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RESPONSE OF CASTOR (*Ricinus communis* L.) YIELD OF SEED AND OIL TO THE FOLIAR APPLICATION OF GREEN TEA EXTRACT

Ahmed Y. Hassan[1] and Nagham S. Ibrahim[2*]

1. Crop Sci. Dept., Fac. Agric., Univ. Diyala, Diyala, Iraq

2. Biol. Dept., Fac. Education for Pure Sci., Univ. Diyala, Diyala, Iraq

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ABSTRACT: A field experiment was conducted at the College of Agriculture, University of Diyala, which located in the city of Baqubah, the center of Diyala Governorate in the Northeastern part of the capital of Iraq, Baghdad. The experiment aimed to study the effect of spraying with four concentrations of *Camellia sinensis* (green tea) extract (0, 50, 75 and 100) ml/l in the yield of seed and oil of two castor plant varieties: Zibo castor and Carmencita. Statistical analysis of the data was performed using a factorial experiment according to a Completely Randomized Block Design (RCBD). The results showed a significant superiority of the concentration of 75 ml/l, which recorded the highest averages of dry weight of leaves (g), number of fruits per plant, weight of 300 seeds (g), seed yield per plant (g/plant), oil percentage (%) and oil yield (kg/ha). These values were 171.6 (g/plant), 122 fruits/plant, 68.2 (g), 53.0 (g/plant), 41.9 (%) and 494.0 (kg/ha), respectively. The study also revealed the significant superiority of the Zibo castor variety, with the highest averages for the mentioned traits, reaching 179.4 (g/plant), 134 fruits/plant, 66.8 (g), 59.2 (g/plant), 43.0 (%), and 562.2 (kg/ha), respectively. Furthermore, the study results indicated significant differences between the means of some studied traits due to the interaction between the experiment factors. The combination of spraying green tea extract at a concentration of 75 ml/l with the Zibo castor variety recorded the highest averages for seed yield, oil percentage and oil yield, which reached 66.0 (g/plant), 43.3 (%), and 630.0 (kg/ha), respectively.

Key words: *Ricinus communis*, Green tea extract, Oil yield, Organic fertilizers, Seed yield, Growth.

INTRODUCTION

The use of plant-based organic fertilizers is considered an agricultural method employed to enhance the nutritional efficiency of plants, especially under environmental stress conditions that plants may encounter throughout various stages of their life. These stressors include elevated temperatures, salinity, drought, pH, nutrient deficiencies, and the loss of nutrients from the soil, whether through leaching or deep percolation (**Pathak *et al.*, 2021**) as well as accumulations of heavy metals (**Abdulrazzaq *et al.*, 2023**). On the other hand, the importance of using these fertilizers comes from its role in reducing the use of chemical origin fertilizers which causes serious pollution to the environment. As a result, attention has turned towards employing the organic fertilizers and applying them as a spray, to speed up its absorption and transmission into different parts of plant **(Vasundhara and Chhabra, 2021; Niu *et al.*, 2021)**.

Camellia sinensis extract is one of these organic fertilizers and the importance of using green tea extract lies in its high content of readily absorbable nutrients and vitamins, as well as polyphenolic compounds that act as antioxidants, in addition to its role in increasing the enzymatic activity, contributing to the reduction of oxidative stress (**Armstronga *et al.*, 2020**).

*** Corresponding author: Tel. :**+207731009007
E-mail address: naghamsa3doon@gmail.com

The castor plant, *Ricinus communis* L., belongs to the Euphorbiaceae family and distributed in various regions worldwide. It has several varieties that vary in morphological characteristics and its production of seed and oil (**Kim *et al*., 2021**). India, China and Brazil are among the top global producers of castor. The castor plant has many important uses, in pharmacological, medicine, in addition to agricultural industries (**Ying *et al*., 2017; Yeboah *et al*., 2020**). Castor oil is distinguished from other vegetable oils by its high content of essential unsaturated fatty acids (**Ojha *et al*., 2024**) with a medical importance, which contributes to reducing the risk of disease of heart diseases, arteries, cancer, and diabetes (**Kapoor *et al*., 2021**). Furthermore, it is valued for its antioxidant properties due to the presence of important vitamins like vitamin E, which consist of Tocotrienols and Tocopherols, which are crucial in treating numerous human diseases (**Ganesan *et al*., 2018; Shahidi *et al*., 2021**).

Castor plant grows well in temperatures ranging from 25 to 32°C, while temperatures above 32°C adversely affect germination and production (**Cafaro *et al*., 2023**). The flowering and fruiting stages of the castor plant coincide with the relative rise in temperatures in summer season. Heat is considered one of the environmental stresses significantly affecting oilseed crops, including castor plant during the flowering and fruit maturation stages (**Ahmad *et al*., 2021**), along with elevated salt levels in field soils, which can hinder optimal castor crop growth and production. Additionally, castor varieties vary in their genetic and morphological compositions, influencing their responses to different environmental conditions. Choosing the appropriate species for a specific environment is a fundamental priority to ensure achieving the highest yield, as emphasized by **Cafaro *et al*. (2023)**. They confirmed that castor crop productivity varies based on the environmental conditions in which they are grown.

