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RESEARCH ARTICLE

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Response of Gazania Plants (Gazania splendens L.) to Spraying with Potassium and Nano-Zinc

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ABSTRACT

The research was carried out in lath house of the Department of Horticulture and Landscaping - College of Agriculture / University of Anbar during growing season 5/1/2025 (shading percentage 50%), in order to study the effect of spraying with potassium (P) and nano-zinc (Z) affected the growth and flowering characteristics of Gazania plants during the 2025 growing season in a protected environment. Two factors were investigated during the experiment: the spraying of potassium (P) at three concentrations of (0, 150, and 300 mg L-1) and nano-zinc (Z) at four concentrations of (0, 20, 40, and 60 mg L-1). The findings indicated that spraying with of potassium, especially at concentration (300 mg L-1) contributed to achieving the best results for all vegetative and flowering growth traits (Plant height, leaves number, dry weight of vegetative growth, offsets number, flowers number, flower diameter, flower fresh weight and flower peduncle length), they were (11.24 cm, 41.27 leaf plant-1, 7.24 g, 7.56 off spring plant-1, 5.39 flower plant-1, 8.35 cm, 1.93 g and 8.53 cm), respectively. Spraying with nano-zinc reached significant impact, especially (40 mg L-1) concentration, which provided the highest values for the traits (Plant height, leaves number, dry weight of vegetative growth, off springs number, flowers number, flower diameter, flower fresh weight and flower peduncle length), they were (11.56 cm, 40.57 leaf plant-1, 7.57 g, 7.89 off spring plant-1, 5.34 flower plant-1, 8.17 cm, 1.83 g and 8.51 cm), respectively.

***Keywords*: *Gazniaa splendens* L.; Potassium; Nano-zinc.**

INTRODUCTION

Gazania (*Gazniaa splendens* L.) - perennial herbaceous plant belonging to Asteraceae family. Noteworthy is its sizeable flowers whose colors range from yellow, though orange, to red. Such features are favorable for landscape design and green spaces [1]. Well adapted to extreme environmental conditions such as drought and high temperatures because it has an effective root system and good water usage [2]. With its fast growth, ability to cover the soil, and effectiveness against erosion, Gazania finds extensive application in ornamental landscaping for garden decoration and roadside beautification [3]. Nyctinastic, the flowers open during the day and close at night, helping to conserve moisture and minimize water loss [4]. Physiologically, Gazania utilizes the Z-type photosynthesis scheme that maximizes utilization of radiance in extreme climatic conditions. This characteristic also permits it to thrive in desert soils, thereby being cultivated in arid and semi-arid regions [5]. Furthermore, Gazania possesses an admirable degree of resistance to diseases and pests, particularly those that afflict other flowering plants, thus making it a favored ornament in low-maintenance gardening situations [6]. For have ornamental value and simple culture, Gazania has developed into a predominant plant for the beautification of roadsides and public spaces. Its vibrant colors and ability to withstand a harsh environment make it an excellent sustainable garden design option [7,8].

Among the essential nutrients required for plant growth and development, potassium is classified as a macronutrient, along with nitrogen and phosphorus, and is required in large quantities [9,10]. It is also significant in strengthening plant resistance to diseases, reinforcing cells walls and making them less accessible to pathogens [11,12]. Plants become more efficient in coping with unfavorable environmental conditions such as drought and salinity with high potassium availability, which is especially needed for these ornamental plants that are generally raised under increased environmental stress in urban structures [13,14]. Potassium deficiency decreases the photosynthetic efficiency, causes yellowing of leaves, and results in feeble flower structures, which consequently lowers the aesthetic value of ornamental plants [15].

Potassium, when applied on the leaf surfaces will improve the quality of flowers and will increase flower number and extend flowering duration in different kinds of ornamental plants [16]. Research shows variation in optimal concentrations for potassium foliar spray across different plant species. However, most commonly effective concentrations ranged between 100 to 300 mgL^{-1}. For example, the study of marigold (Tagetes erecta) reported that application of potassium at 200 mgL^{-1} considerably boosted the number as well as size of flower measured against untreated plants [17]. For geranium (Pelargonium spp.), a concentration of 250 mgL^{-1} was noted to enhance color and density of flowers without any detrimental effects on growth [18]. The effect of unchecked potassium concentrations at levels greater than 400 mgL^{-1} could be adverse in that they may inhibit the absorption of other nutrients such as calcium and/or magnesium, which could in turn affect leaf growth or cause nutrient imbalances in the plant system [19].

