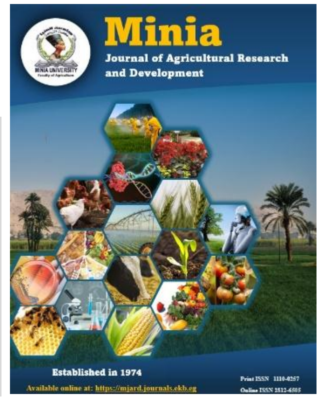
Minia J. of Agric. Res. & Develop., Minia Univ., Vol. 45 (4): 531 - 547, 2025

Minia Journal of Agricultural Research and Development

Journal homepage & Available online at:

https://mjard.journals.ekb.eg




# Effect of humic acid, seaweed extract and active dry yeast in *Calendula officinalis* plants

**Mohamed M. A-H.[1*], Rashwan A. A.[2], Elamen T.A. [3], Ramadan H.A.A. [2]**

[1]Deptartment of Horticulture, Faculty of Agriculture, Minia University,
[2] Department of Vegetable plants, Fac of Agric, south valley Univ.,
[3] Department of Genetics, Fac of Agric, South Valley Univ.

**Received: 13 July 2025 Accepted: 20 July 2025**

## ABSTRACT

*Calendula officinalis* is an annual herbaceous ornamental and medicinal plants were treated with humic HA at (0, 3 and 6 g/l), seaweed extract (SWE) or active dry yeast (ADY) each at (0, 1 and 2 g/l). Investigated factors significantly increased plant fresh and dry as well as flower fresh and dry weights with significant interactions between them. However, the control plants had significantly the lowest dry weight Moreover, the highest value (78.60 g/plant) being for 2g/l of SWE + 6 g/l HA treatment. The lowest flower fresh yield being for non-treated plants however, these treated with 3 or 6 g/l HA + 2 g/l of SWE or ADY had the highest yield (494.5 to 512.0 g/plant). Non-treated plants had the lowest yield of flower dry weights 52.17 g/plant. Whereas these treated with 3 g/l HA + 2 g/l of SWE or ADY had the highest yield (141.35 and 135.72 g/plant respectively). Non-treated plants had the lowest chlorophyll content 38.44. However, the highest value was for plants treated with 3 g/l HA + 1g/l SWE. The plant content of NPK was significantly increased due to HA treatment as well as SWE/ADY application with a significant interaction between them. Generally, there was no significant difference between 3 and 6 g/l of HA and plants treated with (3 g/l of HA + 2g/l of SWE or ADY) and (6 g/l of HA + 1g/l of SWE or ADY) had the highest content of these elements. Therefore, it is recommended to treat marigold plants with 3 g/l HA + 2 g/l of SWE or ADY to achieve the highest yield of flower fresh and dry weights.

**Keywords:** Pot marigold, Seaweed extract, active dry yeast

* Corresponding author: Mohamed M. A-H.
E-mail address: mmahmohamed@gmail.com

## INTRODUCTION

*Calendula officinalis* L., commonly known as pot marigold, is an annual herbaceous plant belonging to the Asteraceae family. It is widely cultivated for its ornamental value, medicinal properties, and industrial uses. Native to the Mediterranean region, pot marigold has spread globally and is commonly grown in gardens and landscapes for its attractive orange to yellow flowers and long blooming period **(Zolfaghari *et al.*, 2013).** This species is renowned for its phytochemical richness, particularly in flavonoids, carotenoids, triterpenoids, and essential oils, which contribute to its use in cosmetics, pharmaceuticals, and traditional medicine for anti-inflammatory, antimicrobial, and wound-healing applications **(Barbour *et al*., 2004, Preethi *et al.*, 2006 and Danielski *et al.*, 2007).**

Recently the agricultural production sector faced numerous serious challenges to feed the world's population. However, reducing the bad impact of pesticides and fertilizers on environmental ecosystems and human health should be considered. Furthermore, plant biostimulants are considered as the most promising innovations makes agricultural systems moving toward more economic, sustainable and environmentally friendly cultivation practices **(du Jardin, 2015 and Zulfiqar *et al.*, 2020)**.

