michalak**, **(2016)** who informed that seaweeds extracts biochemical composition is complex (polysaccharides, minerals, vitamins, oils, fats, acids, antioxidants, pigments, hormones. **Stirk *et al.*, (2014)** reported that *Ecklonia maxima* extracts present a high potential for application in agriculture due to its high content of several plant hormones such as abscisic acid, gibberelins. Therefore, **Arioli *et al.*, (2015)** manifested that the application of liquid seaweed extracts enhancing plant growth properties through metabolic benefits, triggering disease response pathways and increasing stress tolerance. **Battacharyya *et al.*, (2015)** studied that the positive effect of seaweed extract may be due to its constituents of macro and micro nutrients as well as some growth regulators, polyamines and vitamins, which improve the nutritional status and vegetative growth. **Divya *et al.*, (2015)** observed that the enhancement of germination, growth and productivity by using *Sargassum wightii* liquid fertilizer is related to the presence of high levels of several phytohormones in this extract. Also, **Mathur *et al.*, (2015); Pacholczak *et al.*, (2016**) stated that seaweed extracts are known to promote and enhance vegetables, fruits and various other crops because of their richness in growth regulators such as auxins (IAA and IBA), gibberellins and cytokinin, in addition to osmo protectant betains and micronutrients. **Ronga *et al.*, (2019)** revealed that the amino acids contained in the microalgae are a biostimulant with positive effects on plant growth and crop performance. These amino acids can contribute to mitigate the injuries caused by abiotic stress

Effect of seaweed extract (SWE) under drought and salt stresses:

5-2-a. Under drought

Our results are also in harmony with those of **Kang *et al.*, (2012)** found that pretreatment with 70 mg/l SA enhanced growth and tolerance to subsequent drought stress in wheat seedlings, and increased shoot and root dry weights. Furthermore, **Chenping and Leskovar, (2015)** informed that under mild drought stress, SWE improved plant growth of spinach. **Li and Mattson, (2015)** reported that foliar sprays with rockweed (*Ascophyllum nodosum*) extract did not improve drought tolerance of petunia and tomato, whereas substrate drenches significantly improved drought tolerance of both plants. Also**, Goni *et al.*, (2018**) remarked that biostimulant treatments with *Ascophyllum nodosum* increased total chlorophyll content in tomato leaves under drought stress.

5-2-b. Under Salinity

Abdel Aziz *et al.*, (2011) concluded that seaweed extracts application at 2.5 and 3.0 cm3/L enhanced plant tolerance against salinity, and had a favorable effect on vegetative growth, flowering and chemical constituents of *Amaranthus tricolor* plants. However, **Chernane *et al.*, (2015)** declared that seaweed extract from *Ulva rigida* improved salt stress tolerance of wheat plants and enhanced vegetative growth**. Ramarajan *et al.*, (2013)** reported that shoot length, root length, number of leaves of soybean (*Glycine max*) was found to be maximum at 1% SWE , this happened due to the positive effect of (SWE) which reduced the salt stress and increased the cell elongation which ultimately increased the length and diameter. Also, **Rinez *et al.*, (2016)** on capsicum proved that all pre-treatments by algae aqueous extracts have improved germination and growth in saline conditions. **Jithesh *et al.,* (2018)** indicated that bioactive components of an *Ascophyllum nodosum* extract were able to mitigate salinity stress through various mechanisms: by protecting cellular structures from water loss, via acting as a hydration buffer, sequestering ions.

5-3- Effect of moringa extract (MO) on plants:

Our results are in line with **Basra *et al.,* (2011); Yasmeen *et al.*, (2013)** who observed that the increase in potassium uptake and exclusion of sodium could be due t o the presence of different type of plant growth regulators and antioxidant in MLE that improve the growth of plant under salt stress. **Talreja, (2011); Ahmed *et al.*, (2016) and Said Al-Ahl *et al.,* (2017)** noticed that Moringa crude aqueous extract encloses mixture of various categories of active compounds that possess biostimulanting properties such as, carbohydrates, nitrogenous compounds, hormones and polyphenols. **Rady *et al.*, (2013)** stated that *Moringa* leaf extract contains antioxidant including proline and phytohormone such as indol acetic acid (IAA), gibberllins and cytokinins which improve plant growth, metabolism and antioxidant enzymes. Several reports **(Mona, 2013; Emongor, (2015)** concluded that the increases of free proline and soluble sugars concentrations in plants are attributed to MLE applications that increased the concentrations of photosynthetic pigments and cytokinins (a component of MLE), which stimulate carbohydrate metabolism and producing new source-sink relation-ships leading to increase the accumulation of dry matter in plants. **Yasmeen *et al.*, (2013)** reported that significance of MLE (moringa leaf extract) as the leaves contain a heavy amount of mineral contents including K^+ which is an excellent plant nutrient. Many reports have shown the role of MLE in improving crop resistance to salinity. **(Howladar, 2014)** manifested that extract (MLE) contains powerful natural antioxidants, which can be used by crop producers for crop plants to improve growth and yield attributes of various crops, and to overcome environmental stresses. Moreover, **Ali and Ghada, (2014)** reported that MLE produced maximum phenolic contents during both growing seasons, which protect plant tissues against oxidative damage under water stress**.** Also, **Asghari *et al.,* (2015)** stated that Moringa species were calcium-rich, and that MP enclosed higher amounts of calcium compared to MO. **Desoky *et al.*, (2018)** concluded that MLE can be used as plant bio-stimulants/nutritive means of integration under normal or abnormal conditions as an economic and natural source of mineral nutrients, phytohormones, amino acids, osmo-protectants, and antioxidants.

5-3-a. On drought

Treatment (moringa extract 10.0%) achieved the highest position concerning plant height, shoot fresh weight, root fresh, dry weights, and root length.

Azra *et al.* (2013) found an increase in chlorophyll contents when MLE was applied to wheat plants under drought conditions. Furthermore, the applications of MLE, used as seed soaking or foliar spray, have been used to improve the plant tolerance to a biotic stresses as mentioned by **Rady *et al.,* (2013); Yasmeen *et al.,* (2013).** Moreover, **(Yasmeen *et al.,* (2012); Rehman *et al.,* (2014)** reported that MLE applications maintained optimum tissue water status and membranes stabilities, enhanced antioxidant levels and activated plant defense system, increased levels of plant secondary metabolites, reduced uptake of undesirable Na+ and/or Cl-, and enhanced shoot or leaf K+**. Abd El-Mageed *et al.,* (2017)** mentioned that application of 3% MLE was effective on alleviating damages of drought stresses in squash plants by maintaining higher RWC (relative water content), WUE (water use efficiency), and osmo-protectants, and lower EL (electrolyte leakage). However, **Hanafy, (2017)** on *Glycine max*, manifested that MLE (30) was able to enhance the tolerance of the studied plant to drought stress and increase growth parameters (shoot and root length, fresh and dry weight of shoots and roots). **Pervez *et al.*, (2017)** mentioned that exogenous application of *Moringa* aqueous leaf extract (MLE) significantly improved leaf relative water content, leaf area, shoot and root fresh and dry weights, root area, root length and root width under drought stress.

5-3-b. On salinity

Observations of results clearly showed that spraying Terminalia seedlings with moringa extract 10.0% gave the highest values of plant height, number of branches and root length.

Such finding supported the stimulatory effects of moringa extracts as reported by foliar application of MLE enhanced the chlorophyll contents of wheat under normal and NaCl stressed conditions. **Yasmeen *et al.*, (2013)** informed that MLE participated in beneficial roles during growth of squash plants via improving plant metabolism due to its high concentration of essential mineral nutrients and phytohormones (gibberellins, auxin, and cytokinins). These components are known to enhance cell division, elongation and accumulation of dry matter being rich source of growth promoting hormones improved the production of antioxidant activities and alleviate the reduction of chlorophyll contents under salt stress. Furthermore, **Maishanu *et al.*, (2017)** indicates that the cowpea plants treated with moringa extract have the highest mean of stems, number of leaves and branches, length of leaves and branches, and thickness of stem.

Our results are in harmony with the findings of **Yasmeen *et al.*, (2013)** who reported that accumulation of phenols by MLE application enhanced salt tolerance by mediating scavenging of ROS and maintaining membrane stability. **Nawaz *et al.*, (2016)** reported that foliar application of MLE increases Chl “a” and “b” contents in wheat crop when applied at tillering and heading stages. **Merwad, (2017)** on Sudan grass mentioned that spraying of MLE increased values of fresh and dry weights, total chlorophyll, and NPK uptake under different salinity levels. **Muthalagu *et***

***al.*, (2018)** revealed that all treatments of MLE on black pepper (*Piper nigrum*) were very effective on improving total chlorophyll, carotenoids, soluble protein, photosynthetic rate, transpiration rate, water use efficiency and chlorophyll fluorescence. **Desoky *et al.*, (2019)** indicated that application of foliar spraying with *Moringa* leaf extract overcame the harmful effects of salinity stress on the above mentioned criteria of Sudan grass compared with untreated plants.