This study aims to investigate the role of green tea extract as an organic fertilizer in enhancing seed and oil production of two castor varieties. The study also aims to identify the best variety that yields the highest seed and oil output.

MATERIALS AND METHODS

Preparation of Plant Extract

Extraction was carried out by taking 20 g of dried and powdered green tea leaves and placing it in a 500 ml flask. Then, 200 ml of distilled water was added at a temperature of 20 -25°C. The sample was left for half an hour in a horizontal shaker at a medium speed. Afterward, the sample was allowed to settle for an hour. It was then filtered using three layers of medical gauze to separate the residue from the filtrate. The filtrate was then taken, and concentrations of (0, 50, 75, and 100) ml/l were prepared (**Harborne, 1954**).

Experiment Design and Experimental Procedures

To study the effect of foliar spraying with different levels of *Camellia sinensis* extract on the yield of two castor plant varieties in terms of seeds and oil, a field experiment was conducted during the spring season of 2022 in one of the fields of the College of Agriculture - University of Diyala, in silt loam soil. The field was plowed, smoothed, and leveled, and a composite random soil sample was taken at a depth of 0-30 cm for a series of physical and chemical analyses of the study soil, as indicated in Table 2.

Seeds of two castor plant varieties, Zibo castor and Carmencita, which obtained from the College of Agriculture, University of Diyala were manually planted on 6/3/2023 at a rate of 3 seeds per hill. A factorial experiment was conducted according to a Completely Randomized Block Design (RCBD) with 3 replicates, leaving a distance of 1 meter between each replicate. The seeds were sown after soaking them in water for a full day, with a spacing of 75 cm between rows and 60 cm between hills. Thus, the experimental unit area became 304 m × 405m and a plant density of 22058 plants per hectare.

Phosphate fertilizer was added at a rate of 100 kg/ha, and nitrogen fertilizer at a rate of 200 kg/ha, applied in two doses: the first at planting and the second after 20 days from germination according to Iraqi agricultural recommendations for growing castor. The seeds germinated after 9 days of planting, and when the plant reached the

two-true leaf stage, the plants were thinned to one plant per hill. The green tea extract was sprayed on the vegetative parts of the plants at concentrations of (50, 75 and 100) ml/l using a 1-liter manual sprayer. The spraying continued until complete wetting. In the control treatment, plants were sprayed with water only. One milliliter of Tween 20 was added per liter of extract to facilitate adhesion to plant surfaces. Plants were sprayed three times on 25/3, 10/4, and 25/4/2022 and plant characteristics were measured by taking the average of 7 plants sampled from the middle rows of each experimental unit.

Studied Traits

1- Dry weight of leaves (g): (at maturity stage) Plant leaves were dried by using an electric oven at 70°C for 72 hours, and then the dry weight was measured using a sensitive scale.

2- Number of fruits per plant (fruit/plant):

3- Weight of 300 seeds (g): Seeds were randomly selected from each experimental unit and weighed using an electric sensitive scale.

4- Seed yield per plant (g/plant): A sensitive electric scale was used for measurement.

5- Oil content (%): This was determined using a Soxhlet apparatus, and the weight of the oil was measured with a sensitive electric scale. The percentage was calculated according to the following equation:

Oil content (%)=(Weight of extracted oil / Weight of crushed seeds sample) × 100 (Olaniyan, 2010).

6- Oil yield (kg/ha): The oil yield was estimated using the equation:

Yield of oil =oil% × yield of seed/hac

Statistical Analysis

The recorded data underwent analysis using the SAS statistical program. Averages comparisons were performed using Duncan's Multiple Range Test with a significance level set at 5%. This particular test is utilized to discern noteworthy differences among averages in studies involving multiple groups. Essentially, the 5% probability level signifies that statistical significance was attributed when the probability of obtaining the observed results by random chance was below 5% (**Al-Rawi and Khalaf Allah, 1980**).

RESULTS AND DISCUSSION

Effect of Foliar Spraying with Green Tea Extract on Dry Weight of Leaves (G/ Plant) of Two Castor Varieties

The results shown in Table 3 indicated significant differences in the averages of dry weight of leaves characteristic due to the foliar spray with green tea extract at concentrations of (0, 50, 75 and 100) ml/l. The treatment with a concentration of 75 ml/l outperformed and gave the highest average of 171.6 g/plant compared to the lowest average obtained from the control treatment with 0 ml/l, which was 129.5 g/plant. Similarly, the results in the same table revealed significant differences in the averages of dry weight of leaves between the two varieties. The Zibo castor variety recorded the highest average at 179.4 g/plant, compared to the lowest average obtained from the Carmencita variety, which was 115.0 g/plant. Significant interactions were observed between the experimental treatments in the dry weight of leaves (g), where the combination of foliar spray with green tea extract at a concentration of 75 ml/l with the Zibo castor variety showed the highest average of 209.3 g/plant compared to the lowest average obtained from the combination of non- spray with the extract (0 ml/l) and the Carmencita variety, which was 101.0 g/plant.

