Effect of Seaweed Extract and Micronutrients Mixture on some Growth Characters and Flowering of Dianthus chinensis L. and Gazania splender L. Plants

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Abstract. An experiment was conducted on Chinese carnation Dianthus chinesis L. and gazania Gazania splender L. to study the effect of spray seaweed extract (seaweed Fe) and micronutrients mixture at concentrations of 0, 1, and 2 ml. L\textsuperscript{1} for each, in addition to their combination, on some growth characters of the two ornamental plants. Plants were sprayed three times. Treatments were layout in factorial experiment (3x3) in completely randomized design with three replicates. Results showed that the use of the two materials at both concentrations caused significant increase in Chinese carnation plant height. Leaf number increased significantly at 2ml.L\textsuperscript{-1} of micronutrients mixture on Chinese carnation. In gazania, there was a pronounced increase in leaf number with the increase of the concentration of seaweed extract. Sea weed extract had no effect on percent dry weight while the percent increased significantly at both concentrations on Chinese carnation. Chlorophyll content increased due to the use of the highest concentration of both materials on both plants. Number of flowers per plan also increased as a result of the spray of both materials. Length of flower stalk and flower diameter was affected significantly by all the treatments, while flower fresh and dry weight did not affect by the treatments. Nitrogen percent in leaves of Chinese carnation increased significantly due to the use of the two materials, but in gazania the percent increased due to the use of the two concentrations of seaweed extract while the micronutrients had no effect. For carbohydrate content, there was a pronounced increase in leaves of both plants especially at the higher concentration of both materials. It was noted that all combination treatments had significant effect on all parameters measured.

Key words: Chinese carnation, gazania, seaweed extract, micronutrients, plant height, carbohydrate content, nitrogen percent.

1. Introduction

Dianthus genius belongs to Caryophyllus family which consists of 89 genera and 2100 species. This genius includes 300 species which grow in Europe, Asia and central Africa (Anon, 2002). The Chinese carnation (Dianthus chinesis) is one of Dianthus genius, originating from china and it was known there for more than 3000 years as a medical herb. The plant possesses highly branched stems, which collectively reached as high as 40 cm (Bown, 1995; Simon et al., 2012). The plant grows well in fertile, good permeability, and neutral acid soil, as well as in sunny or partial shaded places (Brown, 2011; Thompson, 2013). Flowers of the plant initiate on multiple stems, as one
flower per stem, and rarely as two or three flowers per stem. Flowers have different colors such as red, pink, white or in some cases a single flower may hold two different colors (Mahgoub et al., 2015).

Gazania (Gazania splenders L.) belongs to the compositae family and can be described as perennial grass grow in spring and summer. Plant height may not exceed 15 cm. Flowers open at day time and close at night (Salih and Sufian, 2016). Plant possess long, stripy leaves with silver color at the lower surface of the leaf and they lobbed at the beginning of development. Flowers appear with different colors, 7-10 cm in diameter and there were black spots at the base of radial florets which appear at summer and autumn seasons (Mahmoud and Sami, 1989). Plant propagates by seeds or by partitioning of old plants. Plants introduce as flowering pots or they may cultivate directly in soil (Al-Sultan et al., 1992).

Sea weed extract, which can be produced as a powder or liquid of grass or sea algae, is considered as a natural source of phytohormones, organic materials, macro and micronutrients, in addition to vitamins which act together to improve plant growth and productivity (Colapietra and Alexander, 2006; Dawczynski et al., 2007). In Amaranthus tricolor L., it was found that spray the vegetative part of plant with two concentrations of seaweed; 2.5 and 3 ml. L\(^{-1}\)caused significant increase in plant height, root length, number of branches in addition to the fresh and dry weight of shoot and root (Abdel-Aziz et al., 2011). Same results were obtained by Sridhar and Rengasamy (2010) when they treated Tagetes erecta L. with seaweed extract at 0.25, 0.5, 1.0 or 1.5% after 30 days of germination.