5-4-a. Effect of drought on plant growth characteristics:

The results of this work indicated that drought stress significantly reduced crop yield and the reduction increased with increasing drought time 16 days. This reduction is coincided with the general trends of the effect of drought on plants as reported by many investigators, **Fang *et al.*, (2012)** showed that under drought conditions in two species of *Salix paraqplesia* and *Hippophae rhamnoides*, height, base diameter and number of leaves reduced. **Kamal Uddin *et al.*, (2012)** noticed that in the drought and salt tolerant purslane (*Portulaca oleracea*) K^+ and Ca^{2+} decreased. **Vandoorne *et al.*, (2012)** reported that water stress drastically decreased fresh and dry weight in *Cichorium intybus* (var. *sativum*). Additionally, **Ademilua, (2013)** stated that *Acalypha wilkesiana* plants watered daily had higher fresh and dry weights than those watered every three days. **El-Mekawy, (2013)** on *Achillea santolina* informed that irrigation every 7 days increased fresh and dry weight of herb/plant compared to irrigation every 14 and 21 days.

5-4-b. Effect of drought on plant chemical characteristics:

These findings were similar to those reported by **Mohamed *et al.*, (2014)** found that number of leaves and total carbohydrates of *Curcuma aromatica* and *C. domestica* increased when plants were irrigated every week, compared to irrigation treatments every two or three weeks. **Maguire *et al.*, (2015)** stated that in five temperate tree species (*Acer rubrum*, *Betula papyrifera*, *Fraxinus americana*, *Quercus rubra*, and *Q. velutina*) shade and drought combined caused total nonstructural carbohydrates (NSC) decreases in all species. Starch followed similar patterns as total NSC, but soluble sugars increased under drought for drought-tolerant species. On the contrast, **Caliskan *et al.*, (2017)** noticed that drought stress did not cause a significant change in these compounds in *Hypericum pruinatum* plantlets. **Kumar *et al.*, (2017)** found that strong water deficit (no irrigation) and salt stress (46.800 g/l NaCl) both caused increases in the levels of antioxidant flavonoids in one-year-old oleander seedlings. Also**, Tsuchida and Yakushiji, (2017)** remarked that under the drought stress condition, the photosynthetic rate in Japanese apricot trees (*Prunus mume*) declined. **Bista *et al.*, (2018)** stated that drought reduced %N and P, indicating that it reduced nutrient acquisition more than growth.

5-5- a. Effect of salinity on plant growth characteristics:

Our results are also in parallel with those of **Torbaghan *et al.*, (2011)** who observed that increasing salinity levels from 1200 to 7000 ppm decreased height of *Crocus sativus* plants. **Badran *et al.*, (2013)** stated that soil salinity, especially at high level (0.7%) decreased plant number of leaves of *Khaya senegalensis* seedlings. Furthermore, **Hanafi *et al.*, (2013)** showed that in six weed species, shoot and root dry weight decreased with increasing salinity levels. **Mostajeran and Gholaminejad, (2014)** noticed that in turmeric (*Curcuma longa*), plant dry weight decreased in response to salinity. Meanwhile, **Ali *et al.*, (2015)** showed that *Dalbargia sisso* seedlings stressed with salt solution showed reduction in stem girth and number of branches. Meanwhile. **Murillo-Amador *et al.*, (2015)** found no significant effects of salinity up to 120 mM (7000 ppm) on *Aloe vera* plants concerning leaf dry weight. **Tavousi *et al.*, (2015)** showed that salinity stress can reduce water use efficiency. **Yaish and Kumar, (2015)** on date palm declared that excessive amounts of salt lead to a significant reduction in the productivity of the fruits as well as marked decrease in the viable numbers of the date palm trees. **El-Sharkawy *et al.*, (2017)** remarked that plant biomass of alfalfa (*Medicago sativa*) was reduced under salt concentrations.

