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# Effects of Different Fertilizer and Irrigation Treatments on the Growth of Lemongrass ( *Cymbopogon citratus* L.)

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## Abstract

An experimental study was conducted in the greenhouse at the Department of Biology, College of Education, University of Samarra for the agricultural season 2022-2023 to evaluation combined organic and inorganic fertilizer on growth and chemical content of lemongrass plants *C .citratus* L. Objective of current study focused on impact of combined organic and inorganic fertilizer on *C. citratus* as one of the leafy plants widespread, used , and mean source of bioactive compounds in medicinal and pharmaceutical properties in all over the world .The experiment included 2 factors, the first: was fertilization using the organic fertilizer ORGEVIT with two levels, 250 kg/ha and 125 kg/ha, and the second factor: fertilizing by foliar spraying using the organic stimulant Maxi-Grow with two concentrations of 500 mg/l and 250 mg/l with two irrigation periods after 10 and 15 days. The results showed fertilization levels with 500 mg/l and 250kg/ha treatment excelled with highest average of chlorophyll content and dry weight that reached values were 14.242nm and 42.5 to 41.5 gm respectively, which did not different from the control treatment .While fertilization treatment with 125 kg/ha and 500 mg/L excelled in recording the highest average number of leaves were 11.50 leave/ plant after 10 days of irrigation. Final conclusion organic foliar fertilization in combination with inorganic fertilizers can have an effective role in reducing the harmful effect of drought stress and improving plant growth and metabolism in general.


*Keyword: organic foliar, lemongrass plant, growth, chemical compound*

## 1. INTRODUCTİON

Environmental stress resulting from abiotic factors is one of the most important negative environmental repercussions that affect plants as a direct result of the severe climate changes that most countries in the world suffer from, which require further research to understand their direct effects on plants and their products [1]. The lack of irrigation water, the scarcity of its sources, and the increase in demand for it to a very large extent in the absence of logical solutions. Mismanagement of water resources and the accompanying problem of increased salinity are among the biggest problems at the global and local levels that alarm and threaten vegetation. Scientific reports have indicated that plants form secondary pathways when they are under conditions of biotic and abiotic stress and competition with overlapping critical environmental factors that directly affect growth and metabolic pathways in the plant. Among these factors are temperature, water shortage, soil pollution, relative humidity, and light levels, which effect on the concentration and effectiveness of bio -composites under various environmental stress conditions [2]. Although many studies have focused on the impact of environmental factors on the stages of vegetative growth and the concentration and effectiveness of chemical compounds resulting from primary and secondary metabolic pathways resulting under conditions of abiotic environmental stresses, there is an urgent need for more extensive scientific field studies to find appropriate solutions. To overcome or reduce the negative impact of water stress in conjunction with the noticeable change in environmental conditions that witness extreme, critical, rapid and continuous change supported by biochemical and biological studies [3]. One of the proposed solutions is to use organic fertilizers through foliar fertilization, sprayed on the leaves, to be complementary and synergistic with manufactured compound chemical fertilizers added to the soil to reduce the negative impact they have resulting from random and excessive use on the ecosystem with all its components, and on the other hand to improve and increase the rate of absorption through the leaves from Through the stomata and leaf tissue under non-ideal growth conditions and stresses with negative effects, which is generally reflected in the rate of absorption of total ready-made nutrients [4]. Lemongrass plant *C. citratus* is one of the widespread medicinal leafy plants in the world, and the demand for its products has increased significantly recently due to its medicinal and pharmaceutical properties because it contains many active groups and compounds in its leaves. It is one of the plants that was recently introduced to Iraq with the aim of increasing it, because this plant is of great importance, as the oil contains a basic component, citral, which constitutes 90% of the components of the oil, which is characterized by its yellow-orange color. This oil is used in the manufacture of soap, aromatic scents, and some cosmetics [5]. Therefore, this study came to evaluation of organic combined organic/inorganic fertilizer on the growth and chemical content of lemongrass plants *C. citratus* L. under different irrigation periods.