Plant biostimulants are natural substances or microorganisms that enhance plant growth, productivity, and resilience to stress without acting as traditional fertilizers. Among the most studied biostimulants are humic acid (HA), seaweed extracts (SWE), and active dry yeast (ADY), each playing a unique role in promoting plant health. Humic acid, derived from the decomposition of organic matter, is known to improve nutrient uptake, root architecture, and soil microbial activity **(Canellas and Olivares, 2014).** Also, it enhances plant metabolism and stimulates hormonal activity, particularly auxins, leading to increased biomass production. Seaweed extracts, especially those from brown algae, are rich in bioactive compounds such as cytokinins, auxins, betaines, and micronutrients. Even at minimal doses SWE might activate various physiological and phytochemical reactions which finally cause growth and flowering improvements including quality. These compounds contribute to enhanced chlorophyll synthesis, delayed senescence, and improved tolerance to abiotic stress **(Khan *et al*., 2009).** Active dry yeast serves as a rich source of amino acids, vitamins, and growth regulators, especially cytokinins. Its foliar application has been shown to improve photosynthetic efficiency, flowering, and accumulation of sugars and pigments **(Brown and Saa, 2015 and Mannino *et al*., 2020)**. However, these plant biostimulants have become a very important agricultural input all over the world. They are communally used in many ornamental and medicinal plants, to support their growth and attain commercial standards **(Parrado *et al*., 2008 and Kisvarga *et al.*, 2022).** The investigation aimed to improve the growth and flower production of pot marigold plants by using some biostimulants**.**

## MATERIAL AND METHODS

A randomized complete block design using a split plot arrangement experiment with three replicates **(Clewer and Scarisbrick, 2001)** was conducted during the two seasons 2020/2021 and 2021/2022.The physical and chemical properties of the experimental soil are shown in Table 1 (**Black *et al.*, 1981).** Seeds were sown on 1$^{st}$ of Oct. then seedlings of *C.*

*officinalis*, 30-day old were transplanted in rows with 60 cm distance between them and 40 cm between the seedlings within the row.

**Table 1: Physical and chemical analysis of experimental soils**

| Coarse sand % | Fine sand % | Silt % | Clay % | PH | EC (dSm) | organic matter % |
|---|---|---|---|---|---|---|
| 73.7 | 16.8 | 5.8 | 3.7 | 8.17 | 0.44 | 0.89 |
| **Na Ppm** | **K ppm** | **Ca ppm** | **Mg ppm** | **Cl ppm** | **SO4 ppm** | **$CaCO_3$ ppm** |
| 20.03 | 10.38 | 13.33 | 22.11 | 64.17 | 4.81 | 3.4 |

All plants were fertilized with 300 kg/fed, ammonium sulphate (20.6% N), 200 kg/fed. calcium superphosphate (15.5% $P_2O_5$) and 50 kg/fed. potassium sulphate (48% $K_2O$). Nitrogen was divided into three equal batches; and were applied after 15, 30 and 45 days of transplanting. Potassium fertilizer was added with the first batch of N fertilizer. Whereas P fertilizer was added during preparing the soil to cultivation in both experimental seasons. All other agriculture practices were carried out following farmer habitat.

The main plot included HA at (0, 3 and 6 g/l) of while SWE and ADY each at (0, 1 and 2 g/l). Each sub-plot treatment included one row (each one contains 6 plants) for each treatment. Therefore, the experiment included 15 treatments. Humic acid and SWE were obtained from Itan Biotech Limited However, ADY was prepared from brewer's yeast by adding 1 or 2g/l of water contain sugar at a ratio of 10: 1 and kept for overnight in a warm place before applying.

**Vegetative growth attributes**

At the end of the growth season (15$^{th}$ May) plants were cut just above the soil surface and their fresh weight was estimated, before draying at 70 ℃ to assess the dray weight.

**Flowering attributes**

During the growth season full bloom flowers were collected every 5 days. For each cut the total yield of flower fresh weights were measured, before air draying to measuring total flower dry weight.

**Chlorophyll content**

During flowering and after two weeks of the last treatment total chlorophyll content was determined by a potable Minolta chlorophyll meter SPAD-502 (Spectrum Technologies, Inc., Plainfield, IL, U.S.); that has a 0.71 $cm^2$ measurement area and based on absorbance measurements at 660 and 940 nm **(Richardson *et al.*, 2002).** Thirty separate measurements were made using the fifth-fully developed leaves from the top of 30 plants in each treatment.