It is known that micronutrients play vital role in improving plant growth. Alexe and Amriutei (1998) have mentioned that spray gerbera plant with some micronutrients (Fe, Zn, Mn) increased plant height, number of flowers, flower stalk and flower diameter. Also, Salih and Sufian (2016) found that spraying gazania with Fe caused an increase in some vegetative growth parameters such as number of leaves, fresh and dry weight, total chlorophyll in addition to increase number, diameter and fresh weight of flowers. El-Naggar and El-Sayed (2008) had treated sweet pepper cv. Red Sim with foliar nutrient solution consisting a combination of some macro- and micronutrients, including boron at 6%, and they found that the treatment reduced the days required for flowering and increase number and flower diameter in compare to control treatment. Therefore, the present experiment was aimed to test the effect of the spray with seaweed extract and a mixture of some micronutrients on some growth and flowering characters of Chinese carnation (Dianthus chinensis) and gazania (Gazania splender).

2. Material and Methods

The current experiment was conducted on Chinese carnation Dianthus chinensis and gazania Gazania splender L. grown under the condition of lath house belongs to college of agriculture/Al-Qadisiyah University during the period from 30/11/2016 to 20/4/2017. The experiment aimed to study the effect of spray with Seaweed Fe [contains seaweed extract at a concentration of 200 mg.L\(^{-1}\), amino acids at a concentration of 100 mg.L\(^{-1}\) and chelated iron Fe(EDTA) at a concentration of 60 mg.L\(^{-1}\)] at three concentrations; 0, 1, and 2 ml.L\(^{-1}\) and a mixture of micronutrients (a solution of foliar fertilizer contains iron 0.4%, zinc 0.3%, magnesium 0.2%, copper 0.08%, manganese 0.045%, boron 0.045% and molydbdenum 0.08%) at concentrations of 0, 1, and 2 ml.L\(^{-1}\) and their combination on vegetative and flowering characters of the two plants.

Seedlings of two months old were translated to pots contain a mixture of loamy soil contains peat moss (30% v:v) on 30/11/2016 for Chinese carnation and on 2/1/2017 for gazania. The first spray with seaweed extract and micronutrients mixture was done on 20/2/2017 with one day interval between the spray with the seaweed and the micronutrients. Control plants were sprayed with distilled water only. The spray was done early in the morning and drops of detergent was added to the spray solution as a spray agent. Spray was made three times during the experiment with two weeks between each spray.
Barriers were put between plants during spray to avoid the transfer of the spray mist to other plants. Plants were grown under the lath house condition in college of Agriculture/ Al-Qadisiyah University and they irrigated as needed. All other agricultural processes were performed according to normal practice for the two plants.

Treatments were laid out in factorial experiment (3x3) in completely randomized design with three replicates. At the end of the experiment, several parameters were measured such as: plant height, number of leaves, chlorophyll content (Saric et al., 1967), number of flowers per plant, flower stalk length, flower diameter, and fresh and dry weight of flower. Also, total carbohydrates (mg. g⁻¹ dry weight) were determined according to the method of Dubois et al., (1956). Nitrogen percent was measured by the method of Jackson, (1958). Data were statistically analyzed using analysis of variance table and treatments means were compared using LSD at 0.05 level.

3. Results and discussion

The use of seaweed extract or micronutrients at both concentrations caused significant increase in plant height of Chinese carnation although the two concentrations of both materials did not differ from each other in their effect (Table 1). For the interaction between seaweed extract and micronutrients mixture, there was a pronounced increase in plant height at the combination treatment of the highest concentration of seaweed extract and both concentrations of micronutrients, and the combination treatment of seaweed extract at 1 ml.L⁻¹ and the highest concentration of micronutrient (32 cm).