## 2.METHODOLOGY

### *Study Site 2.1*

A field experiment was conducted in the greenhouse of the Department of Biology - College of Education, .University of Samarra for the period from 10/1/2022 to 2/1/2023

### *2.2 Soil Collection and Preparation*

The soil was brought from the shoulders of the Tigris River in the city of Samarra, cleaned of impurities and plant remains, then left to dry well. Equal quantities were taken from it and mixed together for the purpose of analyzing the properties of the soil and its texture. A soil sample that was designated for agriculture was taken, and the necessary analyzes were conducted in the Central Science Laboratory, University of Baghdad, in order to estimate a number of chemical and physical properties of the soil. The soil texture was estimated according to the method[6], the degree of electrical conductivity and the degree of soil interaction ( pH) in addition to the determination of nitrogen, phosphorus, and potassium, as shown in the following table:

**Table.1** of soil characteristics used in the agricultural experiment

| Soil characteristics | Value |
|---|---|
| pH | 7.5 |
| E.C | 318 |
| Soil texture | |
| Clay | %36 |
| Silt | %48 |
| Sand | %16 |
| Nutrients mg.kg-$^{1}$ | |
| N | 0.09 |
| P | 118 |
| K | 3.4 |
| O.M | %2.9 |

### **2.**3 ***Plant Processing***

Lemongrass cuttings were obtained from the College of Agriculture - Anbar University at the age of 1 month. Well-growing, disease-free cuttings with a suitable length of about 15 cm were selected. The leaves are preserved by soaking their roots in water in clean plastic containers until planting, to maintain their vitality and not expose them to drought.

### *2.4 Product Information Organic Fertilizer*

The information of Fertilizers used in the experiment explain in table 2 below :

**Table 2**. Composition of the Organic fertilizer under study

| Component | Approximate Concentration (%) or Content |
|---|---|
| **Organic Stimulant - Maxi-Grow** | |
| Total Nitrogen (N) | 2–4% |
| Phosphorus ($P_2O_5$) | 1–3% |
| Potassium ($K_2O$) | 2–5% |
| Amino Acids | 5–10% |
| Seaweed Extracts | 10–15% |
| Humic and Fulvic Acids | 5–8% |
| Micronutrients (Fe, Zn, Mn) Cu, B, Mo) | Trace amounts (0.01–0.1%) |
| Vitamins (B-complex, C, E) | Small amounts |
| Organic Carbon | 10–20% |
| **ORGEVIT** | |
| Nitrogen (N) total | 4 |
| Nitrogen (N) organic | 3.6 |
| Nitrogen (N) ammonium | 0.4 |
| Phosphate ($P_2O_5$) total | 3.0 |
| Potassium ($K_2O$) total | 2.5 |
| Magnesium (MgO) total | 1 |
| Sulphur ($SO_3$) total | 1.5 |
| Calcium (CaO) total | 9 |
| Nitrogen (N) total | 4 |

***2.5 Field Experiment***

Soil for study was prepared in advance and packed into plastic pots with a capacity of 15 kg of each and irrigated well to stabilize soil and eliminate air voids. The calves were planted on 10/1/2022 in pots after that watered regularly and monitored on a daily basis until their growth reached the stage of 4 to 5 leaves.

***2.6 Experiment Design***

The experiment was conducted using a Completely Randomized Design (CRD) with a factorial arrangement. The study involved three experimental factors:

1. Soil fertilization (Factor A): Application of the organic fertilizer ORGEVIT at two rates (125 and 250 kg $ha^{-1}$), applied at the five-leaf stage of the seedlings.
2. Foliar fertilization (Factor B): Foliar application of the organic growth stimulant Maxi-Grow at two concentrations (250 and 500 mg $L^{-1}$).
3. Irrigation interval (Factor C): Two irrigation regimes, every 10 days and every 15 days.

