Response of Gazania Plants (Gazania Splendens L.) to Seaweed Extract (Tecamin Algae) and Nano Stimulator (Proteck CalBor)

Ahmed F. Z. Al-Dulaimy¹, Mukhalad H.I. Alani², Ibtihal M. Awad³, Russell I. A. Khudair⁴, Husien A. Salim⁵ and Shawkat M. Jasem⁶

¹-⁶Department of Horticulture and Landscape Gardening, College of Agriculture, University of Anbar, Iraq.

Email: ag.ahmed.fatkhan@uoanbar.edu.iq

Abstract

The study was conducted in the lath house of the Department of the Horticulture and Landscape - College of Agriculture during the growing season of 2020-2021 in Gazania plants, in order to study the effect of ground addition of marine algae extract (Tecamin Algae) at concentrations (0, 2 and 4 ml L⁻¹), symbolized by (A0, A1 and A2) respectively, and spraying with the nanostimulator (Proteck CalBor) manufactured according to nanotechnology in concentrations (0, 0.5 and 1 ml L⁻¹) and it has a symbol (B0, B1 and B2). The results showed that the treatments of adding the extract (Tecamin Algae), especially at concentration A2 (4 ml L⁻¹) contributed to achieving the best results for all vegetative and flowering growth traits (plant height, number of leaves, vegetative dry weight, number of offsprings, leaf content of chlorophyll, total carbohydrates content of leaves, number of flowers, flower fresh weight, flower diameter, flower peduncle length), they were (13.65 cm, 34.64 leaf plant⁻¹, 6.38 g, 7.72 offspring plant⁻¹, 10.94 mg g⁻¹, 7.44%, 5.56 flower plant⁻¹, 2.26 g, 6.08 cm and 9.75 cm), respectively. A Spraying with nano stimulator (Proteck CalBor) achieved significant effect, especially B2 (1 ml L⁻¹) concentration, that gave the highest values for the traits (plant height, vegetative dry weight, number of offspring, leaf content of chlorophyll, total carbohydrates content of leaves, number of flowers, flower fresh weight and flower diameter), they were (13.38 cm, 6.47 g, 7.48 offspring plant⁻¹, 10.61 mg g⁻¹, 7.49%, 5.40 flower plant⁻¹, 2.41 g and 6.40 cm), respectively.

Keywords: Gazaniasplendens L., Seaweed extract, Nanostimulator.

1. Introduction

Ornamental plants are one of the natural elements that have a significant impact on human life, as they play a major role in the psychological, aesthetic, cultural, health and economic conditions [1] Gazania splendens L. belongs to the Composite family. It is a perennial herbaceous plant that blooms in spring and summer. Its height does not exceed 15 cm. It is one of the soil covers. Its flowers open in the day and close in the dark. It is propagated by seeds or offspring produced by the plant and produced as a flowering potted plant or directly planted in the ground [2]. Gazania plants are propagated by seed or division of old plants because they form numerous offspring in the same year and plants are seeded in pots or planted directly in the ground. Despite the efficiency of chemical fertilizers in improving plant growth, it has been scientifically proven that these substances are dangerous to the environment and human health. Therefore, the modern agricultural policy seeks to provide nutrients that improve plant growth and do not harm the environment, and contribute to increasing plant tolerance to unfavourable environmental conditions [3], to achieve these goals, growth stimulants were used in the last period, which may be amino acids, organic acids, plant hormones, plant extracts and biofertilizers. It has proven its efficiency in improving the growth and productivity of various horticultural plants [4]. Organic farming is one of the modern agricultural trends that use natural, organic resources to develop agricultural crops and improve their production away from industrial chemicals that may cause damage to the environment and human health [5]. Marine algae extracts are one of the natural materials that have been widely used recently to improve plant growth, increase their productivity and quality, and to produce crops free of chemical pollutants. It is an important "organic" source, of which approximately (15) million tons annually are used in agricultural fields due to its effectiveness in stimulating plant growth in...
Some chemical and physical properties of soil.

| Texture | Clay | Silt | Sand | SO4+² |
|---------|------|------|------|-------|
| Sandy   | 13.2 | 60.4 | 26.4 | 2.90  |