Effect of Foliar Spraying with Green Tea Extract on the Number of Fruits Per Plant of Two Castor Varieties

The results in Table 4 revealed significant differences between the treatments of foliar spray with green tea extract at concentrations of (0, 50, 75, and 100) ml/l in the number of fruits per plant. The treatment with a concentration of 75 ml/l outperformed, recording the highest average of 122.5 fruits/plant compared to the lowest number of fruits per plant obtained from the control treatment, which was 97 fruits/plant. The same table also showed significant differences between varieties used in the study in the trait of the number of fruits per plant. The Zibo castor variety excelled by yielding 134 fruits/plant compared to the Carmencita variety, which recorded the lowest average of 85 fruits/plant.

Table 1. The chemical composition of green tea leaves as reported in (Lee *et al.*, 2015; Armstronga *et al.*, 2020)

The Components	The quantity
Nitrogen (N)	1.19 g
Phosphorus (P)	1 g
Potassium (K)	0.5 g
Manganese (Mn)	0.7 g
Zinc (Zn)	51 mg
Iron (Fe)	60 mg
Magnesium (Mg)	41 mg
Coneshin	110 mg
Thiamine	90 mg
Vitamin A	88 mg
Vitamin B	74.1 mg
Vitamin C	120 mg
Carbohydrates	11.0 g
Fats	0.4 g
Flavonoids	0.3 g
Tannins	2.9 g

Table 2. Some physical and chemical properties of field soil

Soil Properties		Measurement Unit	The Values
Electrical Conductivity 1:1 EC		dS/m	2.3
pH 1:1		-	7.21
Soil Nitrogen (readily available)		mg/kg	32
Soil Phosphorus (readily available)		-	2.87
Soil Potassium (readily available)		-	337.8
Organic Matter (O.M.)		g/kg	7.2
Calcium Carbonate (CaCO3)		g/kg	217.2
Soluble Calcium (Ca+2)		meq/L	14.58
Soluble Magnesium (Mg+2)		meq/L	12.78
Soluble Sodium (Na+)		meq/L	2.87
Soluble Bicarbonates (HCO3)		meq/L	1.2
Soluble Chloride (Cl)		meq/L	28.24
Soluble Potassium (K)		meq/L	0.98
Soil Texture	**Silt**	g/kg	352
	Sand	g/kg	250
Silt Loam	**Clay**	g/kg	128

Table 3. The effect of foliar spraying with green tea extract on the dry weight of leaves (g/plant) of two varieties of castor plant

Varieties	Concentration of Extract (ml/l)				Average
	0	50	75	100	
Zibo castor	158.0d	171.3c	209.3a	179.0b	179.4A
Carmencita	101.0g	110.0f	134.0e	115.0f	115.0B
Average	129.5D	140.6C	171.6A	147.0B	

Table 4. Effect of foliar spraying with green tea extract on the number of fruits per plant of two varieties of castor plant

Varieties	Concentration of Extract (ml/l)				Average
	0	50	75	100	
Zibo castor	118.3d	131.3c	150.0a	138.0b	134.4A
Carmencita	75.3h	83.0g	95.0e	88.0f	85.3B
Average	96.8D	107.1C	122.5A	113.0B	

The results in Table 4 also indicate significant differences between the averages of this trait due to the interaction between the experimental treatments. The combination of foliar spray with green tea extract at a concentration of 75 ml/l with the Zibo castor variety showed the highest average of 150 fruits per plant compared to the lowest average of 75 fruits/ plant obtained from the combination of the control treatment (no spray with the extract) with the Carmencita variety.

Effect of Foliar Spraying with Green Tea Extract on the Weight of 300 Seeds of Two Castor Varieties

The results in Table 5 indicated significant differences in the averages of the trait of the weight of 300 seeds due to the foliar spraying of plants with green tea extract at concentrations (0, 50, 75, and 100) ml/l. The treatment with a concentration of 75 ml/l outperformed, giving the highest average of 68.2 g, while the control treatment gave the lowest average of 56.2 g. The results also showed a significant superiority of the Zibo castor variety, recording the highest average for this trait at 66.8 g compared to the Carmencita variety, which recorded the lowest average at 59.5 g. Significant differences were obtained between the averages of the trait of the weight of 300 seeds due to the interaction between the experimental treatments. The combination of foliar spraying with green tea extract at a concentration of 75 ml/l with the Zibo castor variety showed the highest average of 73.4 g compared to the combination of the control treatment and the Carmencita variety, which recorded the lowest average of 53.2 g.