All possible combinations of the three factors were included, forming a 2 × 2 × 2 factorial experiment, resulting in eight treatment combinations. In addition, a control treatment without fertilization was included for comparison. Each treatment was replicated, with two plants per experimental unit, and the experimental units were randomly assigned within the greenhouse to minimize experimental error. Experimental units were distributed randomly to reduce experimental error and each treatment was coded with a symbol for ease of handling and distinction from T0 to T8.

**Table.3** Transaction distribution and coding

| No. | Code | Treatments |
|---|---|---|
| 1 | T0 | Control 1 |
| 2 | T1 | ground fertilizer 250 gm - irrigation period 10 days |
| 3 | T2 | ground fertilizer 250 gm - irrigation period 15 days |
| 4 | T3 | ground fertilizer 125 gm - irrigation period 10 days |
| 5 | T4 | ground fertilizer 125 gm - irrigation period 15 days |
| 6 | T5 | fertilization spray 500 mg - irrigation period 10 days |
| 7 | T6 | Fertilization Spray 500 mg - irrigation period 15 days |
| 8 | T7 | Fertilization Spray 250 mg - irrigation period 10 days |
| 9 | T8 | Fertilizer spray 250 mg - irrigation period 15 days |

### 2. 7 *Characteristics Under Study*

#### *2. 7.1 Total Chlorophyll Content in Leaves (mg/g)*

Leaves were taken from each experimental unit, then washed with water, and the wet plant tissue was weighed at the rate of one gram for each sample of three plant leaves. Then, they were soaked in 96% methanol alcohol, in an amount of 40 ml for each sample, for 3 days. Then an extract was taken with a pipette for each sample, amounting to 2.5 ml. After that the amount of absorption was measured using a spectrophotometer to measure the optical density (OD) Optical Density: chlorophyll Ca 666 mg/g and chlorophyll Cb 653 mg/g. The absorbance density was calculated by applying the following equations mentioned by [7].

#### 2.7.2 *Number of Leaves per Plant*

The average number of leaves in each treatment was calculated and divided by the number of leaves of each plant on the number of amount plants in experimental unit.

#### 2.7.3 *Total leaf Area of the Plant ($cm^2$)*

The average leaf area for all plants in each treatment was calculated through the following equation [8]: Leave area = Leave length x maximum width x 0.802.

#### 2.7.4 *Dry weight (gm)*

The dry weight of the plant was calculated by drying the plants naturally in the laboratory with constant stirring. Fresh plants were placed Nin perforated paper. They were placed in an electric drying oven at 45 $C^O$ until fully complete dryness, after that dry weight was calculated according following equation[9].

Dry weight / Fresh weight x 100

### 2.8 *Statistical Analysis*

The data were analyzed statistically using the SAS program, and the arithmetic means of the coefficients were compared based on the Duncuns multiple range test at a probability level of 5% .

## 3. RESULTS AND DİSCUSSİON

### *3.1 Chlorophyll content*

The result in Table .3 shows the fertilization levels recorded significant differences between the fertilization levels in the percentage of chlorophyll content in the leaf as the 500 mg/l fertilization treatment excelled in recording the highest average chlorophyll content in the leaf with values whose averages reached 14.242mg/g. Which did not differ from the control treatment, which recorded values of 14.348mg/g, which in turn differed from the rest of the fertilization levels, which recorded significant differences between them. Irrigation periods of 10 and 15 days did not record significant differences between them. Irrigation averages were also recorded as shown in Table.3. The irrigation averages for 10 days and 15 days did not show significant differences between them.