Table 1. Effect of seaweed extract (A) and micronutrients mixture (B) and their combination on plant height, number of leaves per plant, percent dry weight and total chlorophyll of Chinese carnation.

| Treatment                      | Plant Height (cm) | No. Leaf. Plant⁻¹ | Plant Dry Weight (%) | Total Chlorophyll (mg.100g⁻¹ FW) |
|--------------------------------|-------------------|-------------------|----------------------|----------------------------------|
| Conc. of Seaweed               | 23.33             | 180.00            | 21.23                | 16.80                            |
| Extract (ml. L⁻¹) (A)          | 29.33             | 168.33            | 22.70                | 15.76                            |
| 1.00                           | 29.66             | 173.66            | 23.10                | 18.43                            |
| 2.00                           | 3.35              | 4.55              | NS                   | 1.45                             |
| LSD 0.05                       |                   |                   |                      |                                  |
| Conc. of Micronutrients mixture| 24.66             | 148.33            | 19.40                | 14.03                            |
| (ml. L⁻¹) (B)                  | 28.66             | 181.00            | 23.23                | 17.63                            |
| 2.00                           | 29.33             | 192.66            | 24.46                | 19.33                            |
| LSD 0.05                       | 2.27              | 6.60              | 2.15                 | 2.00                             |
| A x B                          |                   |                   |                      |                                  |
| 0.00                           | 22.00             | 140.00            | 18.10                | 13.70                            |
| 1.00                           | 24.00             | 200.00            | 22.70                | 17.20                            |
| Conc. A x B                    | 24.00             | 200.00            | 22.90                | 19.50                            |
| 0.00                           | 27.00             | 148.00            | 20.00                | 13.00                            |
| 1.00                           | 29.00             | 168.00            | 23.50                | 15.50                            |
| 2.00                           | 32.00             | 189.00            | 24.80                | 18.81                            |
| 0.00                           | 25.00             | 157.00            | 20.10                | 15.40                            |
| 2.00                           | 32.00             | 175.00            | 23.50                | 20.20                            |
| 2.00                           | 32.00             | 189.00            | 23.50                | 19.70                            |
| LSD 0.05                       | 7.00              | 10.55             | 2.35                 | 2.50                             |

Leaf number of Chinese carnation plant was affected negatively by seaweed extract treatments and positively by micronutrients mixture. In gazania (Table 3), there was a pronounced increase in leaf number with the increase of the concentration of seaweed extract, the number achieved 41 leaf. plant⁻¹ at 2 ml. L⁻¹ in compare to 26 leaf. plant⁻¹ for control. Some of the combination between the two factors had significant positive effect on leaf number of the two plants especially the combination treatment of 0 ml.L⁻¹ of seaweed and both concentrations of micronutrients for Chinese carnation, and the combination treatment of 2 ml.L⁻¹ of seaweed along with 0 or 1 ml.L⁻¹ of micronutrients for gazania plant (Table 3).
With regard to percent dry weight of Chinese carnation (Table 1), sea weed extract had no effect while micronutrients mixture at both concentrations increased dry weight significantly. The highest percent was at 2ml.L\(^{-1}\) of the micronutrients. For the interaction, the highest percent was achieved (24.8\%) using the combination of 1 ml.L\(^{-1}\) of seaweed extract and 2ml.L\(^{-1}\) of micronutrients while the control treatment resulted in the lowest percent (18.1\%). Results in table (3) showed that dry weight of gazania did not affect by the spray with the seaweed extract but it increased by the spray with micronutrients.

The noted promoted effect of growth due to the use of seaweed extract may be due to its content of some phytohormones, organic compounds and some macro and micronutrients at different concentration which collectively improve vegetative growth (Colapietra and Alexander, 2006; Dawczynski et al., 2007). Some investigators have mentioned the importance of seaweed extract in improving plant growth through the enhancement of the absorption of nutrients from soil (Verkleij, 1992; Turan and Kose, 2004). The current result comes in agreement with the results of Sridhar and Rengasamy (2010) when they treated Tagetes erecta L. with seaweed extract and results of Ibrahim (2015) who found that spray Calendula plant with sea weed extract at 3 g.L\(^{-1}\) caused significant increase in plant height and number of leaves and he attributed that effect to its content of organic compounds and minerals required to activate the biochemical processes and in turn increase plant vegetative growth. Also, the positive role of spray with micronutrients may be due to the effect on number of biological activities of plant through their involvement as a component