**NPK herb percentage**

Samples weigh 1g of oven-dried for 24 h at 70 ºC of the leaves were ground to a fine powder to determine the leaves content of N, P and K percentage. The sample was humid mineralized using 96% sulfuric acid in the presence of P-free hydrogen peroxide (30 % W/V) at 300 ºC to determine N as following **Tel and Hagarty (1984).** Leaf N was determined by the micro-Kjeldahl digestion method. Ground samples were digested using a nitric-perchloric-sulphuric acid mixture following **AOAC (1990)** methods. However, vanadomolybdate method was followed to determined P calorimetrically. The K was assessed using a flame photometer (**AOAC, 1990).**

**Statistical analysis**

The analysis of variance (ANOVA) as well as LSD 5% between the means of all recorded data were calculated according to **Mead *et al.* (1993)** using MSTAT program (version 4.0) edited in 1986 by the MSTAT development team, Michigan University and Agricultural University of Norway.

## RESULTS AND DISCUSSION

### Plant fresh weight

Both of HA and SWE/ADY application significantly increased plant fresh weights compared with control plants specially at the highest concentrations. Moreover, results showed a significant interaction between the two investigated factors only in the 1st season. In that season the lowest plant fresh weight value (245.51 g/plant) being for plants which did not treat with any of plant biostimulants. Data in Table 2 show that using SWE at 2 g/l in combination with any concentration of HA was more effective than other treatments as under any of HA concentration SWE significantly yielded the highest value plant fresh weights. Moreover, increasing ADY from 1 to 2 g/l significantly reduced plant fresh weights regardless of HA concentration. Therefore, the lowest values for plant fresh weights 245.51 and 287.78 g/plant for both seasons respectively being for plant treated with (0 ml/l HA+2 g/l ADY). However, the highest value for fresh weights 262.50 and 294.33 were for plants treated with 6 g/l HA +2g/l SWE respectively.

**Table 2: Effect of humic acid, seaweed extract and active dry yeast in plant fresh weights (g) of *Calendula officinalis* plants during two seasons (2020/2021 and 2021- 2022)**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) | | | |
|---|---|---|---|---|---|
| | | 0 | 3 | 6 | Mean (B) |
| **First season** | | | | | |
| **Control** | | 245.51 | 253.90 | 260.50 | **253.30** |
| **SWE** | **1** | 247.04 | 259.64 | 256.28 | **254.32** |
| | **2** | 263.46 | 254.56 | 262.50 | **260.17** |
| **ADY** | **1** | 253.60 | 259.64 | 259.32 | **257.52** |
| | **2** | 251.93 | 246.28 | 254.33 | **250.85** |
| **Mean (A)** | | **251.31** | **254.80** | **258.59** | |
| **LSD 5 %** | | **A: 1.52** | **B: 0.72** | **AB: 1.25** | |
| **Second season** | | | | | |
| **Control** | | 287.78 | 289.28 | 290.78 | **289.28** |
| **SWE** | **1** | 289.00 | 291.33 | 293.44 | **291.26** |
| | **2** | 290.33 | 291.44 | 294.33 | **292.04** |
| **ADY** | **1** | 289.67 | 292.11 | 292.78 | **291.52** |
| | **2** | 288.33 | 290.44 | 291.72 | **290.17** |
| **Mean (A)** | | **289.02** | **290.92** | **292.61** | |
| **LSD 5 %** | | **A: 1.32** | **B: 0.56** | **AB: NS** | |

*** SWE: Seaweed and ADY: Active dry yeast**

**Plant dry weight**

Applied plant biostimulants had more pronounced effect on plant dry weights than fresh weights. In the 1st season HA-nontreated plants had the lowest weights (57.34 g/plant) which gradually increased to achieve 76.56 g/plant following the highest concentration of HA. Similarly, the highest concentration of SWE or ADY yielded the highest values 70.53 and 68.54 g/plant. Results showed a significant interaction between the two investigated factors in both seasons. In the 1st season untreated plants had significantly the lowest dry weight 56.44 g/plant however, the highest value (78.60 g/plant) being for 2g/l SWE in combination with 6 g/l HA. But the highest plant dry weight for ADY (76.34 g) was for HA at 6 g/l +2 g/l ADY (Table 3). Similar observations were recorded in the 2nd season.

