International Journal for Research in Applied Sciences and Biotechnology

ISSN: 2349-8889
Volume-9, Issue-3 (May 2022)

www.ijrasb.com

https://doi.org/10.31033/ijrasb.9.3.12

# Response of Lemon Transplants to the Addition of Organic Fertilizer to Withstand Water Stress

Ashwaq Wadi Majeed[1] and Altifat Fadhil Altaai[2]
[1]Department of Biology، Al-Rasheed University College, Baghdad, IRAQ.
[2]Department of Biology، Al-Rasheed University College, Baghdad, IRAQ.

[1]Corresponding Author: ashwaqalwadi90@gmail.com

**ABSTRACT**

**This experiment was carried out in lathhouse at University of Baghdad / college of Agricultural Engineering Sciences / Department of Horticulture and Landscape design during the two season 2019 and 2020 .The experience was conducted according to Split-split plots Within Design (RCBD) By three factors, the first factor was two -irrigation Intervals (every 3, 6 days), the second factor was three of rootstock (Volcamariana, Swingle Stromelo and sour orange) and the third factor organic fertilizer, was three concentrations, which is (0, 2.5 and 5 ml. L-1 / plant). Results showed that irrigation Intervals had a significant effect It has given ( every 3 days) increase in stem diameter, number of branches, number of leaves and Percentage of dry weight in branches. The citrus rootstock has exceeded with each other in the mentioned characteristics, while the organic fertilizer, has a significant effect in all the mentioned characteristics, as the concentration of 5 gm L-1 exceeds the treatment without adding fertilizer for the two seasons in respectively.**

***Keywords-*** water stress, irrigation Intervals, organic fertilizer, citrus rootstock.

## I. INTRODUCTION

The genus Citrus belongs of the family Rutaceae. Citrus is the most important fruit tree crop in the world, lemon is classified as Citrus limon (L.) Lemon is the third most important Citrus species after orange and mandarin( Rafiq et al., 2018), with its production totalling over 4 200 000 tonnes in 2007, with 750 000 tonnes for 2007/2008 Spain being the third main lemon producing country in the world.

Rootstock choice is one of the most important aspects in orchard management because scion cultivars respond differently to growth, fruit quality and nutrients accumulation when grown on diverse rootstocks. Plant nutrient concentrations in scion cultivar may differ even though they are grown in the same conditions (Bergmann, 1992), and too Rootstocks directly affect the ability of plants to uptake the water and nutrients from the soil. ( Smith et al., 2004; Toplu et al., 2012).

Organic fertilizers are effective in promoting environmental sustainability and plant growth after long-term use, the abundant organic matter and soluble nutrients in the liquid organic fertilizers could maintain soil sustainability and plant health (Hou et al., 2017). the special compounds in liquid organic fertilizers, such as , humic and fulvic acids, can be biostimulants to plants (Tang, 2013).

The phenomenon of drought is one of the most important problems facing the agricultural sector, as the lack of water determines agricultural production and distributes it in the world, Water stressing or droughting can be intensified by gradually lengthening the drought period, Drought stress develops when tree water loss exceeds the rate of water uptake for a sustained period. Drought stress influences many components of citrus growth and development, with effects differing by stage of growth and severity of stress, Severe moisture deficits result in familiar symptoms of wilting, abscission of many leaves, poor fruit quality, and small fruit size. (Pirzad et al., 2011)

The lack of rainfall in Iraq , the high temperatures and the increase in evaporation, led to a decrease in the water level in the Tigris and Euphrates rivers, which led to the death of many orchards and agricultural fields. To reduce this phenomenon, modern irrigation methods must be followed, that increase the ability of plants to adapt to face the shortage of irrigation water without harming the plant, and adding some organic compounds to the plant would increase the plant's tolerance to drought on the one hand, and on the other hand, to see the ability of the assets to withstand a certain level of drought for local lemon seedlings.

