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Article

Effect of Spraying with Alpha-Tocopherol on the Floral and Root Growth Characteristics of *Catharanthus vinca* Under Different Levels of Field Capacity

Maryam I. Abdulghani[1,*], Asmaa M. Adil[2] and Ahmed Khairuldeen Abdulsalam[3]

1,2- Department of Horticulture and Landscape Design, College of Agriculture and Forestry, University of Mosul, Mosul, Iraq.

3- Department of Soil Science and Water Resources, College of Agriculture and Forestry, University of Mosul, Mosul, Iraq.

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[*]**Corresponding author:** maryam.23agp8@student.uomosul.edu.iq

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Abstract: This study was conducted in the wooded canopy of the Department of Horticulture and Landscape Architecture, College of Agriculture and Forestry, University of Mosul, from 1/6/ 2024 to 1/12/ 2024. The aim was to investigate the effect of spraying alpha-tocopherol and irrigation levels on some floral and root growth traits and chemical properties of *Catharanthus vinca* . The study included two concentrations of alpha-tocopherol (0, and 0.025) g L^{-1}, with three irrigation levels (60, 80, and 100%) of field capacity. The factorial experiment was implemented using a randomized complete block design (RCBD), with each treatment replicated three times, with four plants per replicate. The results showed a significant effect of spraying with alpha-tocopherol on the two characteristics of anthocyanin content and proline content in the plant, while alpha-tocopherol did not significantly affect the number of flowers, the time required for the appearance of the flower bud, the length of the longest root, and the chlorophyll content in the plant. The results showed a significant effect of spraying with alpha-tocopherol on the two characteristics of anthocyanin content and proline content in the plant, while alpha-tocopherol did not significantly affect the number of flowers, the time required for the emergence of the flower bud, the length of the longest root, and the chlorophyll content in the plant. Meanwhile, irrigation levels significantly affected the time required for the emergence of the flower bud, the chlorophyll content in the plant, and the anthocyanin and proline content in the plant, while irrigation levels did not significantly affect the two characteristics of the number of flowers and the length of the longest root.

Key words: Alpha-tocopherol, *Catharanthus vinca* , field capacity.

1. Introduction

Catharanthus roseus , a member of the Apocynaceae family, is native to the African island of Madagascar. It is an ancient plant, having been cultivated for centuries. It was first cultivated in Europe in the early 18th century, and its cultivation spread due to the beauty of its white and pink flowers **(Mendonce *et al*., 2025)**. *Catharanthus roseus* is a perennial in tropical regions and an annual in warm and temperate regions. It can grow in pots throughout the winter and, under favorable conditions, can continue to flower for several weeks. However, the flower size may decrease with each flowering **(Khanzadeh and Naderi, 2015)**. The plant is important from a medical point of view, as it is used for therapeutic purposes, as the tea extracted from the plant is used to treat diabetics in Jamaica. The leaves of the plant are also characterized by anti-cancer activity due to their content of alkaloid compounds such as Vincristine and Vinblastine. The roots of the plant are characterized by their content of alkaloid compounds useful in treating diseases affecting the circulatory system, such as Ajmalicine and Serpentine, which are characterized by their high price due to their low concentration in the plant, which increases the economic and medicinal value of the plant **(Gantait *et al*., 2020)**. Plants are generally exposed to many stresses, and water stress is one of the stresses that a plant may be exposed to when irrigation water increases or decreases or when temperatures rise or fall due to climate changes, which affects the active ingredient and the vegetative group of the plant **(Zaghloul, 2020)**, as water stress causes a decrease in the fresh weight and then the dry weight of the plant, as well as a decrease in the plant height **(Parviz and Sardoei, 2014; Shima and Omidbaigi, 2014)**.

2. Materials and Methods

The study was conducted during the period 1/6/2024 - 1/12/2024 in one of the fields affiliated to the Department of Horticulture and Field Engineering / College of Agriculture and Forestry at the University of Mosul, northern Iraq. The seeds of the *Catharanthus vinca* plant were planted in plastic dishes filled with the agricultural medium (peat moss). After 14 days of seed germination, the plants were transplanted into plastic pots with a diameter of (17) cm and a depth of (15) cm, containing (2) kg of a mixture of peat moss, construction sand and garden soil at a ratio of (2:1:1) and covered with a net to protect them from high temperatures. The plants were treated with tow concentrations of alpha-tocopherol added as a spray on the vegetative system of the plant (0, 0.025) g L^{-1} and the plants were irrigated with different irrigation levels (60, 80, 100) % of the field capacity. The experiment included (108) plants resulting from the interaction of experimental factors. The experiment was implemented according to the Randomized Complete Block Design (RCBD) with two factors: of alpha-tocopherol and irrigation levels. Each treatment included (3) replicates, with (4) plants per replicate. Samples were taken from the field soil before the start of the study to estimate some physical and chemical properties of the soil, as shown in Table (1).