5-5-b. Effect of salinity on plant chemical analysis:

Campos *et al.*, (2012) manifested that the levels of total soluble sugars and carotenoids in *Jatropha curcas* plants did not significantly differ between salt-stressed and untreated plants. Meanwhile, it caused a significant decrease in total chlorophyll and led to chlorophyll damage However, **Kamal Uddin *et al.*, (2012)** noticed that in the salt tolerant purslane (*Portulaca oleracea*) carbohydrates and Cl increased with increasing salinity. **Rahdari *et al.*, (2012)** reported that an increase occurred in proline and sugar contents in leaves of purslane (*Portulaca oleraceae*) was synchronized with increasing sodium chloride. **Hanafi *et al.*, (2013)** showed that in six weed species, chlorophyll content decreased with increasing salinity levels. **Mostajeran and Gholaminejad, (2014)** informed that in turmeric (*Curcuma longa*), salinity levels reduced the amount of soluble and carbohydrates, while the amount of Na^+ content increased as salinity increased. **Neocleous *et al.*, (2014)** found that in the two baby lettuce cultivars (green “Paris Island” and red “Sanguine”), salinity caused an accumulation of Cl. **Dadkhah, (2015)** mentioned that in two sugar beet cultivars salinity caused a significant reduction in leaf net photosynthesis. Meanwhile **Murillo-Amador *et al.*, (2015)** found no significant effects of salinity up to 120 mM (7000 ppm) on *Aloe vera* plants concerning chlorophylls a and b. Also, **Kumar *et al.*, (2017)** found that strong salt stress (46.800 g/l NaCl) both caused degradation of photosynthetic pigments in one-year-old oleander seedlings. **Shah *et al.*, (2017)** found that increasing salinity significantly reduced the chlorophyll and carotenoid contents in wheat. **Singh *et al.*, (2015)** mentioned that salinity caused significant increase in the ratio of Na^+/Ca^{2+} in both the crops. Reduced Ca2+ uptake under stress environments induced reduction in the binding of Ca2+ to the plasma membrane.

5-6- Proline

Our results are also in harmony with those of the increase in the proline content of plants irrigated at long intervals is in agreement with the findings of **Barzegar *et al.*, (2012)** who observed that in almond, accumulation of proline in response to longer interval between irrigations. Also, **Campos *et al.*, (2012)** reported that irrigation with high NaCl concentrations for 50 days, increased proline levels in *Jatropha curcas*. **Rahdari *et al.*, (2012)** reported that an increase occurred in proline content in leaves of purslane (*Portulaca oleraceae*) was synchronized with increasing Nacl. Moreover, **Mostajeran and Gholaminejad, (2014)** noticed that in turmeric (*Curcuma longa*), the amount of proline increased as salinity increased up to 20 mM (1170 ppm)) and then decreases as salinity increased to 100 mM (5850 ppm) NaCl. **El-Sharkawy *et al.*, (2017)** remarked that application of seaweed extract resulted in higher proline under salt concentrations (10 and 15 dS/m (6400 and 9600 ppm)) in alfalfa. Besides to, increased proline regulated water potential in plant cells enhanced the plant defense under various abiotic stresses as mentioned by **(Sharma *et al.*, 2019).**

In contrast, **Fayez and Bazaid, (2014)** noticed that salt and water deficit stresses reduced proline content in barley (*Hordeum vulgare* cv. Gustoe). Application of 50 mM SA (6.9 g/l) to plants treated with 150 mM (8.78 g/l) NaCl and/or 50% soil water content improved this attribute under salt and water stresses.

SUMMARY

This study was carried out at the nursery of the Ornamental Plants Research Department, Horticulture Research Institute, Giza, Egypt in March of the two seasons, 2016-20167 and 2017-2018, to determine the effect of foliar spray of salicylic acid, moringa leaf extract and seaweed extract on the tolerance of *Terminalia arjuna* seedlings to irrigation intervals and salinity stresses. The seedlings of *Terminalia arjuna* were subjected to 2 experiments of drought and salinity.

Significant results of this study especially that gave the highest values of measured attributes in the two seasons could be summarized in the following:

First experiment:

First factor: Irrigation intervals:

- The 4 days interval occupied the highest position concerning all recorded vegetative characters and contents of chlorophyll "a", chlorophyll "b", carotenoids, total carbohydrates, N%, P%, K% and Ca%.
- The 8 days intervals came directly in the second grade of vegetative characters. Meanwhile, got the greatest value of flavonoids and phenols.
- The 16 days interval obtained the highest values for contents of proline, chloride and Na%.

Second factor: Foliar applications:

- Moringa extract 10.0%: achieved the highest position concerning plant height, root fresh and dry weights, shoot dry weight.
- Seaweed extract 5.0% acquired the top position for root length, chlorophyll "a" chlorophyll "b", and carotenoids contents, Flavonoids, N%, P% and K%.

