Response of sweet lemon seedling to addition dates and levels of seaweed extracts

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Abstract:

The study aimed to demonstrate the importance of dates and levels of seaweed extracts in accelerating the growth of sweet lemon seedlings and improving their vegetative characteristics and mineral content to obtain fast-growing seedlings. Use two dates for adding fertilizers (every 15 and 30 days) and 9 fertilizer treatments that represent a mixture of the two extracts, Hefe algae and Super fifty, that were sprayed on the leaves. The most important results obtained at the end of the study showed that the ninth treatment of the fertilizer combination included (8 $ml.L^{-1}$ of Hefe algae extract + 8 $ml.L^{-1}$ of Super fifty extract) recorded the highest significant increase in the traits (concentrations of nitrogen, phosphorus, potassium and iron in leaves, leaf area, chlorophyll concentration in leaves, and increase in seedling height) compared to the comparison treatment, which gave the least significant values for these traits. While there were no significant differences between the dates of adding fertilizers in most of the studied traits except for the superiority of the first date (every 15 days) over the second date (every 30 days) in terms of traits (phosphorus concentration in leaves and increase in seedling diameter), while the second date was superior to the first date in Adjective (the increase in the height of the seedlings).

Keywords: seaweed extracts, sweet lemon, seedling, dates. Response

Introduction:

The sweet lemon (*Citrus limetta*) is considered one of the members of the acidic group of citrus trees, which also includes (Citron, Lemon, lime, Rough lime, etc.), its trees are characterized by being medium to large in size, many thorns, abundant fruits, the fruit is round, the skin is thin and smooth, the color is light yellow, the taste of the fruits Sweet, early ripening date **(2).**

The trend in the world at the present time is towards reducing the use of manufactured chemical fertilizers because of the health, environmental and economic harms they cause, through the use of natural alternatives such as the use of seaweed and algae extracts that are characterized by their non-toxicity, non-polluting the environment and low costs. Seaweed extracts are among the organic fertilizers that are used in the development of fruit seedlings because they are a good source of macro and micro nutrients as well as natural growth regulators that plants need for the purpose of growth because they are effective and easy to be absorbed by the plant (**5 and 9).**

When these extracts are sprayed on the vegetative system of plants, it leads to accelerated growth by increasing the efficiency of the photosynthesis process, increasing the thickness of the stem, improving the efficiency of the root system in absorbing water and mineral elements from the soil, and thus improving the vegetative and root growth, as a result of what these extracts contain of nutrients necessary for the plant, such as nitrogen. And phosphorus, potassium, iron, copper, zinc, boron, and others, in addition to containing many plant hormones, such as

ISSN 2072-3857

auxins, gibberellins, and cytokinins, The extracts also contain some enzymes and vitamins that stimulate good growth in plants **(11).**

Seaweed extracts can also be used to increase plant resistance to drought, heat and water stress, and protect plants from aging by strengthening and supporting plant cells, as well as plant resistance to many diseases, especially fungal diseases and nematodes **(7).**

Many studies have indicated the importance of foliar spraying with concentrations of seaweed extracts in improving the growth and mineral content of fruit seedlings, including the results of the studies of (10 ، **5, 4, 1 ، 13 ،3)**

This study comes in order to demonstrate the importance of dates and levels of fertilization with seaweed extracts in accelerating the growth of sweet lemon seedlings and improving their vegetative characteristics and mineral content in order to obtain strong, fast-growing seedlings.

Materials and Methods:

The study was carried out in the plastic house in the College of Agricultural Engineering Sciences at the University of Duhok during the growing season 2022 on two-year-old sweet lemon seedlings, budding in rootstock Sour orenge. which are almost identical in growth, 50-70 cm in height, and the diameter of their main stem is 5-6 mm, planted in plastic sticks with a capacity of 7 kg filled with mixed soil. The experience included the following factors:

The first factor: two appointments for spraying seaweed extracts (every 15 days and every 30 days) with 4 sprays for each, as the first spray for each of them began on 3/15.