A two-factors experiment (3 × 3) was carried out according to the randomized complete blocks design (RCBD) with three replications, the experiment included 9 treatments and 5 plants for each experimental unit. Thus, the total number of plants used in the experiment was (135 plants). In the experiment, two factors were used, the first was the addition of marine algae extract Tecamin Algae in concentrations (0, 2 and 4 ml L⁻¹) and the extract consisted of (7% organic matter, 0.1% nitrogen, 0.15% phosphorous P2O5 and 0.25% potassium K2O). The second factor included spraying with the Proteck CalBor nanostimulator, which is manufactured according to nanotechnology, in concentrations (0, 0.5 and 1.0 ml L⁻¹), and the nanostimulator consists of (15% calcium oxide, 0.5% boron and 5% algae extract). The extract was added to the culture medium and the nano-stimulator was sprayed on the plants at the times (20/1, 20/2 and 20/3). In mid-April, the vegetative and flowering growth traits were measured and included (plant height, number of leaves, dry weight of shoots, number of offsprings, chlorophyll content of leaves [16], leaf content of total carbohydrates [17], number of flowers, flower fresh weight, flower diameter, flower peduncle length). The data were statistically analyzed, and the averages were compared using the least significant difference (L.S.D.) test at a probability level of 5% [18], and it was analyzed by the Genstat v12.1 program.

3. Results and Discussion

3.1 Plant height (cm)

The results of Figure (1A) show that the treatments of adding the marine algae extract (Tecamin Algae) reached a significant level in the effect on plant height, especially in treatment (A2), which differed significantly from the two treatments (A0 and A1) and gave the highest value of 13.65 cm. Whereas, treatment (A0) recorded the lowest value of 11.83 cm. On the other hand, spraying with the nano-stimulator Proteck CalBor reached the level of significant effect on the studied trait, especially
treatment (B2), which showed a significant difference from the two treatments (B0 and B1), and achieved the highest height for plants that reached 13.38 cm, while the lowest height reached for plants of the treatment (B0) and reached 12.16 cm. The interaction of the study factors shown in (Table 2) was the same path in the significant effect, especially when the interaction treatment (A2B1), which achieved the highest value of 14.82 cm, while the height of plants reached the lowest rate of 10.53 cm, with the control treatment (A0B0).

### 3.2 Number of leaves per plant (leaf plant⁻¹)

The results of Figure (1B) show that algae extract when added to plants caused a significant increase in the number of leaves, which reached a maximum of 34.64 leaf plant⁻¹ for treatment (A2) and significantly differed from treatment (A0), which gave the lowest value of 29.50 leaf plant⁻¹. The effect of spraying with nano-stimulator reached the level of significance by giving the two treatments (B1 and B2) the highest value, which was 34.61 and 33.17 leaf plant⁻¹, respectively, and they showed a "significant" difference from the non-spray treatment (B0), which gave the lowest value of 28.54 leaf plant⁻¹. The interaction treatments shown in (Table 2) had a "significant" effect, especially the treatment (A2B2), which gave the highest value of 38.47 leaf plant⁻¹. While the lowest average number of leaves (23.35 leaf plant⁻¹) recorded for the control treatment (A0B0).

### 3.3 Vegetative dry weight (g)

The statistical data in Figure (1C) indicates that algae extract significantly affected the vegetative dry weight of the plants, as treatment (A2) significantly outperformed treatment (A0) by giving it the highest value of 6.38 g, while the lowest value was for treatment A0 (5.20 g). Also, spraying plants with nano-stimulator showed a significant effect in the studied trait, through the significant superiority of treatment (B2) over non-spray treatment (B0) and gave the highest value of 6.47 g, whereas, treatment (B0) recorded the lowest value of 5.30 g. The results in (Table 2) showed that the interaction of the study factors reached the level of significance, especially in the treatment (A2B1), which gave the highest vegetative dry weight (6.60 g), while the value decreased to the lowest value of 4.42 g for the control treatment (A0B0).