**Table.3** Effect of Type and level of fertilization and irrigation periods (10 and 15 days) on chlorophyll content of lemon grass plant

| Mean of fertilization | Irrigation periods | | Type and level of fertilization |
|---|---|---|---|
| | 15 day | 10 day | |
| 7.990755 d | 8.18397e | 7.79754d | 250mg/L |
| 14.242345 a | 18.3035a | 10.18119c | mg/L500 |
| 12.99274 c | 9.56085d | 16.42463a | kg/ha125 |
| 13.25494 b | 12.03788c | 14.4742b | kg/ha250 |
| 14.34897 a | 14.34897b | 14.34897b | Control |
| | 12.487034 a | 12.644866a | Mean of Irrigating |

* Similar letters in columns and rows indicate no significant differences, while dissimilar letters indicate a significant difference

### 3.2 *Number of Leave*

The fertilization factor recorded significant differences between the fertilization levels in the number of leaves, as can be seen in Table .4, where the fertilization treatment of 125 kg/ha and 500 mg/L excelled in recording the highest average number of leaves, with values whose averages reached between 11.00 and 11.50 leave/ plant. Also result in table.4 , irrigation periods of 10 and 15 days recorded significant differences between them in the number of leaves. Irrigation averages recorded the highest levels at the 10-day irrigation level, where they reached 9.99, and the lowest levels at the 15-day irrigation level, where they reached 7.87, which differed from the control treatment that recorded values reached 7.00 leaves.

**Table.4** Effect of type and level of fertilization and irrigation periods (10 and 15 days) on number of leave of lemon grass plant

| Mean of fertilization | Irrigation periods | | Type and level of fertilization |
|---|---|---|---|
| | 15 day | 10 day | |
| 8.00 b | 6.67 c | 9.33 b | 250mg/L |
| 11.50a | 9.00 b | 14.00 a | mg/L500 |
| 11.00 a | 9.67 b | 12.33 a | kg/ha125 |
| 7.17 b | 7.00 c | 7.33 c | kg/ha250 |
| 7.00b | —— | —— | Control |
| | 7.87 b | 9.99 a | Mean of Irrigating |

### 3.3 Leave Area

The fertilization treatment recorded significant differences between the fertilization levels in the leaf area characteristic, Table.5, as the fertilization treatment of 250 kg/ha and 250 mg/liter excelled in recording the highest average plant height, with values whose averages reached 217.80 cm, which differed from the control treatment, which recorded values of 54.50. cm, which in turn differed from the rest of the fertilization levels, which did not record a significant difference between them. From table.5 irrigation periods of 10 and 15 days recorded significant differences in leaf area. While irrigation averages recorded the highest levels when watering every 10 days, reached 188.62 cm, and the lowest levels when watering at 15 days was 118.62 cm.

**Table.5** Effect of Type and level of fertilization and irrigation periods (10 and 15 days) on leave area of lemon grass plant

| Mean of fertilization | Irrigation periods | | Type and level of fertilization |
|---|---|---|---|
| | 15 day | 10 day | |
| 217.80 a | 119.82 d | 315.78 a | 250mg/L |
| 138.55 b | 129.52 d | 147.57 c | mg/L500 |
| 144.64 b | 179.80 b | 109.47 e | kg/ha125 |
| 212.63 a | 109.47 e | 315.78 a | kg/ha250 |
| 54.50 c | —— | —— | Control |
| | 118.62 b | 188.62 a | Mean of Irrigating |

**3.4 *Total Dry Weight***

The fertilization factor recorded significant differences between the fertilization levels in terms of dry weight, Table.6. As the fertilization treatment of 250 mg/L and 500 mg/L excelled in recording the highest average dry weight of the plant, with values reaching averages from 42.5 to 41.5 gm, which differed between them significantly. One there hand irrigation periods at 10 and 15 days recorded significant differences in plant dry weight with recorded highest levels at the 10-day irrigation level was 4.37 gm, and the lowest levels at the 15-day irrigation level with value reached 24.8 gm. While control treatment recorded values 12.0 g, that significant difference from other treatment under study.