**Table 3: Effect of humic acid, seaweed extract and active dry yeast in plant dry weight (g) of *Calendula officinalis* plants during two seasons (2020/2021 and 2021/2022)**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) | | | |
|---|---|---|---|---|---|
| | | 0 | 3 | 6 | Mean (B) |
| **First season** | | | | | |
| **Control** | | 56.44 | 67.27 | 74.62 | **66.16** |
| **SWE** | **1** | 57.47 | 73.82 | 77.60 | **69.63** |
| | **2** | 58.43 | 74.57 | 78.60 | **70.53** |
| **ADY** | **1** | 56.59 | 70.79 | 75.63 | **67.62** |
| | **2** | 57.77 | 71.51 | 76.34 | **68.54** |
| **Mean (A)** | | **57.34** | **71.59** | **76.56** | |
| **LSD 5 %** | | **A: 1.71** | **B: 0.77** | **AB: 1.34** | |
| **Second season** | | | | | |
| **Control** | | 56.43 | 57.54 | 58.67 | **57.55** |
| **SWE** | **1** | 58.54 | 60.15 | 61.77 | **60.15** |
| | **2** | 59.68 | 61.24 | 63.36 | **61.43** |
| **ADY** | **1** | 58.84 | 59.81 | 62.23 | **60.29** |
| | **2** | 57.72 | 58.84 | 60.51 | **59.02** |
| **Mean (A)** | | **58.24** | **59.52** | **61.31** | |
| **LSD 5 %** | | **A: 0.76** | **B: 0.44** | **AB: 0.76** | |

* SWE: Seaweed and ADY: Active dry yeast

The observed significant response of HA on biomass of marigold plants were previously highlighted**. Karimi *et al*. (2020)** used HA as foliar spray to improve plant growth, including shoot biomass, leaf area, and stem diameter. Similarly, **Karmakar *et al.* (2023**) reveled that HA significantly augmented many zinnia plant growth attributes. Humic acid could show these effects due to several mechanisms included exhibiting auxin-like properties that promote cell elongation and division. This hormonal mimicry could stimulate root development and shoot growth, leading to increased biomass **(Yildirim, 2007).** Moreover, HA application might increase nutrients uptake which finally optimize plant growth (**Ichwan *et al*., 2017** and **Memon *et al*., 2014**). However, this improvement could be attributed to keeping IAA active for prolong period time and boost plant uptake utilization and transport of P and K **(Memon *et al*., 2014).**

The above illustrated data referred that SWE and ADY application significantly enhanced plant growth traits based on fresh and dry weighs. The highest effect was assessed for plants treated with SW at 1g/l. Moreover, there were slight differences between both concentrations of each biostimulants. A similar response to SWE on other ornamental plants were previously estimated **(Bakr *et al.*, 2024 and Harhash *et al.*, 2023). Yucedag and Cicek (2024)** reviewed many research achievements about the impact of SWE on many ornamental plants and demonstrated that it can significantly enhance various vegetative growth parameters in numerous of ornamental plants. However, these increments were significantly varied among plants and applied concentration. **Featonby-Smith *et al.* (1984)** suggested that these effects are related to hormonal components especially cytokinins. Moreover, SWE as foliar spray, could positively affect root growth so that plants could get more water and nutrients which finally increased yield **(Mancuso *et al.*, 2006 and Alam *et al.*, 2013).**

The increment in vegetive growth traits of pot marigold because of ADY might be due to the presence of different macro and micronutrients, growth regulators, proteins, and vitamins (especially B). These substances encourage the plant to produce dry matter **(Dawood *et al.*, 2013).** Active dry yeast is also a natural source of cytokinins, which promote cell proliferation and differentiation which also governing shoot and root morphogenesis, chloroplast maturation, protein and nucleic acid synthesis. Moreover, ADY being high in tryptophan, which is a precursor to indole acetic acid which promotes cell division and elongation **(Laten, 1995).**