Table (1). Physical and chemical properties of the soil of the study site

Attribute	Value
Available N mg kg^{-1}	0.6
Available N mg kg^{-1}	3.6
Available N mg kg^{-1}	8.2
EC ds.m-1	0.68
pH	7.8
O.M.	1.22
Sand %	72
Clay %	15
Silt %	13
Texture	Sandy loam

The floral growth traits (number of flowers, time required for flower bud emergence), root growth traits (length of the longest root) and some chemical traits (total chlorophyll, anthocyanin content, proline content) were measured and the data were statistically analyzed according to **SAS (2017)**, and statistically tested using Duncan's multiple test at the probability level of 0.05.

3. Results and Discussions

3.1. The effect of spraying with alpha-tocopherol and irrigation levels on the number of flowers of the *Catharanthus vinca* plant

Table (2) shows the effect of spraying with alpha-tocopherol and irrigation levels on the number of flowers trait of the *Catharanthus vinca* plant, as the results showed that there was no significant effect of spraying with alpha-tocopherol on the number of flowers trait in the plant, as the two spray treatments at concentrations (0, 0.025) g L^{-1} recorded close values of (5.27, 5.11) flower per plant, respectively. Irrigation levels had a significant impact on the number of flowers per plant, as irrigation level (100%) of the field capacity recorded the highest value for the number of flowers, amounting to (5.97) flower $plant^{-1}$, compared to irrigation level (60%) of the field capacity, which recorded the lowest value, amounting to (4.14) flowers $plant^{-1}$. The interaction between spraying with alpha-tocopherol and irrigation levels had a significant effect on the number of flowers, as the treatment of spraying with alpha-tocopherol at a concentration of (0.025) g L^{-1} with an irrigation level of (100%) of the field capacity was superior and recorded the highest value of (6.17) flowers $plant^{-1}$, while the treatment of spraying with alpha-tocopherol at a concentration of (0.025) g L^{-1} with an irrigation level of (60%) recorded the lowest value of (4.00) flower $plant^{-1}$.

Table (2). Effect of spraying with, alpha-tocopherol, and irrigation levels on flowers number of *Catharanthus roseus* L

Field capacity level	Alpha-tocopherol concentration g L^{-1}		Field capacity effect
	0.0	0.025	
%100	5.78 ab	6.17 a	5.97 a
%80	5.76 ab	5.15 b	5.46 a
%60	4.28 c	4.00 c	4.14 a
alpha-tocopherol effect	5.27 a	5.11 a	

Treatments with similar letters did not differ significantly among themselves at a probability level of 0.05 according to the Duncan’s test.

3.2. Effect of spraying with alpha-tocopherol and irrigation levels on the period required for the flower bud to appear of the *Catharanthus vinca* plant

The results shown in Table (3) indicate that there is no effect of spraying with alpha-tocopherol on the duration required for the flower bud to appear, as the two spraying treatments at concentrations (0, 0.025) recorded a close number of days, reaching (137.80, 137.54) days, respectively. Irrigation levels had a significant impact on the time required for the flower bud to appear, as the irrigation level (100%) excellence the field capacity and recorded the lowest number of days, reaching (136.36) days, compared to the irrigation level (60%), which took the largest number of days (138.62) days. The interaction between spraying with alpha-tocopherol and irrigation levels had a significant effect on the duration required for the flower bud to appear, as the treatment of spraying with alpha-tocopherol at a concentration of (0) g L^{-1} with an irrigation level of (100%) of the field capacity was superior and recorded the lowest number of days, reaching (136.33) days, compared to the treatment of spraying with alpha-tocopherol at a concentration of (0) g L^{-1} with an irrigation level of (60%), which recorded the lowest number of days (139.69) days.

Table (3). Effect of spraying with alpha-tocopherol, and irrigation levels on The period required for the flower bud to appear of *Catharanthus roseus* L.