**Table.6** Effect of Type and level of fertilization and irrigation periods (10 and 15 days) on total dry weight of lemon grass plant

| Mean of fertilization | Irrigation periods | | Type and level of fertilization |
|---|---|---|---|
| | 15 day | 10 day | |
| 42.5 a | 33.0 c | 52.0 a | 250mg/L |
| 41.5 a | 30.0 c | 53.0 a | mg/L500 |
| 25.0 c | 20.0 d | 30.0 c | kg/ha125 |
| 34.5 b | 29.0 c | 40.0 b | kg/ha250 |
| 12.0 d | —— | —— | Control |
| | 24.8 b | 37.4 a | Mean of Irrigating |

The significant increase in the number of leaves with 125 kg/ha and 500 mg/L fertilization levels reflects the positive effect of nutrient availability on vegetative growth. Adequate fertilization provides the necessary macro- and micronutrients that enhance cell division, meristematic activity, and chlorophyll formation, which collectively promote the initiation and development of new leaves. In particular, nutrients such as nitrogen and phosphorus play key roles in promoting leaf expansion and shoot branching. The observed significant differences in leaf area among fertilization levels can be attributed to the positive role of nutrient availability in promoting vegetative growth. The treatments with 250 kg/ha and 250 mg/L provided an optimal nutrient balance that enhanced cell division, leaf expansion, and chlorophyll synthesis. Adequate fertilization ensures a sufficient supply of nitrogen, which is essential for chlorophyll formation and photosynthetic activity. Increased photosynthesis leads to greater carbohydrate accumulation, which in turn supports the production of larger leaves and a more developed canopy. The treatments with 250 mg/L and 500 mg/L of fertilizer produced the highest dry weights (42.5 g and 41.5 g, respectively). This enhancement in biomass accumulation can be attributed to the adequate supply of essential nutrients, which supports vigorous vegetative growth and improved photosynthetic activity. At these optimal fertilization levels, plants likely experienced balanced nutrient uptake, particularly of nitrogen, phosphorus, and potassium, which are critical for cell division, chlorophyll formation, and carbohydrate synthesis. These processes contribute directly to increased biomass and, consequently, higher dry weight. When essential nutrients are provided to the plant through ground fertilization, such as nitrogen, phosphorus, and potassium, it increases the plant's growth and overall metabolic activity. This improves the formation of chlorophyll in the leaves and thus increases its content foliar organic fertilization also may be allows nutrients to be delivered directly to the leaves, which enhances the plant’s response to nutrition and increases the effectiveness of the use of nutrients, which can lead to improved chlorophyll content in the leaves even in drought conditions [11]. Many studies indicate that drought may lead to a reduction in chlorophyll content in leaves due to the reduction of enzymatic activity and biochemical reactions of plants and its impact on photosynthesis processes. But organic fertilizers in particular may enhance the plant's ability to resist these harsh conditions by improving soil properties, root growth, and providing the nutrients necessary to maintain chlorophyll activity.Some research also indicates that ground fertilization in conjunction with spray fertilization can also affect the composition of amino acids and other secondary compounds in plants, which may affect the composition and content of chlorophyll and increase its content in leaves under conditions of environmental stress[12]. Also size and number of leaves recorded decline in a wide range of herbaceous under drought and nutrient-deficient condition . Another studies found that fertilizer application leads to an increase in area, thickness of leaves and chlorophyll content . The results of the current study were in agreement with both [13,14-18]. Similar results have been reported with increased source of nutrients that increased leaf area as a result of larger average cell size, more cells per leaf, and increased rate of cell expansion. In addition, increased supply nutrients increased leaf number because it enhanced the leaf primordial initiation rate at the stem apex. Current study are in agreement with previous studies[15 ,16 and 19] that combined use of organic and inorganic fertilizers tends to yield better results for lemongrass in terms of growth and chemical content including increased biomass , yield and essential oils. Also optimal irrigation practices regular helps maintain the quality and quantity of essential oils and overall plant growth and development.

## 4. Conclusions

In summary, using a balanced approach with combined organic and inorganic fertilizers, along with well-managed irrigation periods, tends to offer the best results for both growth and chemical content in lemongrass. This integrated approach aligns with findings from various studies, highlighting its effectiveness in achieving optimal crop performance.

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