**Total flower fresh weigh/plant**

All investigated factors significantly affect the total flower fresh weight/plant. Humic acid significantly augmented total yield of non-treated plants from 290.8 g/plant for to 464.7 for these treated with the highest concentration. Similarly, SWE/ADY significantly improved the flower yield production compared with the control plants which yielded (313.4 and 305.8 g/plant for both seasons respectively) with a significant difference between the two concentrations. Data showed a significant interaction between the investigated factors with same trend in both seasons. In the 1$^{st}$, one the lowest flower fresh yield (181.6 g/plant) was estimated for non-treated plants. However, these treated with (3 or 6 g/l HA + 2 g/l SWE or ADY) had a yield of 494.5 to 512.0 g/plant with no significant difference among them. In both seasons under any concentration of SWE/ADY increasing HA concentration significantly increased flower fresh weights (Table 4).

**Table 4: Effect of humic acid, seaweed extract and active dry yeast in total flower fresh weights (g/plant) of *Calendula officinalis* plants during two seasons (2020/2021 and 2021/2022)**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) | | | |
|---|---|---|---|---|---|
| | | 0 | 3 | 6 | Mean (B) |
| **First season** | | | | | |
| **Control** | | 181.6 | 319.9 | 438.6 | **313.4** |
| **SWE** | **1** | 275.9 | 423.5 | 436.1 | **378.5** |
| | **2** | 397.7 | 494.5 | 512.0 | **468.0** |
| **ADY** | **1** | 258.2 | 412.6 | 435.1 | **368.6** |
| | **2** | 340.7 | 486.6 | 501.7 | **443.0** |
| **Mean (A)** | | **290.8** | **427.4** | **464.7** | |
| **LSD 5 %** | | **A: 30.7** | **B: 40.3** | **AB: 74.5** | |
| **Second season** | | | | | |
| **Control** | | 202.8 | 375.8 | 338.7 | 305.8 |
| **SWE** | **1** | 243.1 | 431.5 | 527.5 | 400.7 |
| | **2** | 310.4 | 406.1 | 527.2 | 414.6 |
| **ADY** | **1** | 295.2 | 476.9 | 540.0 | 437.4 |
| | **2** | 348.3 | 559.1 | 485.5 | 464.3 |
| **Mean (A)** | | 280.0 | 449.9 | 483.8 | |
| **LSD 5 %** | | **A: 32.2** | **B: 38.0** | **AB: 66.5** | |

SWE: Seaweed and ADY: Active dry yeast

**Total flower dry weigh/plant**

The effect of both investigated factors on flower dry weights was significant. There was no significant difference between 3 and 6 g/l HA treatment. There was a significant interaction between the two investigated factors in both seasons. Under any concentration of SWE/ADY increasing HA concentration from 3 to 6 did not significantly increase flower dry weights. Moreover, increasing SWE/ADY from 1 to 2 g/l did not significantly affect flower dry weights. Non-treated plants had the lowest yield of flower dry weights (51.10 and 52.17

g/plant in both seasons respectively). Whereas these treated with 3 g/l HA in addition to 2 g/l of SWE or ADY had the highest yield (141.35 and 135.72 g/plant respectively, in the 1st season) without significant difference between them (Table 5). Same trend was observed in the 2nd season.

The augmentation of pot marigold flowering production e.g. flower fresh and dry weights/plants increased by 160 and 120% over the untreated were similar to these findings of **El-Nashar (2021), Karimi (2020), and Essaa (2023)** on pot marigold**. Essaa (2023)** also found that HA treatments increased the percentage of dry matter in flowers, indicating denser and potentially more robust blooms. It seems that the physiological benefits of HA extend beyond flowering itself. In addition to that improving nutrient uptake facilitated by HA also contributes to healthier plants that are more capable of producing flowers **(Nazarova *et al.*, 2022).**