### 3.4 Number of offsprings (offspring plant⁻¹)

The effect of algae extract significantly on the number of offsprings formed through treatment (A2) was significantly superior to treatment (A0) by giving it the highest value of 7.72 offspring plant⁻¹, while the lowest value (6.55 offspring plant⁻¹) was for the treatment A0 (Figure 1D). Spraying with “Proteck CalBor” achieved a significant effect of treatment (B2) over non-spraying treatment (B0), and it gave the highest value of 7.48 offspring plant⁻¹, while treatment (B0) recorded the lowest value of 6.53 offspring plant⁻¹. The interaction of the study factors showed a significant effect, especially when treatment (A2B1), which gave the highest number of offsprings (Table 2) of 8.41 offspring plant⁻¹, while the value decreased to its lowest value when the control treatment (A0B0) was recorded 6.15 of offspring plant⁻¹.

### 3.5 Leaf content of chlorophyll (mg g⁻¹)

The results of Figure (1E) show that the treatments of adding marine algae extract Tecamin Algae reached a significant level in the effect on the chlorophyll content of leaves, especially when treatment (A2), which differed significantly from treatment (A0) and gave the highest value of 10.94 mg g⁻¹. While treatment (A0) recorded the lowest value of 8.81 mg g⁻¹. On the other hand, spraying with Proteck CalBor reached the level of significant effect in the studied trait, especially treatment (B2), which showed a significant difference from treatment (B0) and achieved the highest value of 10.61 mg g⁻¹, while the lowest value achieved by treatment (B0) and reached 9.15 mg g⁻¹. The interaction of the study factors took the same direction in the significant effect on the studied trait, especially when the interaction treatment (A2B1) achieved the highest value of 11.92 mg g⁻¹, while chlorophyll reached the lowest value with the control treatment (A0B0) and reached 7.38 mg g⁻¹ (Table 2).

### 3.6 Carbohydrates content of leaves (%)

The results of Figure (1F) show that the algae extract when added to Gazania plants caused a significant increase in the carbohydrates content of the leaves, and it reached a maximum of 7.44% for treatment (A2), and it differed significantly from treatment (A0), which gave the lowest value of 6.54%. The effect of spraying with nano-stimulator reached the level of significance as well, by giving treatment (B2) the highest value of 7.49%, and it showed a significant difference from the non-spray treatment (B0), which gave the lowest value of 6.57%. The interaction treatments shown in (Table 2) achieved a significant effect, especially the treatment (A2B2), which gave the highest value of 8.42%, while the lowest carbohydrate content in the leaves reached 6.15% for the control treatment (A0B0).
A0= 0 ml L\(^{-1}\) \quad A1= 2 ml L\(^{-1}\) \quad A2= 4 ml L\(^{-1}\) \quad B0= 0 ml L\(^{-1}\) \quad B1= 0.5 ml L\(^{-1}\) \quad B2= 1 ml L\(^{-1}\)

**Figure 1.** Effect of addition of seaweed extract 'Tecamin Algae' and spraying with the nanostimulator 'Proteck CalBor' on vegetative growth traits of Gazania plants.

### 3.7 Number of flowers (flower plant\(^{-1}\))

The extract treatments showed a significant effect in the number of flowers, especially with treatment (A2), which differed significantly from treatment (A0) and gave the highest value of 5.56 flower plant\(^{-1}\), and achieved an increase of 31.44% over the treatment of (A0), which gave the lowest value of 4.23 flower plant\(^{-1}\) (Fig. 2B). The nano-stimulator spraying treatments had a significant effect, with treatment (B2) outperforming treatment (B0) and giving the highest value of 5.40 flower plant\(^{-1}\), while the number of flowers in treatment (B0) reached the lowest rate of 4.43 flower plant\(^{-1}\). Whereas, the results indicate a significant two-way interaction especially with treatment (A1B2), which gave the highest rate of the number of flowers (6.37 flower plant\(^{-1}\)), compared to the control treatment (A0B0), in which the above trait reached the lowest value of 3.42 flower plant\(^{-1}\) (Table 3).
3.8 Flower Fresh Weight (g)

The results of Figure (2B) show that treatment with marine algae extracts caused a significant increase in the fresh flower weight, and it reached its maximum for treatment (A2) and it reached 2.26 g, and it showed a significant difference from treatment (A0), which gave the lowest value of 1.87 g. The results indicate a significant effect of spraying with nano-stimulator with the highest mean achieved by the treatment (B2) with 2.41 g, and it showed a significant difference from the two treatments (B0 and B1), with the lowest value of 1.84 g for B0 treatment. The interaction treatments, as shown in (Table 3), achieved a significant effect, especially the treatment (A2B2), which gave the highest value of 2.76 g, while the lowest value of 1.64 g for the treatment (A0B0).