Zinc is indeed an essential nutrient for plants. It plays important roles in forming various biological functions, regulation of growth, and resistance to stress [20,21]. Importance of conventional zinc for plants: conventional zinc is important for the plant production metabolism and is applied to soils as a soil fertilizer or foliage spray to activate metabolic processes that are necessary for the synthesis of auxins, which are hormones that regulate cell elongation and division [22,23]. Moreover, zinc activates antioxidant enzymes, for instance superoxide dismutase, that aid plants in withstanding oxidative stress brought about by extreme conditions such as drought and salinity [24]. According to the study, nano-zinc increases photosynthetic activity, promotes the better synthesis of protein and enzymes, and therefore influences quality growth parameters of the plants like the ornamental plants [25,26]. Nano-zinc also promotes the plant resistance of diseases through interaction with the cell membranes of bacterial and fungal organisms, thus becoming an element of importance in eco-friendly controls of plant diseases [27,28].

Several studies have established that foliar applications of phi-nano-zinc in concentrations ranging from 20 to 60 mg L^{-1} had a positive effect to promote growth, flowering, and flower quality in ornamental plant species. In marigold (*Tagetes erecta*), flowers could increase on average when treated with 40 mg L^{-1} concentration of nano-zinc in the foliar spray as checked against untreated plants for flower count and improved coloration [29]. In another study conducted on geranium (*Pelargonium* spp.), it was found that the use of nano-zinc at 50 mg L^{-1} has stimulated flower growth and increased the chlorophyll content in leaves [30]. High treatment doses of nano-zinc however, exceeding 80 mg L^{-1} will produce toxicity symptoms such as disturbance of the balance of other nutrients resulting in photosynthetic efficiency loss and plant growth inhibition [31]. This study aims to evaluate the effect of spraying Gazania plants with potassium and zinc nanoparticles on growth and flowering characteristics.

Materials and Methods

Experiment Site

This study was conducted in Hort. Department at the College of Agriculture, University of Anbar in the lath house(shading percentage 50%), From the period 5/1/2025 to 5/4/2025, to determine the effect of spraying with potassium (P) and nano-zinc (Z) and their interaction on the development and flowering parameters of Gazania The pots with diameter 12 cm filled with medium consist of (1 river soil:2 Peat moss) As shown in Table (1).

Table (1). Physical and chemical characters of used medium.

pH	EC ds m^{-1}	O.M %	Bulk density g cm^{-3}	$CaCO_3$ g Kg^{-1}	Total N %	P Av. mg Kg^{-1}
7.71	2.64	1.96	1.28	135.12	0.49	1.83
K Av. mg Kg^{-1}	Ca^{++} Mq L^{-1}	Mg^{++} Mq L^{-1}	Na^{+} Mq L^{-1}	$CO_3^{=}$ Mq L^{-1}	$HCO3^{=}$ Mq L^{-1}	Cl^{-} Mq L^{-1}
54.20	38.92	26.77	0.53	Nil	4.95	61.17
$SO_4^{=}$ Mq L^{-1}	Sand g Kg^{-1}	Silt g Kg^{-1}	Clay g Kg^{-1}	Texture		
24.46	663.2	190.5	146.3	Sandy Clay Loam		

Treatments

- Spraying with the potassium (K_2SO_4) at three concentrations: P0, P1 (150 mg L^{-1}), and P2 (300 mg L^{-1}).
- Spraying with the nano-zinc (ZnO NPs) at four concentrations: Z0, Z1 (20 mg L^{-1}), Z2 (40 mg L^{-1}) and Z3 (60 mg L^{-1}).