Effect of Foliar Spraying with Green Tea Extract on Seed Yield Per Plant (G) of Two Castor Varieties

The results in Table 6 and Fig. 1 revealed significant differences in the averages of the seed yield per plant due to the foliar spraying of plants with green tea extract at concentrations (0, 50, 75, and 100) ml/l. The treatment with a concentration of 75 ml/l gave the highest average for this trait, reaching 53.0 g/plant, compared to the lowest average obtained from the control treatment, which was 41.3 g/plant. Table 6 also showed significant differences between the castor varieties, and the Zibo castor variety giving the highest average for this trait at 59.2 g/plant compared to the lowest average of 36.3 g/plant obtained from the Carmencita variety.

Table 5. Effect of foliar spraying with green tea extract on the weight of 300 seed (g) of two varieties of castor plant

Varieties	Concentration of Extract (ml/l)				Average
	0	50	75	100	
Zibo castor	59.2d	65.2c	73.4a	69.3b	66.8A
Carmencita	53.2e	58.3d	63.1c	63.2c	59.5B
Average	56.2D	61.8C	68.2A	66.2B	

Table 6. Effect of foliar spraying with green tea extract on the seed yield of plant (g/plant) of two varieties of castor plant

Varieties	Concentration of Extract (ml/l)				Average
	0	50	75	100	
Zibo castor	51.3d	57.3c	66.0a	61.0b	59.2A
Carmencita	31.3g	34.0fg	40.0e	37.0ef	36.3B
Average	41.3D	45.6C	53.0A	49.0B	

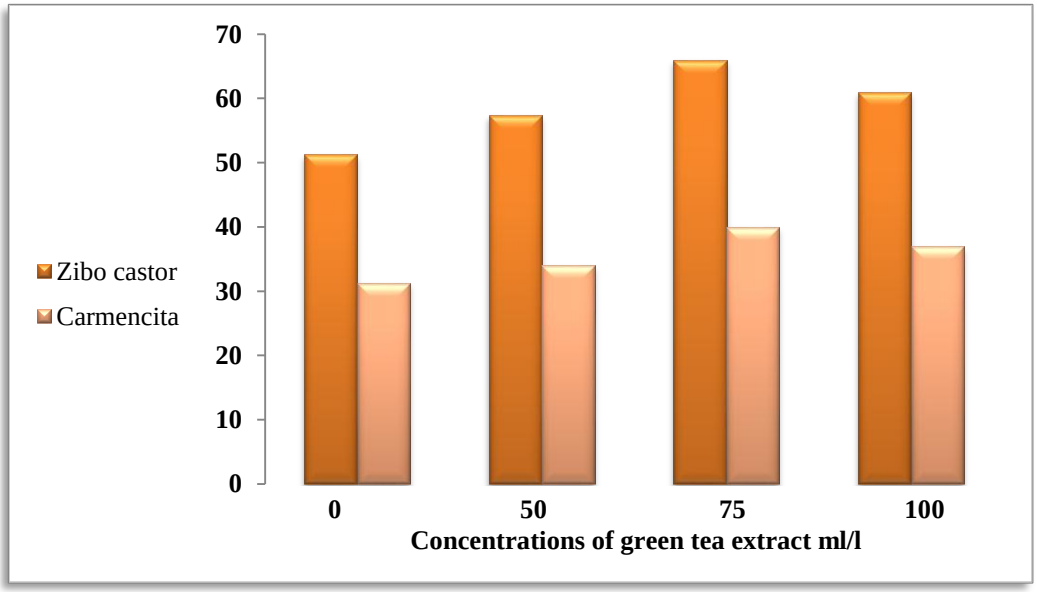

Fig. 1. Effect of foliar spraying with green tea extract on the seed yield of plant (g/plant) of two varieties of castor plant

Significant differences between the averages of seed yield per plant were obtained due to the interaction between the experimental treatments. The highest average of 66.0 g/plant was obtained from the combination of foliar spraying with the extract at a concentration of 75 ml/l with the Zibo castor variety, while the lowest average of 31.3 g/plant was obtained from the combination of the control treatment (non- spray with the extract) with the Carmencita variety.

Effect of Foliar Spraying with Green Tea Extract on Oil Percentage (%) in Seeds of Two Castor Varieties

The results obtained from Table 7 and Fig. 2 indicated significant differences between the foliar spraying treatments with green tea extract at concentrations (0, 50, 75 and 100) ml/l. The treatment with a concentration of 75 ml/l showed the highest average of oil percentage, reaching 41.9%, compared to the control treatment (non-spray with the extract), which recorded the lowest average of 41.1%. Significant differences were also found between the averages of the oil percentage among the planted varieties. The Zibo castor variety outperformed by recording the highest average of 43.0%, compared to the Carmencita variety, which had the lowest average of 40.3%.

Significant differences between the averages of this trait were also obtained due to the interaction between the experimental treatments. The highest average for the oil percentage, 43.3%, was obtained from the combination of foliar spraying with the extract at a concentration of 75 ml/l with the Zibo castor variety, while the lowest average of the oil percentage, 39.8%, was obtained from the combination of the control treatment and the Carmencita variety.