Table 2. Effect of addition of seaweed extract ‘Tecamin Algae’ and spraying with the nanostimulator ‘Proteck CalBor’ interaction on vegetative growth traits of Gazania plants.

| Tecamin Algae (ml L⁻¹) | Proteck CalBor (ml L⁻¹) | Plant height (cm) | Leaves number (leaf plant⁻¹) | Vegetative dry matter (g) | Off sprigs number (off spring plant⁻¹) | Total chlorophyll (mg g⁻¹) | Total carbohydrates (%) |
|------------------------|-------------------------|------------------|-----------------------------|--------------------------|----------------------------------------|---------------------------|------------------------|
| 0                      | 0                       | 10.53            | 23.35                       | 4.42                     | 6.15                                   | 7.38                      | 6.15                   |
| 0.5                    |                         | 10.81            | 36.12                       | 4.71                     | 7.18                                   | 7.91                      | 7.20                   |
| 1                      |                         | 14.15            | 29.03                       | 6.48                     | 6.31                                   | 11.15                     | 6.25                   |
| 0                      | 0.5                     | 12.70            | 26.96                       | 5.53                     | 7.04                                   | 9.70                      | 7.24                   |
| 2                      | 0.5                     | 11.08            | 37.58                       | 6.54                     | 6.38                                   | 8.01                      | 6.38                   |
| 1                      |                         | 13.12            | 32.00                       | 6.35                     | 7.79                                   | 10.14                     | 7.79                   |
| 0                      | 0.5                     | 13.26            | 35.31                       | 5.96                     | 6.40                                   | 10.36                     | 6.33                   |
| 4                      | 0.5                     | 14.82            | 30.13                       | 6.60                     | 8.41                                   | 11.92                     | 7.57                   |
| 1                      |                         | 12.87            | 38.47                       | 6.57                     | 8.35                                   | 10.53                     | 8.42                   |
| LSD 5%                 |                         | 1.78             | 6.87                        | 0.97                     | 0.22                                   | 1.83                      | 1.17                   |

3.9 Flower diameter (cm)

The statistical data in Figure (2C) indicates that algae extract had a significant effect on flower diameter, as treatment (A2) significantly outperformed treatment (A0) by giving it the highest value of 6.08 cm, while the lowest value of the studied trait achieved by treatment (A0) with 4.54 cm. The spraying plants with Proteck CalBor nano-stimulator also showed a significant effect in the studied trait, through the significant superiority of treatment (B2) over the two treatments (B0 and B1) and it gave the highest value of 6.40 cm, while treatment (B0) recorded the lowest value of 4.56 cm. The results indicate a significant two-way interaction of the study factors (Table 3), especially in the treatment (A2B2), which gave the highest flower diameter of 7.72 cm, while control treatment (A0B0) achieved the lowest value of 4.12 cm.

3.10 Flower peduncle Length (cm)

The results of Figure (2D) show that the addition of the algae extract Tecamin Algae indicates a significant effect on the length of the flower peduncle, especially in treatment (A2), which differed significantly from treatment (A0) and gave the highest value of 9.75 cm, and thus achieved an increased rate of 16.21% over treatment (A0), which showed the lowest value of 8.39 cm. On the other hand, none of the nano-stimulator spraying treatments and the interaction between the two study factors showed a significant effect on the studied trait (Table 3).
A_0 = 0 \text{ ml L}^{-1} \quad A_1 = 2 \text{ ml L}^{-1} \quad A_2 = 4 \text{ ml L}^{-1} \quad B_0 = 0 \text{ ml L}^{-1} \quad B_1 = 0.5 \text{ ml L}^{-1} \quad B_2 = 1 \text{ ml L}^{-1}

Figure 2. Effect of addition of seaweed extract "Tecamin Algae" and spraying with the nanostimulator "Proteck CalBor" on flowers traits of Gazania plants.