Third factor: Interaction between irrigation intervals and foliar applications:

- 4 days interval + seaweed extract at 7.5%: achieved the highest position number of leaves, stem diameter, root fresh weight, root length and N%, P%, K% and Ca%.

- 8 days interval + seaweed extract at 7.5%: occupied the highest position of plant height, stem diameter, shoot fresh weight, root fresh weight, chlorophyll "a" and K%.

- 8 days intervals + seaweed extract 5.0%: had the biggest value of chlorophyll "b" and carotenoids.

-16 days + seaweed extract at 5.0%: obtained the highest value of flavonoids.

Second Experiment:

First factor: salinity levels:

- Salinity at 2000 ppm: had the highest value of all vegetative characters besides chlorophyll "a", chlorophyll "b", carotenoids, total carbohydrates, N%, P%, K% and Ca% .

- Salinity at 4000 ppm: got the highest values for flavonoids and phenolics.

- Salinity at 6000 ppm acquired the highest records of contents of proline, chloride and Na%.

Second factor: Foliar applications:

- Moringa extract at 10.0% obtained the highest values of plant height, number of leaves and stem diameter, shoot fresh and dry weight

- Seaweed extract at 7.5% occupied the highest position for root fresh weight, root length, ch"a", ch"b", carotenoids, total carbohydrates, phenol, proline, N%, P%, K% and Ca.

Interaction between salinity levels and foliar applications:

- Salinity at 2000 ppm + moringa extract at 10.0%: attained the highest grade for plant height and root length

- Salinity at 2000 ppm+ seaweed extract at 7.5%: had the highest value of stem diameter, chlorophyll "a", carotenoid, total carbohydrates, P% and Ca%.

- Salinity at 4000 ppm + moringa extract at 10.0%: had the next position for shoot fresh weight.

- Salinity at 4000 ppm + seaweed extract at 7.5%: obtained the next grade of stem diameter, root fresh weight, root length, chlorophyll "a", chlorophyll "b", N%, P% and Ca%

- Salinity at 6000 ppm + seaweed extract at 7.5%: flavonoids and proline

Recommendation

In order to get the best results, it is recommended to perform the following:

First experiment: - 8 days irrigation intervals + seaweed extract at 7.5%: gave the best results for vegetative characters.

8-days irrigation frequency if adopted will save time, labor and money, so it is highly recommended to be applied as an irrigation regime

Second experiment: - Salinity at 4000 ppm + seaweed extract at 7.5% gave the best results for vegetative characters.

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الملخص العربى

أجريت هذه الدراسة في مشتل قسم بحوث نباتات الزينة، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر، في مارس خلال موسمي 2016–2017/ 2017–2018، حيث أجريت على شتلات نبات تيرمينااليا أرجونا تجربتين بهدف معرفة تأثير معاملات الرش الورقي لحمض السالسيليك ومستخلص أوراق المورينجا ومستخلص الطحالب علي تحمل الترمينااليا أرجونا للإجهاد المائي والملوحة. تعرضت شتلات الترمينااليا لتجربتين من مواعيد الري أو مستويات الملوحة. ويمكن تلخيص أهم نتائج هذه الدراسة للصفات المدروسة خلال الموسمين فيما يلى:

التجربة الأولى:

العامل الأول: فترات الري-

- الرى كل 4 أيام: أحرز المركز الأعلى فيما يختص بجميع الصفات الخضرية التى درست، إلى جانب محتويات كلوروفيل "أ"، كلوروفيل "ب"، الكاروتينويدات، الكربوهيدرات الكلية، والنسب المئوية للنيتروجين وللفوسفور والبوتاسيوم والكالسيوم.

- الرى كل 8 أيام: نال المركز الثاني مباشرة في الصفات الخضرية التي درست، بينما حصل على المركز الأعلى لصفتي الفلافونويدات والفينولات.

- الرى كل 16 يوم: أحرز المرتبة العليا في صفات محتويات البرولين والصوديوم والكلورايد.

العامل الثانى: معاملات الرش الورقي-

- حقق مستخلص المورينجا 10.0% المركز الأعلى بالنسبة لطول النبات والوزن الطازج والجاف للجذور والوزن الجاف للمجموع الخضرى.

- أعطى مستخلص الطحالب 5.0% أعلي قيمة لطول الجذور ومحتوى كلوروفيل "أ" وكلوروفيل "ب" والكاروتونويدات والفلافونويدات، بالاضافه إلى نسبة النيتروجين والفوسفور والبوتاسيوم.