## II. MATERIALS AND METHOD

This experiment was carried out in lathhouse of the research station B of University of Baghdad / college of Agricultural Engineering Sciences /Department of Horticulture and Landscape design during the two season 2019 and 2020 , study to the effect of the rootstocks, organic fertilizer and Irrigation Intervals on the growth of seedlings of the local lemon variety. The first factor involved exposing the plants to two Irrigation Intervals which is irrigation each 3 days and is symbolized by (A1) and irrigation every 6 days and is symbolized by (A2), which was calculated by adding irrigation water to the total weight of the pots with their contents at the field capacity depending on the weight method of the pots from each treatment, completing the

water deficiency and estimating the decrease in moisture content, and weight is maintained at each irrigation Intervals for every 3 or 6 days and completed to the number and compensated for the moisture deficiency occurring in each period. the weight of the plant during the growth stages must also be taken into consideration and compensate for the calculations. As for the second factor. It use three citrus rootstock, which are of Volkameriana and is symbolized by C1, Swingle Citrumelo, is symbolized by C2 and Sour orange which is symbolized by C3. As for the third factor, it used Organic fertilizer (Fulvigrow) (Table 2) adding a ground six times between one addition and another for 15 days, which are (1/3, 15/3, 1/4, 15/4, 1/5 and 15/5) in three concentrations, which are comparison treatment (adding water Only) and it's symbolized by F0 , 2.5 ml. $L^{-1}$ / plant its symbolized by F1 and 5 ml. $L^{-1}$ / plant its symbolized by F2. Seedlings were brought at the age of 3 years and then transferred from plastic pots of 10 kg capacity to plastic containers perforated from the bottom of 20 kg capacity. The experiment was carried out using split-split plots within the design of the RCBD with three factors, as the first factor included irrigation with two Intervals (main plots), the second factor included rootstock three types (secondary plots) and the third factor included organic fertilizer in three concentrations (the sub-secondary plots), which includes 18 treatments and three repetitions, with two seedlings for each experimental unit, and the number of seedlings is 108 seedlings. The results will be analyzed using the Genstat program and the averages will be compared using the least significant difference at a 5% probability level.

**Table 1: Physical and chemical characteristics of the soil**

| Character | Values | Unit |
|---|---|---|
| **EC** | **4.2** | **$ds.m^{-1}$** |
| **PH** | **7.3** | **-** |
| **O.M.** | **0.7** | **%** |
| **Ca** | **6.0** | **mg. Kg-1 soil** |
| **Mg** | **4.0** | |
| **Na** | **10.8** | |
| **K** | **1.3** | |
| **$HCO_3$** | **0.8** | |
| **Cl** | **24.0** | |
| **$CaCo_3$** | **19.4** | **%** |
| **N** | **2.2** | **mg. Kg-1 soil** |
| **P** | **4.3** | |
| **K** | **36.7** | |
| **Sand** | **67.2** | **gm. Kg -1** |
| **Clay** | **24.8** | |
| **Silt** | **8** | |
| **PW at field capacity** | **20.34** | |
| **PW for soil** | **1.76** | |
| **Bulk density** | **0.91** | |
| **Texture** | **Sandy mixture** | |

***1. Average increase in stem diameter (mm)***

It was measured 5 cm above the grafting area in the foot (Vernier) at the beginning and end of the experiment and the difference between the two readings represents the rate of increase.

***2. Average increase in number of branches (Sapling branch$^{-1}$)***

The number of branches (2-3) for each seedling was standardized at the beginning of the experiment, and the increase in branches within the experimental unit was calculated at the end of the experiment. The difference between the two readings represents the average increase.

***3. Average number of leaves (leaf seedling$^{-1}$)***

The number of leaves in the experimental unit was calculated at the end of the experiment and divided by the number of plants in it to extract the average.

***4. Percentage of dry weight in branches (%)***

The dry weight of the secondary branches was measured at the end of the growing season, as a known weight was taken from the branches and dried in the electric oven at 65 °C until the weight was stable and the percentage was extracted as (in the paragraph above).

ISSN: 2349-8889
Volume-9, Issue-3 (May 2022)

https://doi.org/10.31033/ijrasb.9.3.12

## III. RESULTS AND DISCUSSION

***1- stem diameter (mm)***

The results of Table (2) showed that irrigation Intervals had a significant effect on stem diameter, as the irrigation Intervals every 3 days achieved a significant exceeded, compared to the irrigation Intervals every 6 days for the two seasons in respectively. The type of rootstock also has a significant effect, as it exceeded the rootstock of Sour orange for the two seasons in respectively. Organic fertilizer has a significant effect on this characteristic, as it exceeds at a concentration of 5 ml. L, compared to a treatment without addition for the two seasons in respectively.