Using a 2-liter sprayer, the plants were sprayed until completely coverage, Tween 20 was added as a dispersant at a rate of 0.1 ml L^{-1} to reduce the surface tension of the molecules in the spray solution and allow the plants to absorb the majority of the sprayed solutions. Plants were sprayed with two factors three times (10/1, 10/2 and 10/3), separated by two days.

Experimental Design

A two-factor experiment with a total of twelve treatments-three blocks in total-with five plants in each experimental unit was carried out using RCBD design. The least significant difference (LSD) test was used to compare the means at the 5% level of significance following statistical analysis of the data [32]. The data was assessed using the Genstat program. In 5th of April, the measured growth characteristics for both vegetative and flowering plants included (height of plant, number of leaves, the dry weight of vegetative growth, number of off springs, number of flowers, diameter of flower, fresh weight of flower, peduncle length of flower).

Results and Discussion

Height of Plant (cm)

The findings showed that potassium treatment had a significant impact on the variations in plant height (Figure 1). The no-spray treatment (P0) had the lowest value, measuring 10.67 cm, while the treatments (P2 and P1) had the greatest values, measuring 11.24 and 11.08 cm, respectively. Nano-zinc foliar spraying, however, had a notable impact, particularly in treatments (Z2) and (Z3), which had the highest values at 11.56 and 11.31 cm, respectively. The lowest value 10.13 cm was for no-spray zinc treatment (Z0). As shown in Table 2, there was a significant two-way interaction between potassium and nano-zinc (Z). The treatment P2Z3 generated the tallest plants, measuring 12.60 cm, while the treatment P0Z0 produced the shortest, measuring 9.81 cm.

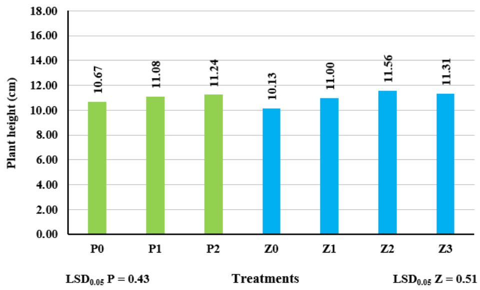

Figure (1). Impact of spraying with potassium (P) and nano-zinc (Z) on plant height (cm) of Gazania

Table (2). Impact of interaction between potassium (P) and nano-zinc (Z) on vegetative growth characteristics of Gazania

Potassium (P)	Nano-zinc (Z)	Height of Plant (cm)	Number of leaves (leaf plant^{-1})	Dry weight of vegetative growth (gm)	Number of off springs (off spring plant^{-1})
P0 (0 mg L^{-1})	Z0 (0 mg L^{-1})	9.81	33.16	5.14	6.15
	Z1 (20 mg L^{-1})	10.98	33.69	5.58	7.33
	Z2 (40 mg L^{-1})	11.64	36.04	6.17	7.95
	Z3 (60 mg L^{-1})	10.25	38.27	5.24	6.59
P1 (150 mg L^{-1})	Z0 (0 mg L^{-1})	10.46	39.44	6.83	6.80
	Z1 (20 mg L^{-1})	11.23	38.86	7.22	7.57
	Z2 (40 mg L^{-1})	11.57	40.73	7.63	7.91
	Z3 (60 mg L^{-1})	11.09	41.56	6.09	7.43
P2 (200 mg L^{-1})	Z0 (0 mg L^{-1})	10.12	39.13	5.97	6.48
	Z1 (20 mg L^{-1})	10.78	41.32	5.78	7.12
	Z2 (40 mg L^{-1})	11.46	44.95	8.91	7.80
	Z3 (60 mg L^{-1})	12.60	39.67	8.30	8.84
LSD $_{5\%}$		0.89	3.21	1.62	0.86

Number of leaves (Leaf plant^{-1})

The number of leaves was significantly influenced by potassium (Figure 2), where treatments P2 and P1 recorded the highest values of 41.27 and 40.15 leaf plant^{-1}, respectively, while the lowest numbers were recorded under P0, with 35.29 leaf plant^{-1}. The nano-zinc foliar spraying, however, had a notable impact, particularly in treatments (Z2) and (Z3), which had the highest values at 40.57 and 39.83 leaf plant^{-1}, respectively, whereas treatment (Z0) had the lowest, at 37.24 leaf plant^{-1}. As can be gleaned from my above experiment in Table 2, there existed a highly significant two-way interaction between potassium (P) and nano-zinc (Z). The highest value was obtained from treatment P2Z2 with 44.95 leaf plant^{-1}, while the control treatment P0Z0 recorded the lowest value with 33.16 leaf plant^{-1}.