Effect of Foliar Spraying with Green Tea Extract on Yield of Oil (Kg/Ha) of Two Castor Varieties

The results in Table 8 indicate significant differences between the averages of the oil yield due to the foliar spraying with green tea extract at concentrations (0, 50, 75, and 100) ml/l. The treatment with a concentration of 75 ml/l outperformed, giving the highest average of 94.04 kg/ha compared to the control treatment, which achieved an average of 383.5 kg/ha. Additionally, the Zibo castor variety showed a superiority in oil yield, with the highest average reaching 562.2 kg/ha compared to the Carmencita variety, which achieved an average of 320.3 kg/ha. The results also show significant differences due to the interaction between the experimental factors. The combination of foliar spraying with green tea extract at a concentration of 75 ml/l with the Zibo castor variety yielded the highest average for oil yield, reaching 630.0 kg/ha compared to the lowest average obtained from the combination of the control treatment (no spraying with green tea extract) with the Carmencita variety, which reached 281.0 kg/ha (Table 8).

Foliar spraying with different concentrations of green tea extract achieved a significant increase in the dry weight of leaves. This increase can be attributed to the extract's high content of nutrients, vitamins, and amino acids as shown in Table 1, stimulating vital activities in plant cells, enhances cell division and increase the leaf area, leading to an overall increase in leaf weight (**Ahmed *et al*., 2014**). Additionally, the presence of antioxidants in green tea, of which catechin and tocopherol are the most important, play an important role in protecting cells against the activity of reactive oxygen species which can lead to the destruction of proteins, lipids and DNA, thus protects the cells from aging, promoting the vegetative growth, and the formation and stimulation of fruit buds (**Pastoriza *et al*., 2017; Ali *et al*., 2022**).

Abada (2014) affirmed in his study, conducted to demonstrate the impact of green tea extract on plant growth, that there was an improvement in vegetative growth of the plants treated with the extract, and these results aligned with what reached by **Al-Malikshah-Zainab and Abdulrasoo (2022)**.

The observed increase in the number of fruits and total seed yield per plant following foliar spraying with green tea extract can be attributed to the vital role of the extract and its active compounds in encouraging both vegetative and root growth. This enhances nutrient absorption, increasing the efficiency of the photosynthetic process and leading to the accumulation of carbohydrates and proteins. These components contribute to oil synthesis in seeds and participate in the formation of solid oxygenated substances in the oil, thereby increasing its specific weight (**Misra and Sharma, 1991**).

Table 7. Effect of foliar spraying with green tea extract on the oil percentage of two varieties of castor plant

Varieties	Concentration of Extract (ml/l)				Average
	0	50	75	100	
Zibo castor	42.5b	43.1a	43.3a	43.1a	43.0A
Carmencita	39.8d	40.4c	40.6c	40.4c	40.3B
Average	41.1C	41.7B	41.9A	41.7B	

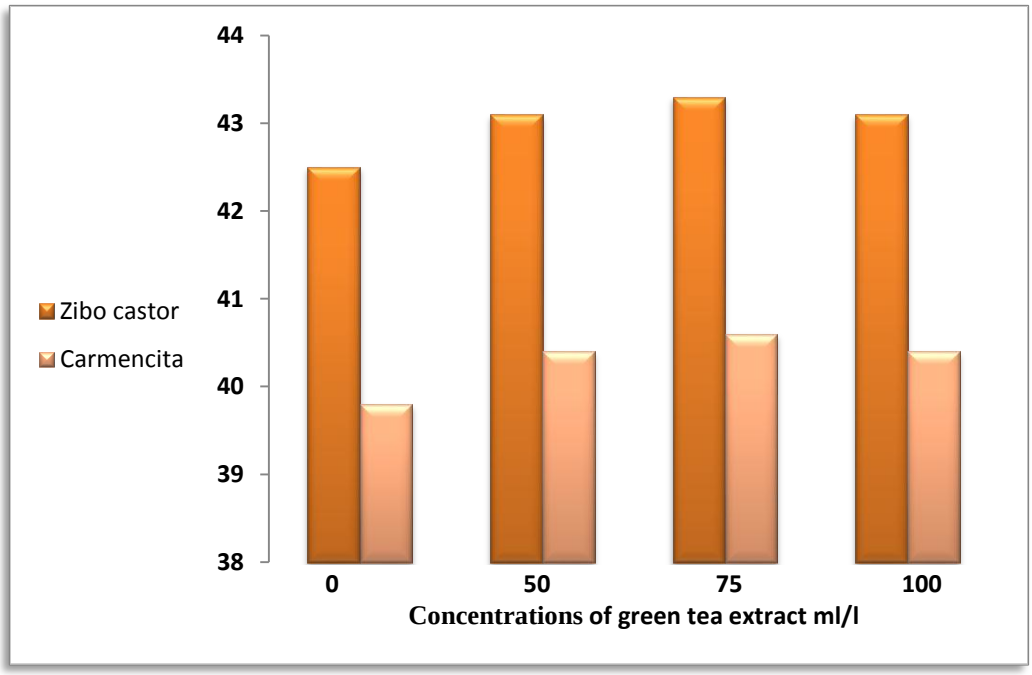

Fig. 2. Effect of foliar spraying with green tea extract on the oil percentage of two varieties of castor plant