**Table 2: Effect of rootstock type and Organic fertilizer and irrigation Intervals on stem diameter (mm) for lemon seedlings for the growing seasons 2019 and 2020**

| | | Season2019 | | | | season 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|
| irrigation intervals | rootstocks | organic fertilizer (ml.L$^{-1}$) | | | A x C | organic fertilizer (ml.L$^{-1}$) | | | A x C |
| | | F0 | F1 | F2 | | F0 | F1 | F2 | |
| A1 | C1 | 2.50 | 2.86 | 3.24 | 2.86 | 3.06 | 3.16 | 3.64 | 3.28 |
| | C2 | 2.34 | 3.00 | 3.15 | 2.83 | 3.01 | 3.35 | 3.57 | 3.31 |
| | C3 | 2.94 | 3.15 | 3.29 | 3.12 | 3.18 | 3.68 | 3.88 | 3.58 |
| A2 | C1 | 1.61 | 1.90 | 1.94 | 1.81 | 1.93 | 2.39 | 2.39 | 2.23 |
| | C2 | 1.61 | 2.04 | 1.72 | 1.79 | 1.89 | 2.40 | 2.32 | 2.20 |
| | C3 | 1.69 | 1.74 | 2.16 | 1.86 | 1.94 | 2.38 | 2.57 | 2.29 |
| LSD | | 0.14 | | | 0.09 | 0.08 | | | 0.05 |
| F | | 2.11 | 2.44 | 2.58 | A | 2.50 | 2.89 | 3.06 | A |
| LSD | | | | | | 0.03 | | | |
| A x F | A1 | 2.59 | 3.00 | 3.22 | 2.94 | 3.08 | 3.39 | 3.69 | 3.39 |
| | A2 | 1.63 | 1.89 | 1.94 | 1.82 | 1.92 | 2.39 | 2.42 | 2.24 |
| | | 0.07\ | | | 0.05 | 0.04 | | | 0.05 |
| | | | | | C | | | | C |
| C X F | C1 | 2.05 | 2.38 | 2.59 | 2.34 | 2.49 | 2.77 | 3.01 | 2.76 |
| | C2 | 1.97 | 2.52 | 2.43 | 2.31 | 2.45 | 2.87 | 2.94 | 2.75 |
| | C3 | 2.31 | 2.44 | 2.72 | 2.49 | 2.56 | 3.03 | 3.22 | 2.93 |
| | | 0.11 | | | 0.08 | 0.06 | | | 0.04 |

***2- number of branches (Sapling branch$^{-1}$)***

The results in Table (3) confirm significant differences in the increase in the number of branches, as the irrigation Intervals every 3 days achieved a significant exceeded, compared to the irrigation Intervals every 6 days for the two seasons in respectively. Also, the type of rootstock also has a significant effect, as it exceeded the rootstock of Volkameriana for the two seasons in respectively. The organic fertilizer has a significant effect in this characteristic, as the concentration of 5 gm L$^{-1}$ exceeds the treatment without adding fertilizer for the two seasons in respectively.

**Table 3. Effect of rootstock type and Organic fertilizer and irrigation Intervals on number of branches (Sapling branch$^{-1}$) for lemon seedlings for the growing seasons 2019 and 2020**

| | | Season 2019 | | | | season 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|
| irrigation intervals | rootstocks | organic fertilizer (ml.L$^{-1}$) | | | A x C | organic fertilizer (ml.L$^{-1}$) | | | A x C |
| | | F0 | F1 | F2 | | F0 | F1 | F2 | |
| A1 | C1 | 8.00 | 9.00 | 11.00 | 9.33 | 10.00 | 13.66 | 14.66 | 12.77 |
| | C2 | 7.00 | 9.00 | 10.00 | 8.66 | 9.00 | 13.00 | 13.50 | 11.83 |
| | C3 | 6.50 | 8.00 | 9.00 | 7.83 | 8.00 | 12.00 | 11.00 | 10.33 |
| A2 | C1 | 6.00 | 8.00 | 8.33 | 7.44 | 8.00 | 9.33 | 10.50 | 9.27 |
| | C2 | 6.00 | 7.50 | 8.50 | 7.33 | 8.50 | 9.50 | 11.50 | 9.83 |