| Treatment | No. Flowers Plant\(^1\) | Length of flower stalk (cm) | Nitrogen (%) | Carbohydrates content (mg.g\(^{-1}\) DW) |
|-----------|------------------------|-----------------------------|--------------|--------------------------------------|
| 0.00      | 48.00                  | 16.00                       | 2.90         | 7.64                                 |
| 1.00      | 50.00                  | 15.66                       | 3.13         | 8.78                                 |
| 2.00      | 50.33                  | 17.66                       | 3.49         | 9.50                                 |
| LSD 0.05  |                        |                             |              |                                      |
| Concent. of Seaweed Extract (ml. L\(^{-1}\)) (A) | 2.15 | 1.10 | 0.10 | 0.85 |
| Conc. of Micronutrients mixture (ml. L\(^{-1}\)) (B) | 43.33 | 15.00 | 3.03 | 7.76 |
| 1.00      | 51.66                  | 15.66                       | 3.18         | 8.78                                 |
| 2.00      | 56.66                  | 18.66                       | 3.25         | 9.39                                 |
| LSD 0.05  |                        |                             |              |                                      |

A B

| A x B | Treatment | No. leaf Plant\(^1\) | Plant Dry Weight (%) | Chlorophyll (mg.100g Fw) |
|-------|-----------|----------------------|----------------------|-------------------------|
| 0.00  | 1.00      | 14.00                | 2.75                 | 6.05                    |
| 1.00  | 1.00      | 16.00                | 2.95                 | 8.08                    |
| 2.00  | 2.00      | 18.00                | 3.00                 | 8.80                    |
| 0.00  | 1.00      | 15.00                | 3.15                 | 8.09                    |
| 1.00  | 1.00      | 15.00                | 3.25                 | 8.10                    |
| 2.00  | 2.00      | 16.00                | 3.45                 | 10.18                   |
| 0.00  | 1.00      | 16.00                | 3.55                 | 9.20                    |
| 2.00  | 2.00      | 17.00                | 3.75                 | 10.18                   |
| LSD 0.05 | 3.99 | 2.65 | 0.18 | 1.05 |
of some important biological molecules in plant cell, their role in activation of some enzymes or their role as cofactors to accelerate some chemical reactions in plant cell. Hassan (2012), stated that spray *Adhatoda vasica* with nitrogen in combination with iron at a concentration of 100 mg. L\(^{-1}\) increased plant height, leaf number, number of branches and chlorophyll content. Also, Khattab and Wasfi, (1988) found that the addition of boron in the form of boric acid 17% at a concentration of 30-150 mg.L\(^{-1}\) and manganese in the form of EDTA-Mn 12% at a concentration of 75-375 mg.L\(^{-1}\) and zinc in the form of EDTA-Zn 14% at a concentration of 45-225 mg.L\(^{-1}\) caused a pronounced increase in parameters of vegetative, flowering and tuber production of Dahlia cv. Moon light sonata. In addition, the promoted effect of the micronutrients in increasing the percent dry weight is agreed with the results of Al-Mousy (2010) on *Foeniculum vulgare* and Khattab and Wasfi (1988) on dahlia plant.

Chlorophyll content increased significantly due to the use of the highest concentration of both materials on both plants (Table 1 and 3). For the effect of the interaction between the two factors, the highest value of chlorophyll content (20.20 mg. g\(^{-1}\) FW) for Chinese carnation was recorded at the combination treatment of seaweed extract at 2ml.L\(^{-1}\) and micronutrients at 1ml.L\(^{-1}\). For gazania, the highest chlorophyll content (20.10 mg. g\(^{-1}\) FW) was obtained at the combination contains seaweed extract and micronutrients at their highest concentration. The lowest values of chlorophyll content were in control of both plants. Sea weed extract used her contains some of macro and micro elements including nitrogen and iron. Nitrogen is known to increase chlorophyll content as it is part of chlorophyll molecule (Abbas et al., 2013). Foliar application of sea weed extract that contains ferrous facilitate the entry of Fe instantly to plant tissue, especially that Fe is known as essential for chlorophyll biosynthesis in addition to its involvement in the activity of some enzymes which means offer energy required for cell division and elongation and in turn enhancement of plant growth (Jones, 1991).