Table 3. Effect of addition of seaweed extract "Tecamin Algae" and spraying with the nanostimulator "Proteck CalBor" interaction on flowers traits of Gazania plants.

| Tecamin Algae (ml L^{-1}) | Proteck CalBor (ml L^{-1}) | Flowers Number (flower plant^{-1}) | Flower fresh weight (g) | Flower diameter (cm) | Flower peduncle length (cm) |
|---------------------------|---------------------------|----------------------------------|------------------------|----------------------|-----------------------------|
| 0                         | 0                         | 3.42                             | 1.64                   | 4.12                 | 7.76                        |
| 0                         | 0.5                       | 4.75                             | 2.20                   | 5.29                 | 8.34                        |
| 0                         | 1                         | 4.53                             | 1.79                   | 4.20                 | 9.07                        |
| 0                         | 0                         | 5.03                             | 1.81                   | 4.94                 | 8.61                        |
| 2                         | 0.5                       | 4.60                             | 2.14                   | 4.57                 | 9.63                        |
| 1                         | 6.21                      | 2.68                             | 7.27                   | 9.47                 |                             |
| 0                         | 4.84                      | 2.08                             | 4.62                   | 9.73                 |                             |
| 4                         | 0.5                       | 6.37                             | 1.92                   | 5.89                 | 9.85                        |
| 1                         | 5.46                      | 2.76                             | 7.72                   | 9.68                 |                             |
| LSD_{0.05}                | 0.89                      | 0.52                             | 1.80                   | N.S                  |                             |

The effect of marine algae extract (Tecamin Algae) in improving the studied traits of growth and flowering may be due to its content of organic matter and major nutrients (N, P and K), as the organic matter contributes to providing raw materials and energy units, which leads to encouraging physiological processes within the plant, which is reflected positively in building new tissues inside plants [19]. The organic matter also improves the physical, chemical and biological properties of the soil, which provides a suitable environment for the growth of plants. As well as increasing the availability of nutrients and numbers of beneficial organisms within the agricultural environment, which has a positive effect on improving the vegetative and flowering growth of plants [20-22]. The content of the algae extract from the mineral elements directly or
indirectly affects the process of fixing carbon dioxide in the green cells of the plant by activating some enzymes related to photosynthesis, this is reflected in one way or another on the growth of the plant and the formation of new cells and tissues. The monosaccharides that are produced directly from the photosynthesis process are the main component of the building material for the various tissues of the plant. Also, the construction of new tissues requires cell division, and this depends mainly on building new nucleic acids and proteins, and these processes require energy units (ATP) produced from the processes of photosynthesis and respiration [23]. Nitrogen contributes to encouraging vegetative growth and strengthening the root system [24], and it is an essential component of the protoplasm of cells after water, with a ratio of (2-4%) of the dry matter of the plant. It is included in the structure of important organic compounds such as amino acids, proteins, nucleic acids (DNA and RNA), enzymes and plant hormones [25]. It is also an "essential" part of the formation of the green pigment for the photosynthesis process represented by chlorophyll and giving the green colour to the plant, as nitrogen has a direct role in building this pigment due to its participation in the synthesis of the porphyrins units that are included in its composition, and that 70% of leaf nitrogen is included in the composition of chlorophyll pigments [26], it also contributes to the formation of energy-transfer compounds such as ATP, which encourages the vital processes that take place inside the plant [27], as trees that suffer from severe nitrogen deficiency are small in size, poor in growth and low in yield [28]. Nitrogen also contributes to stimulating plants to produce auxin, which encourages the process of cell division and cell elongation [29]. Phosphorous also plays important role in the synthesis of carbohydrates and helps in the formation of amino acids and important proteins in building this pigment. Phosphorous also has an important role in encouraging the growth of meristematic tissues and assisting in the division of living cells and the process of photosynthesis and the transfer of materials resulting from this process and the activation of enzyme systems [30]. As well as its role in the formation of energy-rich compounds that the plant needs in the formation of other compounds such as carbohydrates, phospholipids and enzymatic conjugates, which contribute to the activation of vital activities, which leads to an increase in the vegetative growth of plants [31], which is reflected positively on the flowering of plants. As for potassium, it plays an important role in regulating the mechanism of opening and closing stomata, reducing nitrate within the plant, stimulating cell division and growth, increasing the formation of cellulose and lignin, and aiding in the transfer of starch and sugars between plant parts, as well as its role in the growth and development of new tissue cells [32]. It causes low osmosis in the cell vacuole, which enables it to draw water and then increase the rate of leaf expansion, that is, increase the surface area of the leaves [33]. Potassium also contributes to the activation of various physiological processes, including the manufacture of chlorophyll, and then the production of large quantities of carbohydrates, which stimulate all manifestations of vegetative growth and flowering of plants [26]. Potassium also acts as a transporter of carbohydrates from the manufacturing areas in the leaf (Source) to the fruits (Sink), which increases the osmotic effort inside the cells, thus moving large quantities of water into the cells and increasing their size [34]. The algae extract also contains plant hormones, especially auxins and cytokinins, which stimulate cell division and elongation [35,36].