The second factor: the use of a combination of two types of seaweed extracts, namely Hefe algae contains (Ascophyllum Nodosum seaweed extract, Alginic acid, Mannitol, Manganese (Mn) soluble in water, Molybdenum (Mo) soluble in water) and Super fifty contains (*Ascophyllum Nodosum* seaweed extract, acidity 8.5-10.5) sprayed on the shoots,Fertilizers produced by a Spanish company and the combination is:

1- Comparison treatment (without addition)
2- 6 ml. L^{-1} Hefe algae
3- 8 ml. L^{-1} Hefe algae
4-6 ml.L^{-1} Super fifty
5- 8 ml L^{-1} Super fifty
6- 6 mlL^{-1} Hefe algae + 6 mlL^{-1} Super fifty in 1L water
7- 6 mlL^{-1} Hefe algae + 8 mlL^{-1} Super fifty in 1L water
8- 8 mlL^{-1} Hefe algae + 6 mlL^{-1} Super fifty in 1Lwater
9- 8 mLl^{-1} Hefe algae + 8 mlL^{-1} Super fifty in 1L water

The experiment was designed using a completely randomized factorial design (C.B.D) with two factors, three replications, and five seedlings per experimental unit. Thus, the number of seedlings used in the experiment was (2 x 9 x 3 x 5 = 270 seedlings), and the averages were compared using Dunkin's multiple limit test under the probability level of 0.05.

At the end of the growing season, the following characteristics were measured (nitrogen concentration in leaves %, phosphorus concentration in leaves %, potassium concentration in leaves %, iron concentration in leaves %, zinc concentration in leaves, chlorophyll concentration in leaves, leaf area per cm^2, increase in height Seedlings (cm) and the increase in seedling diameter (mm).

ISSN 2072-3857

Results and Discussion: -

The results in Table (1) show that the dates of adding seaweed extracts did not significantly affect the values of nitrogen concentration in the leaves, as there were no significant differences between the two dates. As for the effect of the fertilizing treatments, it is noted that the highest significant value for this trait was for treatment (9), and it outperformed all treatments, especially the comparison treatment, which gave the lowest significant value for the trait. We also find through the results of the bilateral interactions between dates (15 days) and fertilizer treatments that the highest significant value was for the interaction between adding treatment (9) on the first date every 15 days, and the lowest value was for the interaction between the comparison treatment for the same date.

Table (1) Effect of application times and levels of seaweed extracts on leaf nitrogen(%) concentration of sweet lemon seedlings.

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**1.14 G**	**1.33 e-g**	**1.51 c-g**	**1.58 b-g**	**1.53 c-g**	**1.68 a-f**	**1.64 b-g**	**1.86 a-e**	**2.17 a**	**1.60 a**
every 30 days	**1.17 Fg**	**1.36 d-g**	**1.60 b-g**	**1.73 a-e**	**1.89 a-d**	**1.84 a-e**	**1.88 a-d**	**1.97 a-c**	**2.07 ab**	**1.72 a**
Fertilizers treatment Average	**1.15 E**	**1.34 de**	**1.55 cd**	**1.65 b-d**	**1.71 bc**	**1.76 bc**	**1.76 bc**	**1.91 ab**	**2.12 a**	

*** Averages that carry similar letters within the same column do not differ significantly between them according to Duncan's polynomial test under the probability level of 0.05.**

The results of Table (2) indicate that the dates of adding fertilizers affected significantly the concentration of phosphorous in the leaves, as the first date (every 15 days) was superior to the second date (every 30 days) with the values of this characteristic. Also, the fertilizing treatments had a significant impact on the values of this characteristic, as the two treatments (8 and 9) recorded the highest significant values for this characteristic, and outperformed a number of treatments, especially the comparison treatment, which recorded the lowest values. As for the overlap coefficients, the highest significant values were the result of the overlap between the treatment (8) which were added during the first date (15 days), while the lowest were for the overlap between the comparison treatment and the second appointment every 30 days