https://doi.org/10.31033/ijrasb.9.3.12

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C3 | 5.00 | 6.50 | 7.50 | 6.33 | 7.33 | 9.00 | 9.33 | 8.55 |
| | | 0.50 | | | 0.32 | 0.66 | | | 0.37 |
| F | | 6.41 | 8.00 | 9.05 | A | 8.47 | 11.08 | 11.75 | A |
| LSD | | 0.20 | | | | 0.29 | | | |
| A x F | A1 | 7.16 | 8.66 | 10.00 | 8.61 | 9.00 | 12.88 | 13.05 | 11.64 |
| | A2 | 5.66 | 7.33 | 8.11 | 7.03 | 7.94 | 9.27 | 10.44 | 9.22 |
| LSD | | 0.27 | | | 0.28 | 0.36 | | | 0.28 |
| | | | | | C | | | | C |
| C X F | C1 | 7.00 | 8.50 | 9.66 | 8.38 | 9.00 | 11.50 | 12.58 | 11.02 |
| | C2 | 6.50 | 8.25 | 9.25 | 8.00 | 8.75 | 11.25 | 12.50 | 10.83 |
| | C3 | 5.75 | 7.25 | 8.25 | 7.08 | 7.66 | 10.50 | 10.16 | 9.44 |
| | | 0.36 | | | 0.26 | 0.48 | | | 0.30 |

***3- number of leaves (leaf seedling$^{-1}$)***

Notes through a Table (4) that the irrigation Intervals had a significant effect on number of leaves, as the irrigation Intervals achieved the highest rate every 3 days for the two seasons respectively. Also, the type of rootstock; had a significant effect, as the rootstock of the Volkameriana exceeded for the two seasons in respectively. Organic fertilizer has a significant effect on this characteristic, as it exceeds a concentration of 5 ml. L, compared to a treatment without addition for the two seasons respectively.

**Table 4. Effect of rootstock type and Organic fertilizer and irrigation Intervals on number of leaves (leaf seedling$^{-1}$) for lemon s eedlings for the growing seasons 2019 and 2020**

| | | Season2019 | | | | season 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|
| irrigation intervals | Rootstocks | organic fertilizer (ml.L$^{-1}$) | | | A x C | organic fertilizer (ml.L$^{-1}$) | | | A x C |
| | | F0 | F1 | F2 | | F0 | F1 | F2 | |
| A1 | C1 | 83.00 | 101.00 | 125.00 | 103.00 | 104.00 | 120.00 | 156.00 | 126.67 |
| | C2 | 84.00 | 97.00 | 108.00 | 96.33 | 96.00 | 127.00 | 132.00 | 118.33 |
| | C3 | 81.00 | 85.00 | 97.00 | 87.83 | 92.00 | 113.00 | 132.00 | 112.33 |
| A2 | C1 | 60.50 | 68.00 | 79.00 | 69.33 | 80.00 | 88.00 | 93.00 | 87.00 |
| | C2 | 45.00 | 63.00 | 73.00 | 60.33 | 55.00 | 92.00 | 98.00 | 81.67 |
| | C3 | 54.00 | 72.50 | 69.50 | 65.33 | 79.00 | 92.00 | 84.00 | 85.17 |
| | | 4.89 | | | 2.98 | 5.63 | | | 3.27 |
| F | | 67.92 | 81.08 | 92.08 | A | 84.33 | 105.42 | 115.83 | A |
| LSD | | 2.11 | | | | 0.53 | | | |
| A x F | A1 | 82.67 | 94.33 | 110.17 | 95.72 | 97.33 | 120.00 | 140.00 | 119.11 |
| | A2 | 53.17 | 67.83 | 74.00 | 65.00 | 71.33 | 90.83 | 91.67 | 84.61 |
| LSD | | 3.17 | | | 2.72 | 2.93 | | | 1.79 |
| | | | | | C | | | | C |
| C x F | C1 | 71.75 | 84.50 | 102.25 | 86.17 | 92.00 | 104.00 | 124.50 | 106.83 |
| | C2 | 64.50 | 80.00 | 90.50 | 78.33 | 75.50 | 109.50 | 115.00 | 100.00 |
| | C3 | 67.50 | 78.75 | 83.50 | 76.58 | 85.50 | 102.75 | 108.00 | 98.75 |
| | | 3.34 | | | 1.79 | 4.20 | | | 2.77 |

***4- Percentage of dry weight in branches (%)***

The results of Table (5) showed that the irrigation Intervals had a significant effect on the Percentage of dry weight in branches, as the irrigation Intervals every 3 days achieved the highest rate compared to the irrigation period every 6 days and for the two seasons respectively Also, the type of rootstock; had a significant effect, as the rootstock of the sour

ISSN: 2349-8889
Volume-9, Issue-3 (May 2022)

https://doi.org/10.31033/ijrasb.9.3.12

orange exceeded for the two seasons in respectively. As for organic fertilizer, it gave a significant effect, as it was exceeded to the comparison treatment without adding, measured at a concentration of 5 ml. For the two seasons respectively.