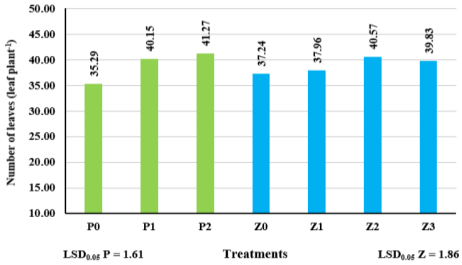

Figure (2). Impact of spraying with potassium (P) and nano-zinc (Z) on number of leaves (leaf plant^{-1}) of Gazania

Dry weight of vegetative growth (gm)

The highest value, 7.24 gm, was displayed by treatment (P2), followed by treatment (P1), 6.95 gm, treatment P0 which gave the lowest values 5.53 gm. The dry weight of vegetative growth was significantly impacted by the potassium added foliarly (Figure 3). According to the results, nano-zinc spraying significantly affected the trait being studied; treatment (Z2) had the greatest effect, weighing 7.57 gm, while treatment (Z0) had the least, weighing 5.98 gm. In contrast, treatment (P2Z2) produced the maximum flower weight, measuring 8.91 gm, while treatment (P0Z0) produced the lowest value, measuring 5.14 gm (Table 2).

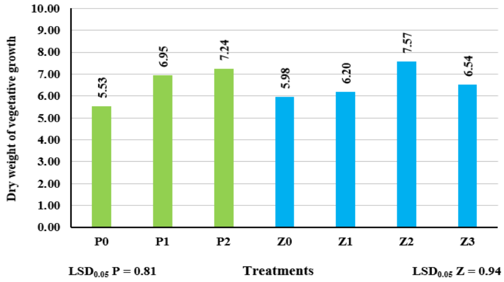

Figure (3). Impact of spraying with potassium (P) and nano-zinc (Z) on the dry weight of vegetative growth of Gazania

Number of off springs in plant (off spring plant^{-1})

The significant effect of potassium spraying treatments on the quantity of offspring is depicted in Figure 4. Treatment (P0) showed the lowest amount of 7.01 spring plant^{-1}, while treatment (P2) showed the highest value of 7.56 off spring plant^{-1}. With treatment (Z2) showing the highest amount of 7.89 off spring plant^{-1} and treatment (Z0) showing the lowest amount of 6.47 off spring plant^{-1}, the nano-zinc spray showed a significant impact. Potassium and nano-zinc were shown to interact significantly in both directions; treatment P2Z3 generated the tallest plants, measuring 8.84 spring plant^{-1}, while treatment P0Z0 produced the smallest, measuring 6.15 spring plant^{-1} (Table 2).

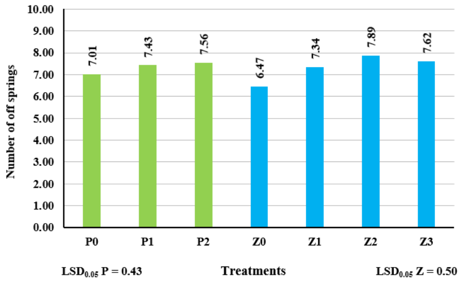

Figure (4). Impact of spraying with potassium (P) and nano-zinc (Z) on number of off springs of Gazania

Flowering Traits

Number of flowers (flowers plant^{-1})

Results in Figure 5 reveal that number of blooms was significantly influenced by potassium spraying. The highest number of flower plants was obtained with treatment (P2) with 5.39 flowers plant^{-1}, while treatment (P0) achieved the lowest 4.48 flowers plant^{-1}. Treatment (Z2) produced the maximum amount of nano-zinc spray, which reached 5.34 flower plant^{-1}, while treatment (Z0) had the lowest value of 4.72 flower plant^{-1}. These results imply a two-way interaction between potassium (P) and nano-zinc (Z) at treatment (P2Z2) with an output of 6.25 flower plant^{-1}, opposing the treatment (P0Z0), which gave the least flowers of 5.32 flower plant^{-1} (Table 3).