**Table 5: Effect of humic acid, seaweed extract and active dry yeast in flower dry weights (g) of *Calendula officinalis* plants during two seasons (2020/2021 and 2021/2022)**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) | | | |
|---|---|---|---|---|---|
| | | 0 | 3 | 6 | Mean (B) |
| **First season** | | | | | |
| **Control** | | 51.10 | 68.64 | 88.23 | **69.32** |
| **SW** | **1** | 109.27 | 102.00 | 100.74 | **104.00** |
| | **2** | 121.55 | 141.35 | 130.05 | **131.98** |
| **ADY** | **1** | 60.45 | 92.82 | 83.3 | **78.86** |
| | **2** | 92.25 | 135.72 | 120.96 | **116.31** |
| **Mean (A)** | | **86.92** | **108.12** | **104.76** | |
| **LSD 5 %** | | **A: 17.30** | **B:20.31** | **AB: 35.52** | |
| **Second season** | | | | | |
| **Control** | | 52.17 | 93.59 | 93.81 | **79.86** |
| **SW** | **1** | 91.84 | 138.78 | 142.19 | **124.27** |
| | **2** | 97.58 | 126.72 | 145.58 | **123.3** |
| **ADY** | **1** | 74.7 | 107.8 | 112.22 | **98.24** |
| | **2** | 98.55 | 129.6 | 150.8 | **126.32** |
| **Mean (A)** | | 83.97 | 123.54 | 124.68 | |
| **LSD 5 %** | | **A: 15.8** | **B: 30.6** | **AB: 53.55** | |

SWE: Seaweed and ADY: Active dry yeast

Many studies have highlighted the potential of ADY of enhancing many of flower traits of ornamental plants. The promotion of flower yield of pot marigold plants due to ADY application are in agreements of **Youssef *et al.* (2022), Ibrahim and Tawfik (2021), and Zaky (2012)** on various ornamental plants based on flower number, size, and overall yield. This improvement on flower production could be because of improving vegetive growth as mentioned above and enhancement the chlorophyll and nutrient content. The cytokinins in ADY stimulate cell division, leading to increased flower bud formation and development **(Devi *et al.*, 2025).**

**Chlorophyll content**

The chlorophyll content of marigold plants was significantly affected with both factors, moreover, there was a significant interaction between them in both seasons. In the 1st one no significant difference was observed between 3 and 6 g/l of HA but both sustained higher chlorophyll content than the control treatment (40.37). Similarly, all SWE/ADY-treated plants had higher chlorophyll content than the control plants (41.82). But the differences among SWE/ADY treatments were not significant. Results showed that non-treated plants had the lowest chlorophyll content (38.44 and 37.01 in both seasons respectively). However, the highest chlorophyll content was for plants treated with 3 g/l HA + 1g/l SWE. However, there were no significant difference among plants treated with 3 and 6 g/l HA in combination with any concentration of SWE/ADY wit varied between 43.66 and 45.40 (Table 6) Similar trend was observed in the 2nd season with some significant difference among plants treated with 3 and 6 g/l HA in based on SWE/ADY application (Table 6).

This increments on chlorophyll content of marigold plants over the control plants using any of HA concentration was similar to other findings on pot marigold, African marigold, zinnia, and lemon balm plants (**Hasan, 2019, Khan *et al.*, 2020, Alziyituni, 2023 and Essaa, 2023, and Mohamed *et al.*, 2024).** These investigators thought that this effect is attributed to improved nutrient uptake and better physiological responses. Moreover, the application of HA not only boosts chlorophyll content but also enhances other physiological traits, including carotenoid levels and overall plant vigor. Moreover, **Hasan (2019)** thought that HA may stimulate the expression of genes involved in chlorophyll biosynthesis, leading to increased production of chlorophyll molecules within the plant cells.

In the same context to SWE application showed similarity in chlorophyll contents of other plants **(Elansary *et al.*, 2016 and Laribi *et al.*, 2023).** This positive influence of SWE on the chlorophyll content has been previously stated the of many horticultural crops **(Whapham *et al.*, 1993; Blunden *et al*., 1997).** The enhancement pattern of chlorophyll content has been suggested by the increase in the biosynthesis of chloroplasts and the reduction in chlorophyll degradation **(Battacharrya *et al.*, 2015).**