Table 8. Effect of foliar spraying with green tea extract on the yield of oil (kg/ha) of two varieties of castor plant

Varieties	Concentration of Extract (ml/l)				Average
	0	50	75	100	
Zibo castor	486.0d	543.0c	630.0a	578.0b	562.2A
Carmencita	281.0h	312.0g	358.0e	328.0f	320.3B
Average	383.5D	427.5C	494.0A	453.0B	

As for the castor varieties, It is clear from the results obtained that genetic and morphological variation among plant varieties had an impact on determining their response to environmental conditions, vital activity, and productivity and this was indicated by the results presented in the tables (from 3 to 8). The limited production of seeds and oil in the Carmencita variety compared to the Zibo castor variety may be attributed to the limited ability of this variety to resist the critical environmental conditions such as high temperatures during the flowering stages, negatively affecting the pollination and fertilization processes, leading to a decrease in fruit set. Additionally, heat stress accelerates the maturation of the formed fruits, resulting in a decrease in the metabolic rates of carbohydrate compounds into seeds and oil. Moreover, exposure of oil crops to high temperatures causes instability of essential vegetable oils, which may lead to rapid evaporation and decomposition of some biologically active components (**Al Hilfy *et al*., 2022**). **Dosio *et al*. (2000) and Aguirrezábal *et al*. (2023)** affirmed that the variation in plant varieties' efficiency in intercepting sunlight due to their morphological characteristics leads to differences in the rates of conversion of food compounds into seeds and increase its oil percentage.

The current research results align with (**Nabizadeh *et al*., 2011**) findings that castor varieties vary in seed specific weight, number of fruit per plant and total yield of seed and oil. The results also correspond with the findings of **Salamatbakhsh *et al*. (2012) and Landoni *et al*. (2023)** that the production of seed and the biological yield of castor plants vary depending on their varieties and their responsiveness to environmental conditions.

Conclusion

Based on the results of the current study, it is concluded that the Zibo castor variety exhibited a higher response to environmental conditions in the agricultural region and under foliar spray treatments with green tea extract. It showed higher seed and oil production compared to the Carmencita variety. Similarly, foliar spray treatments with green tea extract significantly outperformed the control treatment, highlighting the role of this organic fertilizer and its nutrient contents and effective compounds in enhancing vegetative growth. This, in turn, increases the efficiency of photosynthetic processes, leading to higher yields in photosynthesis and the metabolic conversion of these substances for seed formation and an increase in their oil content. We hope to conduct further studies on foliar spraying with nutrients and fertilizers at different stages of the castor plant's life.

REFERENCES

Abada, M.A.M. (2014). A comparative study for the effect of green tea extract and some antioxidants on Thompson seedless grapevines. Int. J. Plant Soil Sci., 3 (10): 1333-1342. http://dx.doi.org/10.9734/IJPSS/2014/8611.

Abdulrazzaq, A.G. and A.A.S. Al-Hamdani (2023). Synthesis, characterization, thermal analysis study and antioxidant activity for some metal ions Cr (III), Fe (III), Mn (II) and Pd (II) complexes with Azo Dye Derived from p-methyl-2- hydroxybenzaldehyde. Baghdad Sci. J., 20 (5Suppl.): 1964-1975. https://doi.org/10.21123/bsj.2023.8188.

Aguirrezábal, L.A., Y. Lavaud , G.A. Dosio, N.G. Izquierdo, F.H. Andrade and L.M. González (2023). Intercepted solar radiation during seed filling determines sunflower weight per seed and oil concentration. Crop Sci., 43 (1): 152-161. https://doi.org/10.2135/cropsci2003.1520.

Ahmad, M., E.A. Waraich, M. Skalicky, S. Hussain, U. Zulfiqar, M.Z. Anjum, H.R. Muhammad, B. Marian , R. Disna, L. Laura, A. Ibrahim and E. Ayman (2021). Adaptation strategies to improve the resistance of oilseed crops to heat stress under a changing: An overview. Front Plant Sci., 12, 1-36. https://doi. org/10.3389/fpls.2021.767150.

Ahmed, F.F., M. Kh. Kamel and H.I.M. Ibrahim (2014). The synergistic effects of using plant extracts and salicylic acid on yield and fruit quality of Keitte mango trees. Stem Cell., 5 (2): 30-39. http://www.dx.doi.org/10.7537/marsscj050214.04.

Al Hilfy, A.A.A.H., S.A. Kathiar and H.I. Al Shammari (2022). Effects of castor oil

nanoemulsion extracted by hexane on the fourth larval stage of culex quinquefsciatus from Al Hawizeh Marsh/Iraq, and non-targeted organism. Baghdad Sci. J., 19 (6 Suppl.): 1512-1512. https://dx.doi.org/10.21123/bsj.2022.

