



The Effect of Water Stress and Potassium Addition on Zinnia Plants' Vegetative and Flowering Growth and Mineral Content

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Abstract:

The study was conducted in the field of the Horticultural Facilities Unit of the Department of Horticulture and Landscape Engineering / College of Agriculture - Tikrit University during the 2023 agricultural Spring season to produce *Zinnia spp*, Profusion Doube mix as flowering potted plants. The experiment included two factors; the first factor was three levels of water stress: irrigation at a level of 100%, %75, %50 of field capacity (FC). The second factor was addition of potassium at four concentrations (0, 1, 2, 3) g l^{-1} . The experiment was carried out according to the randomized complete block design (R.C.B.D) with split-plot system, and 4 pots per experimental unit at three replications. The results showed that irrigation treatment of 100% field capacity was significantly superior to in dry weight of shoot ($4.00 \text{ g Plant}^{-1}$). This treatment gave the lowest value ($5.125 \text{ mg } 100 \text{ g l}^{-1}$) of chlorophyll content in leaves compared to the other irrigation levels. The treatment of 75% FC gave the lowest stem diameter (2.960 mm). Potassium addition treatment at 3 g l^{-1} had a significant superiority in all the studied traits. The interaction between study factors showed that irrigation at 100% FC and adding potassium at 3 g l^{-1} gave a significant superiority in all characteristics.

Key words: Zinnia, Seedlings, Potassium.

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Introduction:

Zinnia elegans Jacq, is summer annual plant belonging to the Asteraceae family. *Zinnia*'s origin is America, Mexico, and Central America. The genus has approximately 20 species. Height of the plant reaches approximately 90 cm in some varieties, and the root extends to 20 cm wide. The flowers are inflorescence of ray florets with various colors, including pink, purple, orange, white, yellow, and red. The disc floret is black and yellow and may be double or single [1]. The plant has economic importance, as it is an ornamental plant whose flowers are used for cutting. It can be grown in gardens, ponds, rock gardens, as well as grown in pots and on window hedges. It is widely used in flowering arrangements due to diversity in its appearance characteristics, such as colors of radial florets and shape of leaf inflorescences [2]. The plant also treats contaminated soil because it accumulates heavy metals, such as cadmium, in its branches [3].

Lack of irrigation is one of the most important factors that limit plant growth, especially in dry and semi-arid areas. Water stress is considered one of the most important types of abiotic environmental stress that negatively affects plant productivity [4]. In most cases, water deficiency, especially severe deficiency, leads to a negative effect on vegetative growth indicators by stimulating the production of free radicals that have an oxidative effect on plant cells and, ultimately, the transition to oxidative stress, which leads to an increase in the negative effect on the various growth indicators of the plant [5]. When it is intended to produce ornamental plants as potted plants and under different irrigation levels, attention must be given to the nutritional elements necessary for the plant. The zinnia plant is one of the ornamental plants produced as potted plants and potassium play a greatest role when the plant grows and completes its life. Potassium (K⁺) is free in plant tissues [6]. The study aimed to determine the interaction between water stress and the addition of potassium in the growth, flowering, mineral content and proline of *Zinnia* plants.

Materials and methods:

The experiment was conducted in the wooden canopy of the Horticultural Facilities Unit Department of Horticulture and Landscape Engineering/College of Agriculture/Tikrit University for the 2023 agricultural season and on the *Zinnia* hybrid plant. Profusion Double class.

The seeds of the variety were planted on 2/13/2023. The planting process was carried out in propagation trays. Peat moss was used as a planting medium. After the plants increased and reached a suitable height, the seedlings were transferred from the propagation trays to the pots on 3/20/2023. Plastic pots 18 cm high and 17 cm in diameter were used. Three seedlings were planted in each pot (anvil), and a planting medium consisting of peat moss and sand was used in a ratio of 1:1 (volume. volume). The plants were subjected to mulching (removing the growing top). The experiment included a study of two overlapping factors. The first factor was treating the plants with water stress at three levels of field capacity (100, 75, 50%), and the second factor was adding potassium to the plants for irrigation at four concentrations (0, 1, 2, 3) g^l⁻¹. Potassium sulphate was added in the form of watering the plants with irrigation water in two additions at a rate of 250 ml pot⁻¹. The chlorophyll pigment was determined by mashing 1 gm fresh weight of leaves in acetone alcohol at a concentration of 80%. A spectrophotometer with wavelengths of 645 and 655 nm was used for measurement. [7] The anthocyanin pigment in the flower was estimated using a spectrophotometer, with a wavelength of 533 nm, and the reading of the device was recorded. [8]