**NPK content**

Nitrogen content of marigold plants was significantly improved following HA application without significant difference between 3 and 6 g/l. Moreover, the SWE/ADY application significantly increased the N% over the control plants (2.43%) without significant difference among the treatments. Regarding the interaction, ANOVA showed significant interaction between the two factors. However, only plants treated with (3 g/l of HA + 2g/l of SWE or ADY) and 6 g/l of HA + 1g/l of SWE or ADY) which had N% (2.94-3.01%) had higher N% than the control plants (2.10%). That means all plants treated with 3 or 6 g/l of HA in addition to 1 or 2 g/l of SW or had not any significant difference in N% (Table 7)

**Table 6: Effect of humic acid, seaweed extract and active dry yeast in chlorophyll content (SAPD unit) of *Calendula officinalis* plants during two seasons (2020/2021 and 2021/20).**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) | | | |
|---|---|---|---|---|---|
| | | 0 | 3 | 6 | Mean (B) |
| **First season** | | | | | |
| **Control** | | 38.44 | 43.66 | 43.37 | **41.82** |
| **SWE** | **1** | 42.33 | 45.40 | 44.15 | **45.16** |
| | **2** | 40.48 | 44.87 | 43.81 | **44.81** |
| **ADY** | **1** | 39.89 | 45.79 | 43.76 | **44.76** |
| | **2** | 40.69 | 44.84 | 43.57 | **44.57** |
| **Mean (A)** | | **40.37** | **44.91** | **44.99** | |
| **LSD 5 %** | | **A: 1.97** | **B: 1.75** | **AB: 2.98** | |
| **Second season** | | | | | |
| **Control** | | 37.01 | 44.42 | 42.03 | **41.15** |
| **SWE** | **1** | 41.08 | 43.97 | 42.88 | **43.87** |
| | **2** | 39.88 | 44.41 | 43.31 | **43.98** |
| **ADY** | **1** | 40.70 | 43.82 | 42.26 | **42.93** |
| | **2** | 41.09 | 43.52 | 43.09 | **43.42** |
| **Mean (A)** | | **39.95** | **44.03** | **43.64** | |
| **LSD 5 %** | | **A: 2.43** | **B: 2.32** | **AB: 3.94** | |

* SWE: Seaweed and ADY: Active dry yeast

**Table 7: The effect of some plantbiostimulants on the nitrogen (%) in *Calendula officinalis* plants**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) 0 | 3 | 6 | Mean (B) |
|---|---|---|---|---|---|
| **First season** | | | | | |
| **Control** | | 2.10 | 2.68 | 2.51 | **2.43** |
| **SWE** | **1** | 2.73 | 2.85 | 2.94 | **3.02** |
| | **2** | 2.61 | 3.00 | 2.81 | **2.90** |
| **ADY** | **1** | 2.41 | 2.87 | 2.94 | **2.94** |
| | **2** | 2.61 | 3.01 | 2.88 | **3.21** |
| **Mean (A)** | | **2.50** | **2.88** | **3.08** | |
| **LSD 5 %** | | **A: 0.47** | **B: 0.41** | **AB: 0.81** | |

* SWE: Seaweed and ADY: Active dry yeast

Data (Table 8) showed significant effect of HA on plant P% over the non-treated plants without significant differance between the 3 and 6 g/l. On the other had all SWE/ADY concentrations significantly improved plant contents of P% over the control plants. However, no significant difference among the SWE/ADY treatments was estimated. There was significant interaction between the two treatments and the lowest percentage (0.09%) was for the non-treated plants however the highest values (0.15%) being for plants treated with 6 g/l of HA + 2 g/l SW or 1 g/l ADY.

**Table 8: The effect of plantbiostimulants on the phosphorus (%) in *Calendula officinalis* plants.**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) 0 | 3 | 6 | Mean (B) |
|---|---|---|---|---|---|
| **Control** | | 0.09 | 0.09 | 0.09 | **0.09** |
| **SWE** | **1** | 0.11 | 0.13 | 0.13 | **0.12** |
| | **2** | 0.11 | 0.13 | 0.15 | **0.11** |
| **ADY** | **1** | 0.13 | 0.12 | 0.15 | **0.13** |
| | **2** | 0.11 | 0.13 | 0.13 | **0.12** |
| **Mean (A)** | | **0.11** | **0.12** | **0.13** | |
| **LSD 5 %** | | **A: 0.02** | **B: 0.03** | **AB: NS** | |

* SWE: Seaweed and ADY: Active dry yeast

Plant K content showed a similar trend to N and P as both factors significantly improved K% with no significant difference between 3 and 6 g/l of HA. But unlike the N and P% marigold K% (3.90%) of plants which treated with the highest concentration of ADY was significantly higher than the other SWE/ADY concentration (Table 9). Nevertheless, all treated plants had K% higher than the control plants (3.02%). Overall non-treated plants had the lowest K% (2.71%) however, all other treated plants had significantly higher K% which increased up to 3.99% for plants treated with 6 g/l HA +2g/l ADY.