Al-Malikshah-Zainab, R. J. and I.J. Abdulrasoo (2022). Effect of adding fulzyme plus and spraying with green tea extract on vegetative growth and yield of pepper cv. California Wonde Basrah. J. Agric. Sci., 35(2):302-312. https://doi.org/10.37077/25200860.2022.35.2.23.

Ali, E., S. Hussain, N. Hussain , K. U. Kakar , J. M. Shah, S.H.R. Zaidi, M. Jan, K. Zhang and M.A. Khan (2022). Tocopherol as plant protector: An overview of Tocopherol biosynthesis enzymes and their role as antioxidant and signaling molecules. Acta Physiol. Plantarum., 44 (2): 1-11. https:// doi.org/10.1007/s11738-021-03350-x.

Al-Rawi, K.M. and A.M. Khalaf Allah (1980). Design and analysis of agricultural experiments. El Mousel Univ., Iraq, 19: 487.

Armstronga, L., M. A. V. do Carmob , Y. Wuc, L. A. Esmerinod , L. Azevedob, L. Zhangc, D. Cranato (2020). Optimizing the extraction of bioactive compounds from pu-erh tea (*Camellia sinensis* var. assamica) and evaluation of antioxidant, cytotoxic, antimicrobial, antihemolytic and inhibition of α-amylase and α -glucosidase activities. Food Res. Int., 137, 109430. https://doi.org/10.1016/j.foodres.2020.109430.

Cafaro, V., E. Alexopoulou, S.L. Cosentino and C. Patanè (2023). Germination response of different castor bean genotypes to temperature for early and late sowing adaptation in the mediterranean regions. Agric., 13(8): 1-16. https://doi.org/10.3390/agriculture13081569.

Dosio, G. A.A., L.A.N. Aguirrez´abal, F.H. Andrade and V.R. Pereyra (2000). Solar radiation intercepted during seed filling and oil production in two sunflower hybrids. Crop Sci., 40(6): 16637–1644. https://doi.org/10.2135/cropsci2000.4061637x.

Ganesan, K., K. Sukalingam and B. Xu (2018). Impact of consumption and cooking manners of vegetable oils on cardiovascular diseases-A critical review. Trends Food Sci. Technol., 71: 132-154. https://doi.org/10.1016/j.tifs.2017.11.003.

Harborne, H.E. (1954). Phytochemical methods. 2nd Ed. London. NewYork: Chapman and Hall, p 288. https://doi.org/10.1007/978-94-009-5570-7.

Kapoor, B., D. Kapoor, S. Gautam, R. Singh and S. Bhardwaj (2021). Dietary polyunsaturated fatty acids (PUFAs): Uses and potential health benefits. Curr. Nutr.Rep., 10, 232-242. https://doi.org/10.1007/s13668-021-00363-3.

Kim, H., P. Lei, A. Wang, S. Liu, Y. Zhao, F. Huang, Z. Yu,G. Zhu, Z. He, D. Tan, H. Wang and F. Meng (2021). Genetic diversity of castor bean (*Ricinus communis* L.) revealed by ISSR and RAPD markers. Agron., 11(3): 1-14. https://doi.org/10.3390/agronomy11030457.

Landoni, M., G. Bertagnon, M. Ghidoli, E. Cassani, F. Adani and R. Pilu (2023). Opportunities and challenges of castor bean (*Ricinus communis* L.) genetic improvement. Agron., 13 (8): 1-20. https://doi.org/10.3390/agronomy13082076.

Lee, L.S., Kim, S.H., Kim, Y.B. Kim and Y.C. Kim (2015). Quantitative analysis of major constituents in green tea with different plucking periods and their antioxidant activity. Molec., 19 (7): 9173 -9186. https://doi.org/10.3390/molecules19079173.

Misra, A. and S. Sharma. (1991).Critical concentration of iron in relation to essential oil yield and quality prameters of Japanese. mint (*Mentha arvensis*). Soil Sci Plant Nutr., 37 (2): 185-190. https://doi.org/10.1080/00380768.1991.10415028.

Nabizadeh, E., T. Elnaz and G. Farzad (2011). Effect of pruning lateral branches on four varieties of medicinal castor bean plant (*Ricinus communis* L.) yield, growth and development. J. Med. Plants Res., 5 (24): 5828-5834. http://www.academicjournals.org/JMPR.

Niu, J., C. Liu, M. Huang, K. Liu and D. Yan (2021). Effects of foliar fertilization: A review of current status and future perspectives. J Soil Sci. Plant Nutr., 21: 104-118. https:// doi.org/10.1007/s42729-020-00346-3.

Ojha, P.K., D.K. Poudel, A. Rokaya, S. Maharjan, S. Timsina, A. Poudel, R. Satyal, P. Satyal and W.N. Setzer (2024). Chemical compositions and essential fatty acid analysis of selected vegetable oils and fats. Compounds., 4(1): 37-70. https://doi.org/10.3390/compounds4010003.

Olaniyan, A.M. (2010). Effect of extraction conditions on the yield and quality of oil from castor bean. J. Cereals Oilseeds, 1 (2): 24-3. https://doi: 10.4236/gsc.2015.54019.