Field capacity level	Alpha-tocopherol concentration g L^{-1}		Field capacity effect
	0.0	0.025	
%100	136.33 c	136.92b c	136.36 b
%80	137.38 bc	138.15 b	137.76 a
%60	139.69 a	137.54b c	138.62 a
alpha-tocopherol effect	137.80 a	137.54 a	

Treatments with similar letters did not differ significantly among themselves at a probability level of 0.05 according to the Duncan's test.

3.3. Effect of spraying with alpha-tocopherol and irrigation levels on Length of the longest root of the *Catharanthus vinca* plant

Table (4) shows the effect of spraying with alpha-tocopherol and irrigation levels on the root length trait of the bazon plant. The results showed that there was no significant effect of spraying with alpha-tocopherol on the root length trait, as the two spray treatments at a concentration of (0, 0.025) g L^{-1} recorded (36.44, 36.69) cm, respectively. Irrigation levels did not have a significant effect on the longest root length trait of the *Catharanthus vinca* plant, which ranged from (35.70) cm at the irrigation level (100%) of the field capacity to (37.10) cm at the irrigation level (80%) of the field capacity. The interaction between alpha-tocopherol and irrigation levels did not significantly affect the length of the longest root, which ranged from (35.42) in the treatment of spraying with alpha-tocopherol at a concentration of (0.012) g L^{-1} with an irrigation level of (100%) of the field capacity to (37.92) in the treatment of spraying with alpha-tocopherol at a concentration of (0.025) g L^{-1} with an irrigation level of (80%) of the field capacity.

Table (4). Effect of spraying with alpha-tocopherol and irrigation levels on Length of the longest root of *Catharanthus roseus* L

Field capacity level	Alpha-tocopherol concentration g L^{-1}		Field capacity effect
	0.0	0.025	
%100	35.97 a	35.42 a	35.70 a
%80	36.28 a	37.92 a	37.10 a
%60	37.08 a	36.72 a	36.90 a
alpha-tocopherol effect	36.44 a	36.69 a	

Treatments with similar letters did not differ significantly among themselves at a probability level of 0.05 according to the Duncan's test.

3.4. Effect of spraying with alpha-tocopherol and irrigation levels on Total chlorophyll content of the *Catharanthus vinca* plant

Table (5) shows the effect of spraying with alpha-tocopherol and irrigation levels on the total chlorophyll content in the *Catharanthus vinca* plant, as the results showed that there was no significant effect of spraying with alpha-tocopherol on the total chlorophyll content in the plant if the two spray treatments were recorded at concentrations (0, 0.025) g L^{-1} (4.19, 4.43) microgram.g. wet weight^{-1} respectively, while the irrigation levels significantly affected the total chlorophyll trait in the *Catharanthus vinca* plant, as the irrigation level (60%) exceeded and recorded the highest value for total chlorophyll, which amounted to (4.76) compared to the irrigation level (80%), which recorded the lowest value (3.99) microgram.g. wet weight^{-1}. The effect of the two-way interaction between spraying with alpha-tocopherol and irrigation levels was significant on the total chlorophyll content, which ranged from (3.86) in the treatment of spraying with alpha-tocopherol at a concentration of (0.025) g L^{-1} with an irrigation level of (80%) of the field capacity to (5.06) in the treatment of spraying with alpha-tocopherol at a concentration of (0.025) g L^{-1} with an irrigation level of (60%).

Table (5). Effect of spraying with alpha-tocopherol and irrigation levels on Total chlorophyll content of *Catharanthus roseus* L

Field capacity level	Alpha-tocopherol concentration g L^{-1}		Field capacity effect
	0.0	0.025	
%100	3.99b c	4.37 b	4.19 b
%80	4.11b c	3.86 c	3.99 b
%60	4.46 b	5.06 a	4.76 a
alpha-tocopherol effect	4.19 a	4.43 a	

Treatments with similar letters did not differ significantly among themselves at a probability level of 0.05 according to the Duncan's test.