With regard to number of flowers per plant, tables 2 and 4 clearly showed that the number was significantly affected by the treatments of both materials especially in gazania plant. This positive effect may be attributed to the enhancement role of seaweed extract which consists of several components, vitamins and macronutrients such as NPK in addition to micronutrients which improve plant vegetative growth and in turn increased flower number and this agrees with the results of Al-Dullamy (2005) on dianthus. For the interaction between the two factors, the highest number of flowers was obtained at the combination treatment consists of the highest concentration of both materials in Chinese carnation and at the combination treatment consists of 1 and 2ml.L\(^{-1}\) of seaweed extract and 2 ml.L\(^{-1}\) of micronutrients mixture in gazania. Abbas and Ali., (2013) attributed the noticed increase in some flower characters of *Dianthus* to the increase in vegetative characters such as leaf number, chlorophyll content and then in photosynthesis efficiency and metabolism and translocation

| Conc. of Micronutrients mixture (ml. L\(^{-1}\)) | 0.00 | 1.00 | 2.00 | LSD 0.05 |
|-----------------------------------------------|------|------|------|----------|
| A                                             | 0.00 | 1.00 | 2.00 | 2.95     |
| B                                             | 2.50 | 3.50 | 2.25 | 1.20     |
| A x B                                         | 13.00| 16.00| 16.00| 3.25     |
| LSD 0.05                                      | 2.65 | 3.25 | 1.35 | 1.00     |

| Conc. of Micronutrients mixture (ml. L\(^{-1}\)) | 0.00 | 1.00 |
|-----------------------------------------------|------|------|
| A                                             | 0.00 | 1.00 |
| B                                             | 2.00 | 3.00 |
| A x B                                         | 2.25 | 2.00 |
| LSD 0.05                                      | 2.00 | 3.00 |
of foods from leaves to flowers which is reflected in flower number and other flower characters. This results agreed with results of Jeffecoat (1977) on dianthus.

Table 4. Effect of seaweed extract (A) and micronutrients mixture (B) and their combination on number of flowers per plant, length of flower stalk, flower diameter, and fresh and dry weight of flower of gazania.

| Treatment                        | No. flower Plant$^{-1}$ | Length of flower stalk (cm) | Flower diameter (cm) | Flower fresh weight | Flower Dry weight |
|----------------------------------|--------------------------|----------------------------|----------------------|---------------------|------------------|
| Conc. of Seaweed Extract (ml. L$^{-1}$) (A) | 0.00 3.66 19.73 8.80 2.44 0.705 | 1.00 4.66 21.10 8.95 2.46 0.768 | 2.00 6.00 20.96 9.40 2.03 0.681 |
| LSD 0.05                         | 0.45 NS 0.20 NS NS        | 1.00 4.66 21.43 8.96 2.43 0.777 |
| Conc. of Micronutrients mixture (ml. L$^{-1}$) (B) | 0.00 4.00 19.73 8.76 2.41 0.633 | 2.00 5.66 20.63 9.40 2.10 0.743 |
| LSD 0.05                         | 0.50 1.0 0.25 NS NS       | 0.743 |
| A x B                            |                          |                            |                      |                     |
| A                                | 0.00 3.00 18.2 8.30 2.73 0.665  |
| 1.00 4.00 20.4 8.50 2.71 0.760  |
| 2.00 4.00 20.6 7.50 2.39 0.690  |
| Conc.                            | 0.00 4.00 19.4 8.40 3.40 0.780 |
| A x B                            | 0.00 4.00 22.6 8.25 2.17 0.663 |
| 1.00 4.00 21.3 8.25 1.83 0.861  |
| 2.00 5.00 21.6 7.00 1.44 0.455  |
| 2.00 7.00 20.0 8.00 2.24 0.680  |
| LSD 0.05                         | 0.70 1.25 0.40 0.35 0.056  | 0.910 |

For the flower stalk, it was clear that the highest concentration of both seaweed extract and micronutrients caused significant increase in flower stalk of Chinese carnation (Table 2), while in gazania, the highest flower stalk was achieved at 1ml.L$^{-1}$ of both materials (Table 4). In addition, the combination treatments of 2 ml.L$^{-1}$ of seaweed extract and 2 ml.L$^{-1}$ of micronutrients recorded the highest (21cm) flower stalk in Chinese carnation, while in gazania, the highest flower stalk (22.6 cm) was recorded at the combination of 1ml.L$^{-1}$ of seaweed extract and 1ml.L$^{-1}$ of micronutrients. Measurements of flower fresh and dry weight of gazania plant showed that either seaweed extract nor micronutrients mixture used had any significant effect on these parameters. Flower diameter increased significantly at the highest concentration of both materials. Combination treatments had different effects on the parameters studied.