The study was conducted as an experiment with two factors, with 12 treatments for each replicate and three replicates. Each experimental unit included 4 pots, so the total number of pots became 108 pots. A randomized complete block design (R.C.B.D) and a split-plot system were used, where irrigation levels were set in the main panels. Measurements were taken of stem diameter, dry weight of shoots, chlorophyll content of leaves, anthocyanin content of flowers, and concentration of nitrogen and phosphorus in

leaves according to the method of [9]. The results were analyzed statistically using the SAS program, and the averages were compared using the Duncan multinomial test and at the 5% test level in comparing the averages of the coefficients [10].

Results and discussion:

From the data in the table, we notice significant differences for the irrigation factor, as the 50% water stress treatment caused a significant decrease in the studied traits and gave the shoot's lowest stem diameter and dry weight, amounting to 2.965 mm and 3.57 g. Plant⁻¹ and the full irrigation treatment recorded the highest chlorophyll content of 5.125. mg 100 gl⁻¹, anthocyanin concentration 522.5 mg kg⁻¹, and nitrogen and phosphorus concentration in the leaves are 2.008 and 0.254%, respectively. From the table, we find significant differences between the potassium fertilization treatments compared to the comparison treatment, and the concentration treatment of 3 gl⁻¹ excelled and gave the highest rate in all the studied traits. From the interaction treatments between water stress and potassium fertilization, we find significant differences between the treatments. We note that the interaction treatment between full irrigation and potassium fertilization of 3 gl⁻¹ gave the highest rate for all the study characteristics.

Water shortage is considered one of the most important abiotic stress factors that can affect plants' physiological and biochemical processes, including their growth and development and then their production [11]. Reducing field capacity (increasing water stress) from 100% to 50% significantly decreased vegetative, flowering, and chemical growth characteristics. This decrease can be attributed to the response to water stress

conditions, which can lead to some mutations or morphological changes in the plant, such as reducing processes of division and elongation occurring in cells. This results in reducing the surface area of the leaves to reduce water lost during transpiration process to help adapt or acclimatize. In turn, the plant resists such conditions and continue to grow and develop [12].

The reason might also be due to the effect of water stress on the formation of the hormone abscisic acid (ABA), which is responsible for reducing the level of gibberellin, which leads to lowering the height of the plant or its role in reducing the availability of elements and their absorption from the soil, which reduces the water stress in the plant cell and leads negatively to its division and elongation, especially in tissues. Meristematic growth of the stem and thus slow or stop growth [13]. Potassium fertilization plays a role in the metabolism and transport of carbohydrates manufactured from production areas. This element allows carbohydrates to accumulate in flowers as they help in increasing the osmotic pressure or regulating cells osmotic potential. This maintains a high water potential in flower cells, in addition to controlling water relations in the plant by regulating opening and closing of stomata. [14]. mentioned that a lack of potassium causes an increase in respiration speed and decreases the synthesis of carbohydrates. Thus, its addition leads to a clear reduction in the rate of Rapid respiration and an increase in photosynthesis through increasing the number of manufactured carbohydrates. Potassium helps the plant absorb more nitrogen and encourages its conversion into protein by activating enzymatic systems [15].

Table 1. Effect of water deficit and potassium on growth and flower of zinnia hybrid.