3.5. The effect of spraying with alpha-tocopherol and irrigation levels on content of anthocyanin on the *Catharanthus vinca* plant

Table (6) shows the effect of spraying with alpha-tocopherol and irrigation levels on the anthocyanin content of the *Catharanthus vinca* plant. The results showed a significant effect of spraying with alpha-tocopherol on the anthocyanin content of the plant, as the spraying treatment with a concentration of (0) g L^{-1} outperformed and achieved the highest value of (47.49) mg g wet weight^{-1}, while the spraying treatment with a concentration of (0.025) g L^{-1} recorded the lowest value of (36.39) mg g wet weight^{-1}. The results also showed a significant effect of irrigation levels on the anthocyanin content of the plant, as the irrigation level (80%) outperformed and recorded the highest value of (45.69) mg g wet weight^{-1}, compared to the irrigation level (60%), which recorded the lowest value of (39.30) mg g wet weight $^{-1}$. The interaction between spraying with alpha-tocopherol and irrigation levels also had a significant effect on the anthocyanin content in the plant, as the treatment of spraying with alpha-tocopherol at a concentration of (0) g L^{-1} with an irrigation level of (80%) was superior and recorded the highest value of (53.78) mg g wet weight^{-1}, while the treatment of spraying with alpha-tocopherol at a concentration of (0.025) g L^{-1} with an irrigation level of (60%) recorded the lowest value of (35.05) mg g wet weight $^{-1}$.

Table (6). Effect of spraying with alpha-tocopherol and irrigation levels content of anthocyanin on *Catharanthus roseus* L

Field capacity level	Alpha-tocopherol concentration g L^{-1}		Field capacity effect
	0.0	0.025	
%100	45.15 b	36.54 c	40.84 b
%80	53.78 a	37.59 c	45.69 a
%60	43.55 b	35.05 c	39.30 b
alpha-tocopherol effect	47.49 a	36.39 b	

Treatments with similar letters did not differ significantly among themselves at a probability level of 0.05 according to the Duncan's test.

3.6. The effect of spraying with alpha-tocopherol and irrigation levels on content of proline on the *Catharanthus vinca* plant

Table (7) shows the effect of spraying with alpha-tocopherol and irrigation levels on the proline content trait in the bezoar plant, as the results showed that there was no significant effect of spraying with alpha-tocopherol on the proline content trait in the plant, as the two spray treatments with concentrations (0, 0.025) g L^{-1} recorded (196.62, 207.60) micrograms.gm dry weight^{-1}, respectively. While the interaction between spraying with alpha-tocopherol and irrigation levels significantly affected the proline content in the plant, where the treatment of spraying with alpha-tocopherol at a concentration of (0) g L^{-1} with an irrigation level of (60%) outperformed and achieved the highest value for the trait, reaching (225.64) micrograms.gm dry weight^{-1} compared to the treatment of spraying with alpha-tocopherol at a concentration of (0) g L^{-1} with an irrigation level of (100%), which recorded the lowest value, reaching (168.22) micrograms.gm dry weight^{-1}.

Table (7). Effect of spraying with alpha-tocopherol and irrigation levels on content of proline on *Catharanthus roseus* L

Field capacity level	alpha-tocopherol concentration g L^{-1}		Field capacity effect
	0.0	0.025	
%100	168.22 c	212.49 ab	190.35b
%80	196.02 b	201.42 b	198.72 b
%60	225.64 a	208.91 ab	217.27 a
alpha-tocopherol effect	196.62 b	207.60 a	

Treatments with similar letters did not differ significantly among themselves at a probability level of 0.05 according to the Duncan's test.