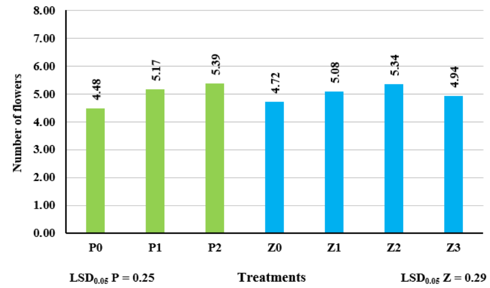

Figure (5). Impact of spraying with potassium (P) and nano-zinc (Z) on number of flowers (flower plant^{-1}) of Gazania

Table (3). Impact of interaction between potassium (P) and nano-zinc (Z) on vegetative growth traits of Gazania

Potassium (P)	Nano-zinc (Z)	Number of flowers (flowers plant^{-1})	Diameter of flower (cm)	Fresh weight of flower (gm)	The peduncle length of flower (cm)
P0 (0 mg L^{-1})	Z0 (0 mg L^{-1})	4.24	7.31	1.22	7.10
	Z1 (20 mg L^{-1})	4.53	7.47	1.40	8.32
	Z2 (40 mg L^{-1})	4.57	7.72	1.08	8.51
	Z3 (60 mg L^{-1})	4.59	7.64	1.31	7.16
P1 (150 mg L^{-1})	Z0 (0 mg L^{-1})	4.84	7.76	1.52	7.80
	Z1 (20 mg L^{-1})	5.27	7.45	1.70	8.34
	Z2 (40 mg L^{-1})	5.18	7.93	2.17	8.19
	Z3 (60 mg L^{-1})	5.40	8.07	1.69	8.42
P2 (200 mg L^{-1})	Z0 (0 mg L^{-1})	5.06	7.98	1.67	7.47
	Z1 (20 mg L^{-1})	5.43	8.21	2.05	8.06
	Z2 (40 mg L^{-1})	6.25	8.86	2.26	8.83
	Z3 (60 mg L^{-1})	4.82	8.34	1.74	9.75
LSD $_{5\%}$		0.51	N.S	N.S	1.10

Diameter of flower (cm)

The significant effect of potassium spraying treatments on blossom diameter is depicted in Figure 6. The highest value was 8.35 cm for treatment (P2), while the lowest value was 7.53 cm for treatment (P0). However, there was no discernible impact on the characteristic under study from spraying treatments with nano zinc alone or with a combination of potassium and nano zinc (Table 3).

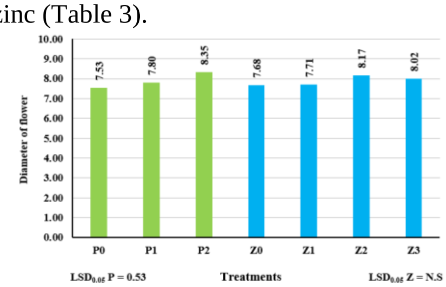

Figure (6). Impact of spraying with potassium (P) and nano-zinc (Z) on diameter of flower (cm) of Gazania

Fresh weight of flower (gm)

According to Figure 7, treatment (P2) had the highest value (1.93 gm), whereas treatment (P0) had the lowest (1.25 gm). However, there was no discernible impact on the characteristic under study from spraying treatments with potassium or nano zinc alone (Table 3).