Field capacity	Diameter Stem mm	The dry weight of the shoot	chlorophyll	Anthocyanin	N %	P %	
100	3.600 a	4.00 a	5.125 a	522.5 a	2.008 a	0.254 a	
75	2.960 b	3.59 b	4.544 b	514.7 b	1.728 b	0.243 b	
50	2.965 b	3.57 b	4.045 c	509.4 c	1.552 c	0.233 c	
Potassium fertilizer GM pot ⁻¹							
0	2.296 d	3.02 d	4.083 d	509.1 d	1.206 d	0.219 d	
1	3.213 c	3.46 c	4.365 c	513.2 c	1.630 c	0.226 c	
2	3.404 b	4.06 b	4.816 b	517.7 b	2.011 b	0.243 b	
3	3.786 a	4.33 a	5.021 a	522.2 a	2.204 a	0.285 a	
interaction							
100	0	2.500 e	3.20 fe	4.616 e	514.3 ed	1.350 i	0.224 g
	1	3.600 c	3.90 d	4.733 b	518.6 c	1.850 e	0.234 f
	2	4.000 b	4.30 b	5.426 b	525.3 b	2.383 b	0.254 d
	3	4.300 a	4.60 a	5.723 a	531.7 a	2.450 a	0.308 a
75	0	2.233 f	3.06 f	3.950 h	510.5 g	1.150 j	0.220 g
	1	3.000 d	3.20 fe	4.483 f	512.7 ef	1.150 j	0.222 g
	2	3.060 d	4.00 dc	4.793 d	516.0 d	1.623 g	0.243 e
	3	3.550 c	4.10 c	4.950 c	519.7 c	2.220 c	0.286 b
50	0	2.156 f	2.80 g	3.683 i	502.4 i	1.120 j	0.214 h
	1	3.040 d	3.30 e	3.880 h	508.3 h	1.416 h	0.222 g
	2	3.153 d	3.90 d	4.230 g	511.9 gf	1.730 f	0.231 f
	3	3.510 c	4.30 b	4.390 f	515.0 d	1.943 d	0.267 c

Different letters explained significant statistical differences $P \leq 0.05$ range according to Duncan's test. Values in the columns are represented by means \pm standard error.

Conclusions:

As the results of study it was concluded, the vegetative, flowering, and mineral contents are strongly affected by water stress in zinnia plant. The plant can withstand water stress conditions up to 50% of the field capacity in the presence of potassium fertilization, which reduces the damage of water stress while being important for the growth and flowering of the plant.

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تأثير الآجهد المائي وإضافة البوتاسيوم في النمو الخضري والزهري والمحتوى المعدني لنباتات الزينيا *Zinnia hybrid*

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• البحث مسئل من رسالة ماجستير للباحث الاوول

• تاريخ استلام البحث 2024/2/26 وتاريخ قبوله 2024/3/24 .

الملخص:

أجريت الدراسة في الحقل التابع لوحدة المنشآت البستنية التابع لقسم البستنة وهندسة الحدائق / كلية الزراعة - جامعة تكريت خلال الموسم الزراعي الربيعي 2023 لإنتاج نباتات الزينيا *Zinnia Spp.* صنف *Profusion Double mix* كنبات اصص مزهر . قد تضمنت التجربة عاملين العامل الاوول ثلاثة مستويات من الشد المائي الري بمستوى 100 % من السعة الحقلية والري بمستوى 75 % من السعة الحقلية والشد المائي بمستوى 50 % ، والعامل الثاني اضافة البوتاسيوم بأربعة تراكيز (0 ، 1 ، 2 ، 3) غم لتر⁻¹ نفذت التجربة حسب تصميم القطاعات العشوائية الكاملة (R . C . B . D) وينظام القطع المنشقة وبمعدل 4 اصص في الوحدة التجريبية وبثلاثة مكررات، وتلخصت عن الدراسة النتائج التالية:

1- تفوقت معاملة الري 100 % من السعة الحقلية تقوفاً معنوياً في صفة الوزن الجاف للمجموع الخضري والتي اعطت معدل بلغ 4.00 غم نبات⁻¹ واعطت المعاملة نفسها لمحتوى الكلوروفيل في الاوراق اقل معدل مقارنة مع مستويات الري الاخرى 5.125 ملغم 100 غم⁻¹ .

2- اعطت معاملة الري بنسبة 75 % سعة حقلية اقل معدل في صفة قطر الساق الى جانب الري بمستوى 50 % وبلغ 2.960 ملغم .

3- اعطيت اعلى نتائج في صفة تركيز صبغة الانثوسيانين في الازهار 522.5 ملغم كغم⁻¹ ، تركيز النتروجين في الاوراق 2.008 % وتركيز الفسفور في الاوراق 0.254 % عند معاملة الشد المائي بنسبة 100 % .

4- تفوقت معاملة اضافة البوتاسيوم بتركيز 3 غم لتر⁻¹ تفوق معنوي في جميع الصفات المدروسة وكانت متفردة بذلك .

4- من نتائج التداخل الثنائي بين عوامل الدراسة توضح ان الري بمستوى 100 % سعة حقلية واطافة البوتاسيوم بتركيز 3 غم لتر⁻¹ اعطى تفوق معنوي في جميع الصفات .

الكلمات المفتاحية: زينيا ، شتلات ، بوتاسيوم .