The results shown in Tables (2,3) indicate that the addition of alpha-tocopherol did not significantly affect the floral growth characteristics (number of flowers, time required for flower bud emergence). This is consistent with what was found by **(Soltani *et al*., 2018)**, who found that low concentrations (less than 0.1 g L^{-1}) did not have a significant effect on the growth and floral characteristics of chrysanthemum plants. Table (4) shows that the addition of alpha-tocopherol did not significantly affect the longest root length characteristic. This is consistent with what was obtained by **(Mahgoub *et al*., 2015)** on zinnia plants, who attributed the reason to the low concentration added. Table (6) shows that the addition of alpha-tocopherol led to a significant increase in the anthocyanin content in the plant, and this is consistent with what was found by **(Soltani *et al*., 2020)** on the petunia plant. Table (7) shows that the addition of alpha-tocopherol led to a significant increase in the proline content in the plant, and this is consistent with what was indicated by **(Soltani *et al*., 2020)** that alpha-tocopherol reduces oxidative stress, which allows for an increase in the production of protective compounds such as proline. Regarding the effect of water stress on Floral growth traits, Table (2) shows that water stress significantly affected the number of flowers trait. This is attributed to the fact that under stressful conditions, the plant uses energy for survival and adaptation (such as root strengthening or stress resistance) rather than flowering. This is consistent with what was found by **(Álvarez and Sánchez Blanc,2022)** on zinnia plants. Table (3) also shows that the time required for flower bud emergence decreased at a stress level of (60%). This is consistent with what was found by **(Jaleel, 2008)**, who found that water stress significantly reduced the time required for flower bud emergence in *Catharanthus vinca* plants. The results shown in Table (4) indicate that water stress significantly affected the length of the longest root trait. This is consistent with what was found by **(Demirel *et al*., 2021)**, who noted that water stress levels significantly affected the length of the longest root trait in zinnia plants. Table (5) indicates a significant effect of water stress on the total chlorophyll content of the plant, as the stress level (60%) exceeded this. This is consistent with the findings of **(Jaleel, 2008)**, who observed that increasing water stress led to an increase in total chlorophyll in the *Catharanthus vinca* plant. Table (6) shows that the stress level (80%) significantly excelled the anthocyanin content of the plant. This is due to the fact that water stress conditions expose the plant to oxidative stress due to the accumulation of reactive oxygen species (ROS), which stimulates the activation of anthocyanin biosynthesis pathways. Anthocyanins act as powerful antioxidants that help reduce cell damage and protect plastids. Increasing anthocyanin also enhances the plant's ability to absorb excess light and reduces damage caused by high light, which helps the plant adapt to drought conditions. This is consistent with the findings of **(Kumar and Sharma, 2020)**, who observed that water stress led to a significant increase in a number of ornamental plants. Table (7) shows that water stress significantly increased the proline content of leaves, as proline accumulation is an adaptive aspect in cases of water stress as a means of osmotic regulation by reducing the water stress value of leaf cells, causing water to enter them. The reason for this accumulation is that drought stimulates enzymes that degrade proteins and amino acids, such as the enzyme Arginase, and converts it to Ornithine and then proline acid by the enzyme (Pyrroline-2-Carboxylate) **(Abdal Qudus, 2010)**. Drought stress also stimulates the genes responsible for building proline **(Verdoy *et al*., 2009)**. This is consistent with the findings of **(Koi, 2021)** on the scented geranium plant.

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تأثير الرش بألالفاتوكوفيرول على صفات النمو الزهري والجذري لنبات عين البزون تحت مستويات مختلفة من السعة الحقلية

مريم إبراهيم عبدالغني[1] و أسماء محمد عادل[2] و أحمد خيرالدين عبدالسلام[3]

[1،2] قسم البستنة وهندسة الحدائق، كلية الزراعة والغابات، جامعة الموصل، الموصل، العراق

[3] قسم علوم التربة والموارد المائية، كلية الزراعة والغابات، جامعة الموصل، الموصل، العراق

الخلاصة

أُجريت هذه الدراسة في المظلة الخشبية التابعة لقسم البستنة وهندسة الحدائق، كلية الزراعة والغابات، جامعة الموصل، خلال الفترة من 2024/6/1 إلى 2024/12/1. هدفت الدراسة إلى دراسة تأثير الرش بألالفا توكوفيرول ومستويات الري على بعض صفات النمو الزهري والجذري والخصائص الكيميائية لنبات عين البزون. شملت الدراسة تركيزين من ألفا توكوفيرول (0، 0.025) غم لتر$^{-1}$، مع ثلاثة مستويات ري (60، 80، و100%) من السعة الحقل. نُفذت التجربة العاملية بتصميم القطاعات الكاملة العشوائية (RCBD)، بثلاث مكررات، وبأربع نباتات لكل مكرر. أظهرت النتائج تأثيراً معنوياً للرش بألفاتوكوفيرول على صفتي محتوى الأنثوسيانين ومحتوى البرولين في النبات، بينما لم يؤثر ألفا توكوفيرول بشكل معنوي على عدد الأزهار والوقت اللازم لظهور البرعم الزهري وطول أطول جذر ومحتوى الكلوروفيل في النبات. في حين أثرت مستويات الري بشكل معنوي على المدة اللازم لظهور البرعم الزهري ومحتوى الكلوروفيل في النبات ومحتوى الأنثوسيانين والبرولين في النبات، بينما لم تؤثر مستويات الري بشكل معنوي في صفتي عدد الأزهار وطول أطول جذر.

الكلمات المفتاحية: الفاتوكوفيرول، عين البزون، السعة الحقلية.