Pastoriza, S., M. Mesías, C. Cabrera and J.A. Rufián-Henares (2017). Healthy properties of green and white teas: An update. Food Funct., 8 (8): 2650-2662. https:// doi.org/ 10. 1039/C7FO00611J.

Pathak, H.M., K.A.M. Kumar and K. Chakraborty (2021). Abiotic stresses in rice production: Impacts and management. Oryza., 58(4): 103-125. https://doi.org/10.35709/ory.2021. 58.spl.4.

Salamatbakhsh, M.R., T. Ahmad and T. Elnaz (2012). Effects of foliar application of micronutrients on yield and yield components of castor bean (*Ricinus communis* L.) varieties. Eur. J. Exp. Biol ., 2 (4): 975-979. http://www.pelagiaresearchlibrary.com/.

Shahidi, F., A.C.C. Pinaffi-Langley, J. Fuentes, H. Speisky and A.C. de Camargo (2021). Vitamin E as an essential micronutrient for human health: Common, novel, and unexplored dietary sources. Free Radic. Biol. Med., 176, 312-321. https://doi.org/10.1016/ j.freeradbiomed.2021.09.025.

Vasundhara, D. and V. Chhabra (2021). Foliar nutrition in cereals: A review. Pharma Innov. J., 10: 1247-1254. https://www.thepharmajournal.com/archives/2021/vol10issue8/PartR/10-7-234-955.pdf.

Yeboah, A., S. Ying, J. Lu, Y. Xie, H. Amoanimaa-Dede, K.G.A. Boateng, M. Chen and X. Yin (2020). Castor oil (*Ricinus communis* L.): a review on the chemical composition and physicochemical properties. Food Sci. Technol., 41: 399-413. https://doi.org/10.1590/fst.19620.

Ying, S., A. T. Hill, M. Pyc, E. M. Anderson, W. A. Snedden, R. T. Mullen, Y. She, W.C. Plaxton (2017). Regulatory phosphorylation of bacterial-type PEP carboxylase by the Ca^{2+}-dependent protein kinase RcCDPK1 in developing castor oil seeds. Plant Physiol., 174 (2): 1012-1027. https://doi.org/10.1104/ pp.17.00288.

استجابة محصول نبات الخروع *Ricinus communis* من البذور والزيت للاضافة الورقية لمستخلص الشاي الأخضر

أحمد ياسين حسن[1] - نغم سعدون ابراهيم[2]،

1- قسم علوم المحاصيل ، كلية الزراعة ، جامعة ديالى ، ديالى ، العراق

2- قسم علوم الحياة ، كلية التربية للعلوم الصرفة ، جامعة ديالى، ديالى، العراق

نفذت تجربة حقلية في كلية الزراعة - جامعة ديالى والواقعة في مدينة بعقوبة مركز محافظة ديالى شمال شرق عاصمة العراق، بغداد، لدراسة تأثير الرش بثلاث تراكيز من مستخلص الشاي الاخضر *Camellia sinensis* (0 و50 و75 و100) مللي/لتر فضلا عن معاملة في محصول البذور والزيت لصنفين من نبات الخروع وهما، Zibo castor وCarmencita. تم تحليل البيانات احصائيا باستخدام تجربة عامليه وفق تصميم القطاعات العشوائية الكاملة (RCBD). اظهرت النتائج تفوق التركيز 75 مللي/لتر معنويا مسجلا المتوسطات الاعلى لكل من الوزن الجاف للأوراق (جم) وعدد ثمار النبات الواحد ووزن 300 بذرة (جم) وحاصل البذور بالنباتات (جم/نبات) ونسبة الزيت (%) وحاصل الزيت (كجم/هكتار) وبلغت 171.6 (جم/نبات) و122(ثمرة/نبات) و 68.2 (جم) و 53.0 (جم/نبات) و 41.9 (%) و494.0 (كغم/هكتار) على التوالي، واظهرت نتائج الدراسة ايضا تفوق الصنف Zibo castor معنويا مسجلا المتوسطات الاعلى للصفات المذكوره اعلاه والتي بلغت 179.4(جم/نبات) و 134(ثمرة/نبات) و66.8 (جم) و59.2 (جم/ نبات) و43.0(%) و 562.2 (كجم/هكتار) على التوالي. بينت نتائج الدراسة كذلك وجود فروق معنوية بين متوسطات بعض الصفات المدروسة نتيجة التداخل الثنائي بين معاملات التجربة، اذ سجلت التوليفة المتكونة من الرش بمستخلص الشاي الاخضر بالتركيز 75مللي/ لتر مع الصنف Zibo castor المتوسطات الاعلى لكل من حاصل البذور ونسبة ومحصول الزيت وبلغت 66.0 (جم/ نبات) و 43.3 (%) و 630.0 (كجم/هكتار) على التوالي.

الكلمات الإسترشادية: الخروع ، مستخلص الشاي الاخضر، حاصل الزيت، مخصبات عضوية، حاصل البذور، نمو.