ISSN 2072-3857

Table (2) Effect of application times and levels of seaweed extracts on leaf phosphorous (%) concentration of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**0.144 De**	**0.160 cd**	**0.177 b-d**	**0.195 bc**	**0.199 b**	**0.191 bc**	**0.201 b**	**0.238 a**	**0.212 ab**	**0.191 a**
every 30 days	**0.113 E**	**0.144 de**	**0.142 de**	**0.160 cd**	**0.187 bc**	**0.192 bc**	**0.185 bc**	**0.190 bc**	**0.199 b**	**0.168 b**
Fertilizers treatment Average	**0.129 E**	**0.152 d**	**0.160 cd**	**0.177 bc**	**0.193 ab**	**0.192 ab**	**0.193 ab**	**0.214 a**	**0.206 a**	

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The results in Table (3) show that the date of application did not have any significant effect on the values of potassium concentration in the leaves, as there were no significant differences between the two dates. While the fertilizer treatments affected significantly the values of this characteristic, especially treatment (9), which was significantly superior to a number of treatments, especially the comparison treatment. With regard to the bilateral overlap, the overlap treatment between the two fertilizer treatments (8 and 9) added every 15 days achieved the highest significant increase in the trait and they outperformed a number of treatments, especially the overlap treatment between the comparison and the additive every 30 days.

Table (3): Effect of application times and levels of seaweed extracts on the potassium (%) concentration in leaves of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**1.43 d-f**	**1.54 a-f**	**1.64 a-f**	**1.52 b-f**	**1.62 a-f**	**1.75 a-d**	**1.69 a-e**	**1.90 a**	**1.90 a**	**1.66 a**
every 30 days	**1.31 F**	**1.38 ef**	**1.48 c-f**	**1.50 b-f**	**1.64 a-f**	**1.77 a-d**	**1.76 a-d**	**1.82 a-c**	**1.86 ab**	**1.61 a**
Fertilizers treatment Average	**1.37 F**	**1.46 ef**	**1.56 c-f**	**1.51 d-f**	**1.63 b-e**	**1.76 a-c**	**1.73 a-d**	**1.86 ab**	**1.88 a**	

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The results shown in Table (4) indicate that the dates of application did not have any effect on the characteristic of iron concentration in the leaves. While it is noted that the highest significant value recorded by the fertilizer treatments was for the two treatments (8 and 9), and they outperformed most of these treatments, especially the comparison treatment, which gave the lowest values for this characteristic. As for

ISSN 2072-3857

the interaction between the two workers, the results show that it was significantly affected by the superiority of the overlap treatment (No. 9, added every 15 days) over the rest of the treatments. Especially the interference (comparison treatment every 15 days), which gave the lowest values for this trait.

Table (4) Effect of application times and levels of seaweed extracts on iron concentration in leaves (ppm) of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**44.01 F**	**55.81 a-d**	**54.59 a-e**	**54.15 b-f**	**56.78 a-d**	**59.34 a-d**	**59.70 a-d**	**64.11 ab**	**65.32 a**	**57.09 a**
every 30 days	**44.29 Ef**	**50.75 d-f**	**50.70 d-f**	**52.48 c-f**	**53.95 b-f**	**56.25 a-d**	**60.47 a-d**	**61.66 a-c**	**61.03 a-d**	**54.62 a**
Fertilizers treatment Average	**44.15 D**	**53.28 bc**	**52.64 c**	**53.31 bc**	**55.37 bc**	**57.79 a-c**	**60.08 ab**	**62.89 a**	**63.18 a**	

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The dates of adding fertilizers had no significant effect on the values of zinc concentration in the leaves, as there were no significant differences between them (Table 5), While the fertilizer treatments caused a significant increase in the values of this characteristic through the moral superiority of treatment (7) compared to treatment (1), which gave the least significant value for this characteristic. At the bilateral overlap, we find that the highest significant value was for the treatment (7, added every 15 days), while the lowest significant value was for the overlap treatment (1, added every 15 days).