The role played by Proteck CalBor in improving the traits of the study, except for the length of the flower peduncle, was attributed to the small size of the fertilizer nanoparticles and its manufacturing technology, which allows it to penetrate and spread rapidly within the plant tissues, which leads to stimulating the action of hormones inside the plant, which encourages the growth of secondary roots, which is reflected positively on plant growth and production [37], also, when these substances enter the plant and bind to protein carriers such as Aquaporin, Endocytosis, and Ion channels, they lead to the formation of new openings that penetrate into the covers or cell walls, which causes stimulating the plant to absorb water and, as a consequence, increases the growth and yield of the plant. Marine algae extracts, which contain many nutrients such as vitamins and amino acids, have a wide range of effects on the biological activities of plants [30]. As well as containing plant hormones, especially auxins and cytokinins, which have an effective role in increasing growth and stimulating plant height and lateral branching [38]. Cytokinins play a major role in stimulating chlorophyll biosynthesis in mature tissues, regulating nutrient distribution, opening stomata, and delaying leaf ageing [39,40]. The extract also contains the essential nutrients for growth, which all affect the improvement of the vegetative and flowering traits of plants. The nanostimulator also contains the element boron, which plays a key role in the formation of cell walls and works to facilitate the movement and transfer of photosynthetic products from the leaves to the active areas in the plant, such as the transfer of sugars in the plant, as the sugar moves easily through the cell membranes after its union with boron, which is necessary for cell divisions, and phloem formation, and the transmission of some stimulant hormones, and controls the speed of plant water absorption, and its presence increases plants’ resistance to drought, and it has a great relationship with plant hormones that affect the growth of the apical cells of stems and roots [41-43]. In addition, the entry of calcium as one of the components of the nanostimulator has a major role in the formation of cell walls, especially in the formation of the middle lamina. As pectic acid reacts with calcium to form insoluble calcium pectate, and calcium pectate with magnesium pectate works to stick cellulose chains to each other during the formation of cell walls, and therefore it contributes to the hardness of plant tissues and increase their ability to withstand adverse weather conditions such as high temperature and frost, as well as sudden exposure to drought or lack of water in the soil and also tolerate to some bacterial and fungal diseases. Calcium also has a role in the formation of cell membranes, as the calcium salt of the fatty substance Lechitin is included in the composition of the cell membrane, it is also believed that calcium is important in the processes of cell division and elongation and is necessary for the continuation of
the growth of the Apical meristems responsible for new growth, and it may have a role in the formation of the spindle and in the installation and stability of the chromosome. As well as its role as an activator of some enzymes. Calcium also appears to be necessary in reducing the occurrence of flower and fruit separation after the fruit set, as well as helps to speed the transport of carbohydrates and amino acids and contributes to building plant proteins by increasing the nitrate absorbed by plants when adding nitrate-containing fertilizers, it was found that some plants cannot absorb nitrates in the absence of calcium because they are unable to reduce nitrates to ammonia in their tissues. Calcium also neutralizes and precipitates organic acids that are produced in plant cells in the form of calcium oxalate, thus preventing damage arising from an increase in the concentration of these acids. It also plays an important role in neutralizing the toxic effect of salinity in soil on plants[44-48].

Conclusions

We conclude from the results of the study that the addition of algae extract (Tecamin Algae) and nanostimulator (Proteck CalBor) is an effective way Gazania plants nutrition, as both fertilizers, contributed to improving the vegetative growth traits of Gazania plants, which reflected positively on the flowering traits of those plants. Therefore, we recommend the use of these two fertilizers as an effective way to stimulate the growth and flowering of Gazania plants, as well as to reduce pollution due to the use of chemical fertilizers.

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