**Table 5: Effect of rootstock type and Organic fertilizer and irrigation Intervals on Percentage of dry weight in branches (%) for lemon seedlings for the growing seasons 2019 and 2020**

| | | Season2019 | | | | season 2020 | | | |
|---|---|---|---|---|---|---|---|---|---|
| irrigation intervals | rootstocks | organic fertilizer (ml.L$^{-1}$) | | | A x C | organic fertilizer (ml.L$^{-1}$) | | | A x C |
| | | F0 | F1 | F2 | | F0 | F1 | F2 | |
| A1 | C1 | 43.42 | 44.64 | 53.48 | 47.18 | 53.13 | 56.86 | 57.42 | 55.81 |
| | C2 | 44.12 | 50.48 | 56.38 | 50.33 | 53.97 | 64.42 | 56.01 | 58.14 |
| | C3 | 44.22 | 53.02 | 58.31 | 51.85 | 53.84 | 63.79 | 60.23 | 59.28 |
| A2 | C1 | 30.06 | 34.69 | 37.46 | 34.07 | 26.25 | 47.57 | 53.88 | 42.57 |
| | C2 | 30.15 | 34.92 | 42.52 | 35.86 | 32.99 | 46.29 | 54.98 | 44.75 |
| | C3 | 30.31 | 36.73 | 47.00 | 38.01 | 44.93 | 53.83 | 54.70 | 51.16 |
| | | 2.21 | | | 1.15 | 4.79 | | | 2.68 |
| F | | 37.05 | 42.41 | 49.19 | A | 44.19 | 55.46 | 56.20 | A |
| LSD | | 0.99 | | | | 2.09 | | | |
| A x F | A1 | 43.92 | 49.38 | 56.05 | 49.78 | 53.65 | 61.69 | 57.89 | 57.74 |
| | A2 | 30.17 | 35.44 | 42.32 | 35.98 | 34.73 | 49.23 | 54.52 | 46.16 |
| LSD | | 1.26 | | | 1.10 | 2.75 | | | 2.65 |
| | | | | | C | | | | C |
| C X F | C1 | 36.74 | 39.66 | 45.47 | 40.62 | 39.69 | 52.22 | 55.65 | 49.19 |
| | C2 | 37.14 | 42.70 | 49.45 | 43.09 | 43.48 | 55.36 | 55.50 | 51.45 |
| | C3 | 37.27 | 44.87 | 52.65 | 44.93 | 49.39 | 58.81 | 57.46 | 55.22 |
| | | 1.59 | | | 0.89 | 3.43 | | | 2.05 |

The irrigation interval has a significant effect on the vegetative growth of the plant. The three-day irrigation interval has given a significant increase for all vegetative characteristics. The reason may be due to the abundance of sufficient water for the plant, which enables it to carry out its vital operations in the different stages of growth, especially in the vegetative stage and leads to an increase in the speed of photosynthesis and an increase in The solubility of the nutrients added to the soil and originally present in it, which makes it more ready, as well as the efficiency of the root system of plants in absorbing elements and nutrients, which was positively reflected on the increase in cell division and elongation and an increase in the number and size of vascular bundles in the stem and this leads to an increase in the efficiency of the leaves in the process of carbon metabolism and from Then increase the overall plant growth (Taiz and Zeiger, 2002). As for exposing plants to water stress, at a six-day interval, this led to a decrease in vegetative growth indicators, perhaps due to the lack of water absorption from the roots and water loss through transpiration, and this leads to a loss or disruption of the ionic and osmotic balance of plant cells, which causes changes in physiological features. In the plant, and then reduced photosynthesis and weak plant growth (Caddell et al., 2019).

As for the effect of organic fertilizer in increasing the vegetative and root characteristics, it may be due to its content of organic compounds, amino acids and nutrients, especially potassium, which plays an important role in many processes inside the plant, including regulating the work of stomata (Dumas et al., 2004 and Dantas et al., 2007). In addition to the role of organic acids in Maintaining soil moisture and ventilation, which is reflected in plant growth and the formation of a root system capable of absorbing nutrients and then stimulating vegetative growth (Taiz and Zeigar, 2010).