Table (5) Effect of application times and levels of seaweed extracts on zinc concentration in leaves (ppm) of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**30.29 C**	**34.73 a-c**	**37.48 a-c**	**35.09 a-c**	**37.72 a-c**	**37.62 a-c**	**40.75 a**	**39.70 a**	**38.98 ab**	**36.93 a**
every 30 days	**31.40 b-c**	**34.69 a-c**	**36.81 a-c**	**34.90 a-c**	**39.03 ab**	**37.88 a-c**	**39.59 a**	**38.26 ab**	**37.29 a-c**	**36.65 a**
Fertilizers treatment Average	**30.84 C**	**34.71 bc**	**37.14 ab**	**34.99 a-c**	**38.37 ab**	**37.75 ab**	**40.17 a**	**38.98 Ab**	**38.13 ab**	

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The results in Table (6) indicate that there are no significant differences in the leaf area characteristic between the dates of addition. While it was the highest significant value for the trait when using the fertilizing treatments for treatment (9), and it was significantly

superior to all treatments, especially treatment (1), which gave the lowest values. And when the bilateral overlap shows that the highest values were the result of the overlap between the treatment (9 and added every 15 days) and it was significantly superior to all the overlaps Especially the overlap treatment between (1 and added every 15 days).

Table (6) Effect of application times and levels of seaweed extracts on leaf area (cm2) of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**19.93 E**	**22.06 c-e**	**24.45 b-e**	**27.41 b**	**27.63 b**	**25.77 b-d**	**26.20 bc**	**28.15 b**	**34.85 a**	**26.27 a**
every 30 days	**20.65 De**	**24.92 b-e**	**29.84 b**	**27.70 b**	**25.71 b-d**	**26.73 bc**	**27.32 b**	**27.47 b**	**29.60 b**	**26.66 a**
Fertilizers treatment Average	**20.29 D**	**23.49 cd**	**27.15 b**	**27.55 b**	**26.67 bc**	**26.25 bc**	**26.76 bc**	**27.81 b**	**32.22 a**	

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It is clear from the results of Table (7) that there are no significant differences between the dates of application in the values of the characteristic of chlorophyll concentration in the leaves. While the fertilizer treatments had a significant effect through the superiority of treatment (9) and recording the highest values compared to treatment (1), which gave the least significant values. In the case of bilateral overlap, the results in the same table confirm the significant superiority of the overlap treatment between (treatment 9 with the date of addition every 15 days) over most of the overlaps, especially the overlap treatment between treatment (1 and the one added every 30 days), as it gave the lowest values for this characteristi

Table (7) Effect of application times and levels of seaweed extracts on chlorophyll concentration in leaves(SPAD unit) of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**35.76 Cd**	**37.89 bc**	**39.29 bc**	**40.20 bc**	**41.30 ab**	**40.00 bc**	**39.30 bc**	**39.86 bc**	**45.45 a**	**39.89 a**
every 30 days	**32.97 D**	**39.53 bc**	**37.74 bc**	**40.07 bc**	**40.49 b**	**41.03 b**	**39.93 bc**	**38.15 bc**	**41.75 ab**	**39.07 a**
Fertilizers treatment Average	**34.36 C**	**38.71 b**	**38.51 b**	**40.13 b**	**40.89 ab**	**40.51 b**	**39.61 b**	**39.00 b**	**43.60 a**	

*** Averages that carry similar letters within the same column do not differ significantly between them according to Duncan's polynomial test under the probability level of 0.05**

ISSN 2072-3857

The dates of addition had a significant effect on the characteristic of the increase in the height of the seedlings, as the date of every 15 days was significantly superior to the date of every 30 days with the values of this characteristic (Table 8). As for the fertilizer treatments, it is clear that treatment (8) recorded a significant superiority over the rest of the treatments and gave the highest significant values compared to treatment (1), which gave the lowest values. The overlap treatment between (8 and added every 15 days) recorded the highest significant value for this trait, compared to the lowest value, and the overlap treatment was between (1 and added every 15 days).