Use of sea weed extract or micronutrients mixture caused significant increase in nitrogen percent in leaves of Chinese carnation (Table 2). Also, nitrogen percent increased significantly in leaves of gazania using the two concentrations of seaweed extract while the micronutrients had no effect (Table 5). This increase in nitrogen

Table 5. Effect of seaweed extract (A) and micronutrients mixture (B) and their combination nitrogen percent and carbohydrate content of gazania leaves.

| Treatment                        | Nitrogen (%) | Carbohydrate (mg.g$^{-1}$ DW) |
|----------------------------------|--------------|-------------------------------|
| Conc. of Seaweed Extract (ml. L$^{-1}$) (A) | 0.00 3.16 5.47  |
| 1.00 3.60 6.84  |
| 2.00 3.68 7.88  |
| LSD 0.05                         | 0.24 1.04    | 3.42 4.48                     |
| Conc. of Micronutrients mixture (ml. L$^{-1}$) (B) | 0.00 3.42 4.48  |
| 1.00 3.42 7.51  |
| 2.00 3.60 8.21  |
| LSD 0.05                         | NS 1.10      | 3.42 4.48                     |
| A                                |              | 1.04                           |
| B                                |              | 3.42 4.48                      |
content is expected due to the use of sea weed extract as a source of some macronutrients and organic compounds. For the combination treatments, highest nitrogen percent (3.75%) in Chinese carnation leaves was recorded at the treatments consist of 2ml.L\(^{-1}\) seaweed extract and 2L\(^{-1}\) micronutrients mixture and the lowest percent was in control treatment. In gazania, the combination treatment of 2ml.L\(^{-1}\) seaweed extract and 2ml.L\(^{-1}\) micronutrients mixture gave the highest nitrogen percent (3.85%) while combination treatment of 0ml.L\(^{-1}\) of seaweed extract along with 1ml.L\(^{-1}\) of micronutrients recorded the lowest percent (3.10%).

For carbohydrate content, seaweed extract and micronutrients treatments caused pronounced increase in the content in both plants especially at the highest concentration of both materials. The highest content of carbohydrate was 9.5 mg.g\(^{-1}\) DW for Chinese carnation and 7.88 mg.g\(^{-1}\) DW for gazania which was obtained at the 2ml.L\(^{-1}\) of seaweed extract. The increase in carbohydrates content may be due to the increase in efficiency of photosynthetic process due to increase in vegetative growth, which led to increase assimilation of leaf CO2 (Kandil et al., 2011). In addition, sea weed extract contains nitrogen and other macronutrients such as potassium which is known to play role in activating some enzymes and the accumulation of carbohydrate and in turn increases carbohydrate leaf content. This result agrees with result of Abbas et al., (2013) on gazania and (Azza et al., 2014) on Schefflera arboricola plants. In addition, it was noticed that the combination treatment of seaweed extract at 1 and 2ml.L\(^{-1}\) and micronutrient at 1ml.L\(^{-1}\) resulted in highest carbohydrate content in Chinese carnation leaves while the lower content was at control treatment. In gazania leaves, the highest carbohydrate content (10.25 mg.g\(^{-1}\)DW) was obtained at the combination treatment of both materials at their highest concentration.

It is obvious from these results that both seaweed extract and microelements mixture had clear effect on the parameters studied as they significantly increase plant height and number of leaves of Chinese carnation and gazania in addition to increase leaf content of chlorophyll and number and leaf stalk of flowers. However, the two materials did not have any effect on fresh and dry weight. All combination treatments recorded significant effects also.

4. References

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