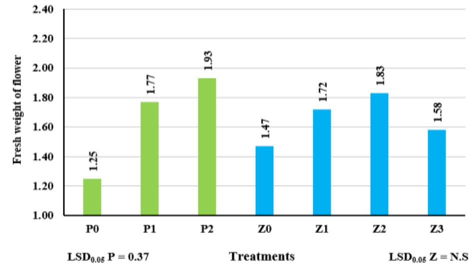

Figure (7). Impact of spraying with potassium (P) and nano-zinc (Z) on fresh weight of flower (gm) of Gazania

The peduncle length of flower (cm)

The results showed that potassium supplementation had a considerable impact on the variations in floral peduncle length (Figure 8). In terms of measurement, the no-spray treatment (P0) had the lowest value at 7.78 cm, while the treatment (P2) had the greatest at 8.53. However, foliar spraying with nano-zinc had a notable impact, particularly in treatments (Z2) and (Z3), which had the lowest value at 7.46 cm and the highest at 8.51 cm and 8.44 cm, respectively, whereas treatment (Z0) had the lowest. Table 3 illustrates the significant two-way interaction between potassium and nano-zinc. The treatment P2Z3 yielded the greatest value at 9.75 cm, while the treatment P0Z0 provided the lowest amount at 7.10 cm.

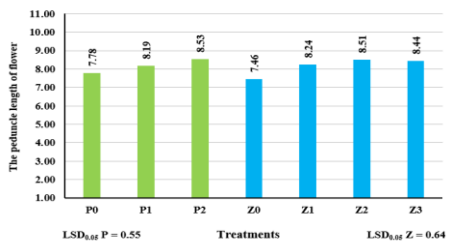

Figure (8). Impact of spraying with potassium (P) and nano-zinc (Z) on the peduncle length of flower (cm) of Gazania

Conclusion

Statistical analysis of the experiment showed that potash and nano-zinc foliar application improved Gazania vegetative and floral traits significantly, with the best results obtained at concentrations of 300 mg L^{-1} for potassium and 40 mg L^{-1} for nano-zinc. Based on these findings, it is recommended to use these concentrations to enhance the quality of Gazania plants with respect to vegetative growth and flowering.

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استجابة نباتات الكزانيا للرش بالبوتاسيوم والزنك النانوي

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قسم البستنة وهندسة الحدائق، كلية الزراعة، جامعة الانبار، الانبار، العراق.

الخلاصة
نفذ البحث في الظلة الخشبية التابعة لقسم البستنة وهندسة الحدائق، كلية الزراعة ، جامعة الانبار خلال موسم النمو 2025 وذلك لمعرفة تأثير الرش بالبوتاسيوم(***P***)) والنانو زنك(***Z***)) على خصائص النمو والإزهار لنباتات الكزانيا والمزروعة في بيئة محمية. تم استخدام عاملين أثناء التجربة: رش البوتاسيوم(***P***)) بثلاثة تراكيز من (0 و 150 و 300 ملغم لتر-1) ونانو الزنك(***Z***)) بأربعة تراكيز (0 و 20 و 40 و 60 ملغم لتر-1). وأشارت النتائج إلى أن رش البوتاسيوم ولا سيما عند التركيز (300 ملغم لتر-1) ساهم في تحقيق أفضل النتائج لجميع صفات النمو الخضري والزهري (ارتفاع النبات، عدد الأوراق، الوزن الجاف للنموات الخضرية، عدد الخلفات، عدد الأزهار، قطر الزهرة، الوزن الطري للزهرة وطول الحامل الزهري) وبلغت (11.24 سم ، 41.27 ورقة نبات-1 ، 7.24 غم ، 7.56 خلفة نبات-1 ، 5.39 زهرة نبات -1 ، 8.35 سم ، 1.93 غم و 8.53 سم) ، على التتابع. بلغ الرش بنانو الزنك مستوى التأثير المعنوي ، لا سيما عند التركيز (40 ملغم لتر-1) ، والذي حقق أعلى القيم للصفات (ارتفاع النبات ، عدد الأوراق ، الوزن الجاف للنمو الخضري ، عدد الينابيع ، عدد الأزهار ، قطر الزهرة، الوزن الطري للزهرة وطول الحامل الزهري) ، وبلغت (11.56 سم ، 40.57 ورقة نبات -1 ، 7.57 غم ، 7.89 خلفة نبات-1 ، 5.34 زهرة نبات-1 1.83 غم ، 8.51 سم و 8.51 سم) ، على التتابع.

الكلمات المفتاحية: ***Gazniaa splendens L***، البوتاسيوم ، الزنك النانوي.