It is noticed that the different origins differ among themselves in the characteristics of vegetative growth mentioned above, and this disparity is due to the genetic difference between the origins and the result of the variation of the genetic factors responsible for the characteristics of vegetative growth, which reflected positively on the physiological processes necessary for vegetative and root growth (Hartmann, 1997).

ISSN: 2349-8889
Volume-9, Issue-3 (May 2022)

https://doi.org/10.31033/ijrasb.9.3.12

## REFERENCE

[1] Bergmann, T. (1992). The re-privatization of farming in Eastern Germany. *Sociologia Ruralis*, *32*(2-3), 305-316.

[2] Caddell, D. F., S. Deng, and D. Coleman-Derr, . 2019. Role of the plant root microbiome in abiotic stress tolerance. In seed endophytes (pp. 273-311). Springer, cham.

[3] Dantas,B.F.;M.S.pereira;L.D.Ribeiro;J.L.T.Mala;a ndL.H.Bassoi.2007.Effect of humic substances and weather conditions on leaf biochemical changes of fertigated Guava tree during orchard establishment. Rev. Bras. Frutic. Jaboticabal- sp. V.29 n.3 P 632 – 638.

[4] Dumas, Y., S. Smail and A. Benamara, . 2004. Effect of potassium fertilization on the behavior of three processing tomato cultivars under various watering levels . Acta hort.13 .

[5] Hartmann, H. T., D. E. Kester, F.T. Davies, and R. L. Genever, . 1997. Plant propagation. Principles and practices. Hall inc., New Jersey, USA.

[6] Hou, J.Q.; Li, M.X.; Mao, X.H.; Hao, Y.; Ding, J.; Liu, D.M.; Xi, B.D.; Liu, H.L. Response of microbial community of organic-matter-impoverished arable soil to long-term application of soil conditioner derived from dynamic rapid fermentation of food waste. PLoS ONE 2017, 12, e0175715. [CrossRef] [PubMed]

[7] Pirzad, A., Shakiba, M. R., Zehtab-Salmasi, S., Mohammadi, S. A., Darvishzadeh, R., & Samadi, A. (2011). Effect of water stress on leaf relative water content, chlorophyll, proline and soluble carbohydrates in Matricaria chamomilla L. *Journal of Medicinal Plants Research*, *5*(12), 2483-2488.

[8] Rafiq, S., Kaul, R., Sofi, S. A., Bashir, N., Nazir, F., & Nayik, G. A. (2018). Citrus peel as a source of functional ingredient: A review. *Journal of the Saudi Society of Agricultural Sciences*, *17*(4), 351-358.

[9] Shirgure, P. S., Srivastava, A. K., & Singh, S. (2000). Water management in citrus–A review. *Agricultural Reviews*, *21*(4), 223-230.

[10] Smith, M. E., Kane, A. S., & Popper, A. N. (2004). Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water?. *Journal of Experimental Biology*, *207*(20), 3591-3602.

[11] Taiz, L., and E. Zeiger, .2002. Plant Physiology Third Ed Sinauer Associates Inc. Sunderland, MA, USA.

[12] Taiz, L., and E. Zeiger, .2010. Plant Physiology.5th (Ed.), Sianauer Associates, Sunderland, UK :P 629.

[13] Tang, H.; Zhang, L.Y.; Hu, L.Y.; Zhang, L.N. Application of chitin hydrogels for seed germination, seedling growth of rapeseed. J. Plant Growth Regul. 2013, 33, 195–201.

[14] Toonsiri, P.; Del Grosso, S.J.; Sukor, A.; Davis, J.G. Greenhouse gas emissions from solid and liquid organic fertilizers applied to lettuce. J. Environ. Qual. 2016, 45, 1812–1821. [CrossRef] [PubMed]

[15] Toplu, C., Uygur, V., Kaplankıran, M., Demirkeser, T. H., & Yıldız, E. (2012). Effect of citrus rootstocks on leaf mineral composition of 'Okitsu','Clausellina', and 'Silverhill'mandarin cultivars. *Journal of plant nutrition*, *35*(9), 1329-1340.

[16] Trevisan, S., Francioso, O., Quaggiotti, S., & Nardi, S. (2010). Humic substances biological activity at the plant-soil interface: from environmental aspects to molecular factors. *Plant signaling & behavior*, *5*(6), 635-643