العامل الثالث: التفاعل بين معدلات الري ومعاملات الرش الورقي-

- حازت التوليفة المكونة من معاملات الرى كل 4 أيام + مستخلص الطحالب 7.5% على المركز الأعلى لعدد الأوراق وسمك الساق والوزن الطازج للجذور وطول الأوراق، بالإضافة إلى نسبة كل من النيتروجين والفوسفور والبوتاسيوم والكالسيوم.

- احتلت معاملة الرى كل 8 أيام + مستخلص الطحالب 7.5% المركز التالي مباشرة في طول النبات وسمك الساق والوزن الطازج للنمو الخضري والجذري، بالإضافة إلى كلوروفيل "أ" ومحتوى عنصر البوتاسيوم.

- حققت معاملات الرى كل 8 أيام + مستخلص الطحالب 5.0% المركز الثاني لقيمة كلوروفيل "ب" والكاروتونويدات.

- احتلت معاملة الرى كل 16 يوم + مستخلص الطحالب 5.0% المركز الأعلى لنسبة الفلافونويدات.

التجربة الثانية:

العامل الأول : معدلات الملوحة-

- حصلت الملوحة 2000 ppm على أعلى قيمة لجميع الصفات الخضرية، بالإضافة إلى "كلوروفيل "أ" وكلوروفيل "ب" والكاروتونويدات والكربوهيدرات والنيتروجين والفوسفور والبوتاسيوم والكالسيوم.

- حصلت الملوحة 4000 ppm على أكبر نسبة من الفلافونويدات والفينولات.

- حصلت الملوحة 6000 ppm على أكبر نسبة من مكونات البرولين والكلوريد والصوديوم.

العامل الثانى: معاملات الرش الورقي-

- حقق مستخلص المورينجا 10.0% أعلى قيمة لطول النبات وعدد الأوراق وسمك الساق والوزن الجاف والطازج للمجموع الخضري.

- حقق مستخلص الطحالب 7.5%: المستوى الأعلى للوزن الطازج للجذور وطول الجذور وكلوروفيل "أ" وكلوروفيل "ب" والكاروتونويدات والكربوهيدرات الكلية والفينول والبرولين والنيتروجين والفوسفور والبوتاسيوم والكالسيوم.

العامل الثالث: التفاعل بين معدلات الملوحة ومعاملات الرش الورقي-

- حقق استخدام ملوحة 2000 ppm + مستخلص المورينجا 10.0% أعلى مستوى لطول النبات وطول الجذور.

- حقق استخدام ملوحة 2000 ppm + مستخلص الطحالب 7.5% أعلى قيمة لسمك الساق وكلوروفيل "أ" والكاروتونويدات والكربوهيدرات الكلية والفوسفور والكالسيوم.

- حقق استخدام ملوحة 4000 ppm + مستخلص المورينجا 10.0% أعلى قيمة للوزن الطازج للمجموع الخضرى.

- حقق استخدام ملوحة 4000 ppm + مستخلص الطحالب 7.5% أعلى ناتج من سمك الساق والوزن الطازج للجذور وطول الجذور وكلوروفيل "أ" وكلوروفيل "ب" والكاروتونويدات والكربوهيدرات الكلية والفوسفور والكالسيوم.

- حقق استخدام ملوحة 6000 ppm + مستخلص الطحالب 7.5 % أكبر قيمة للفلافونويدات والبرولين.

التوصيات: للحصول على أفضل النتائج ينصح بمايلى:

التجربة الأولى: الرى كل 8 أيام + مستخلص الطحالب 7.5% حققت أفضل النتائج عند استخدام الرى كل 8 أيام سيعمل على توفير الوقت والمال والأيدى العاملة لذلك يوصى بشدة باستخدام هذه المعاملة.

التجربة الثانية: الملوحة بتركيز 4000جزء فى المليون + مستخلص الطحالب 7.5 % أحرزت أفضل النتائج

الكلمات المفتاحية: ترمينالیا أرجونا، معاملات رى، جفاف، ملوحة، حمض السالسيليك، مستخلص المورينجا، مستخلص الطحالب

تأثير معاملات الرش الورقي علي شتلات الترمينااليا تحت تأثير الإجهاد المائي والملحي في مصر والسودان

رسالة مقدمة من

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درجة الدكتوراه

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(الموارد الطبيعية – موارد نباتية)

كلية الدراسات الأفريقية العليا – جامعة القاهرة

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قسم الموارد الطبيعية

كلية الدراسات الأفريقية العليا

جامعة القاهرة

مصـــر

2021