Table (8) Effect of application times and levels of seaweed extracts on the increase in seedling height (cm) of sweet lemon seedlings

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**11.34 K**	**19.62 h-i**	**21.07 f-h**	**18.99 hi**	**23.96 d-g**	**25.47 d-f**	**21.55 f-h**	**35.41 a**	**29.92 bc**	**23.04 b**
every 30 days	**12.45 Jk**	**16.06 ij**	**22.00 e-h**	**26.14 c-e**	**24.62 d-f**	**31.00 b**	**28.35 b-d**	**30.88 b**	**30.66 b**	**24.68 a**
Fertilizers treatment Average	**11.90 F**	**17.84 e**	**21.53 d**	**22.56 cd**	**24.29 cd**	**28.23 b**	**24.95 c**	**33.14 a**	**30.29 ab**	

*** Averages that carry similar letters within the same column do not differ significantly between them according to Duncan's polynomial test unde the probability level of 0.05**

The results in Table (9) indicate that the date of addition every 15 days recorded a significant superiority over the date every 30 days with the values of the characteristic of increase in seedling diameter. The fertilizing treatments had a significant effect on the values of this trait through the superiority of treatment 9,8 and7 over the rest of the treatments, especially treatment 1, which gave the lowest of these values. As for the bilateral overlaps, the results show that the overlapping treatment between (7 and added every 15 days) is significantly superior to a number of these overlaps, especially the overlap between (1 treatment and added every 30 days).

Table (9) Effect of application times and levels of seaweed extracts on the increase in seedling diameter (ml) of sweet lemon seedlings.

	Fertilizers treatment									
spray time	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**spray time Average**
every 15 days	**1.30 Ef**	**2.26 a-d**	**2.14 b-d**	**2.11 b-d**	**2.02 c-e**	**2.57 a-c**	**3.02 a**	**2.88 ab**	**3.00 a**	**2.37 a**
every 30 days	**1.05 F**	**1.56 d-f**	**1.87 c-e**	**2.07 b-e**	**2.56 a-c**	**2.27 a-d**	**2.56 a-c**	**2.45 a-c**	**2.68 a-c**	**2.12 b**
Fertilizers treatment Average	**1.17 C**	**1.91 b**	**2.01 b**	**2.09 b**	**2.29 ab**	**2.42 ab**	**2.79 a**	**2.66 a**	**2.84 a**	

ISSN 2072-3857

The significant superiority of the foliar spray treatments with the combination of the two extracts, especially the treatment of (8 ml^{-1} Hefe algae + 8 ml^{-1} Super fifty) in increasing the concentration of nutrients in the leaves may be due to the marine extracts containing organic nitrogen, which is directly absorbed when sprayed on the leaves. This leads to an increase in its concentration in the leaves, In addition to the presence of other elements in the two extracts, especially potassium, which may have contributed to the deepening and spread of the roots, thus increasing the ability of the roots to absorb nutrients from the soil and transfer them to the top of the plant to be concentrated in the leaves and their concentration increases **(13 and 3)** , The reason is also due to the role of seaweed extracts in increasing the efficiency of absorption of nutrients, which is reflected positively in increasing the content of leaves of chlorophyll and thus increasing the efficiency of photosynthesis, and accordingly increases plant growth as a result of improving the characteristics of vegetative growth **(8 and 12)** , and the extracts contain plant hormones such as auxins, gibberellins and cytokinins, which It has a great effect in increasing cell division and elongation, and thus increasing the characteristics of vegetative growth, such as seedling height, diameter, and leaf area **(4 and 1).**

Conclusions:

Through the results of the study obtained, the positive effect of adding levels of seaweed extracts used in the study was shown to obtain the best of these results, especially by adding a mixture of the two treatments (8 ml L^{-1} of Hefe algae extract + 8 ml L^{-1} of Super 50 extract) as it gave the highest significant values for the studied traits, so the study recommends using this treatment to obtain fast-growing sweet lemon seedlings for the purpose of planting them in the orchard early.

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ISSN 2072-3857

ISSN 2072-3857