**Table 9: The effect of humic acid, seaweed extract and active dry yeaston the potassium (%) in *Calendula officinalis* plants.**

| Growth biostimulants* (g/l) (B) | | Humic acid (ml/l) (A) | | | |
|---|---|---|---|---|---|
| | | 0 | 3 | 6 | Mean (B) |
| **Control** | | 2.71 | 2.79 | 3.55 | **3.02** |
| **SWE** | **1** | 3.11 | 3.52 | 3.63 | **3.42** |
| | **2** | 3.06 | 3.53 | 3.50 | **3.36** |
| **ADY** | **1** | 2.85 | 3.87 | 3.42 | **3.38** |
| | **2** | 3.56 | 4.15 | 3.99 | **3.90** |
| **Mean (A)** | | **3.06** | **3.57** | **3.62** | |
| **LSD 5 %** | **A: 0.13** | **B: 0.16** | **AB: 0.27** | | |

* SWE: Seaweed and ADY: Active dry yeast

Tables (9) showed that HA at 6g/l significantly increased NPK content of treated plants by about 115-125% depending on the season. This increase in nutrients uptake could finally optimize plant growth (**Ichwan *et al*., 2017 and Memon *et al*., 2014).** Humic acid application showed a significant increase in nutrient uptake of *Tagetes patula* (**Nazarova *et al.*, 2022)**. The foliar application of HA has been showed significantly enhance plant nutrient uptake through various mechanisms. **Ampong et al. (2022)** confirmed that HA primarily structure, composed of phenolic and carboxylic groups, forms hydrophilic (polar) and hydrophobic (non-polar) parts when dissociated. This structure aids in nutrient chelation and transportation through the root's plasma membrane. **Mutlu and Tas (2022)** thought that HA application been linked to increased leaves chlorophyll content which was similar to achieved data (Table 6). Higher chlorophyll content enhances photosynthesis, which consequently boosts the overall nutrient uptake capacity, including N, P, and K.

The achieved data regarding the enhancement of NPK of *C. officinalis* plants were similar to these of **Abdel-Wahid *et al.* (2006) and Abou El Salehein *et al.* (2021).** Numerous investigators showed that SWE, contain a complex mixture of organic compounds, polysaccharides, micronutrients, and phytohormones. These constituents work synergistically to enhance root development, increasing the surface area for nutrient absorption and stimulate metabolic pathways responsible for nutrient uptake and assimilation **(Yucedag and Cicek, 2024 and Khan *et al*., 2009).**

## REFERENCES


**Abdel-Wahid, S. M., Labib, N. Y., & Rezk Alla, B. B. (2006).** Effect of active dry yeast and chemical fertilization on vegetative growth and the main constituents of *Euonymus japonicus* Thunb. Plant. *Fayoum Journal of Agricultural Research and Development*, 20(1), 136-147.

**Abou El Salehein, M., Ibraheim, D. & Helal, A. E. M. (2021).** Effect of NPK, humic acid and dry yeast on growth, oil yield and chemical constituents of sweet basil (*Ocimum basilicum* L.). *Journal of Productivity and Development*, 26(3), 513-529.

**Alam, M. Z., Braun, G., Norrie, J. & Hodges, D. M. (2013).** Effect of Ascophyllum extract application on plant growth, fruit yield and soil microbial communities of strawberry. *Canadian Journal of Plant Science*, 93(1), 23-36.

**Alziyituni, H. O. M. (2023).** Effect of humic acid and gibberellic acid on growth, flowering and chemical composition of African marigold (*Tagetes erecta*). *Journal of the Advances in Agricultural Research*, 28(1), 193-201.

**AOAC. (1990).** Association of Official Analytical Chemists. Official Methods of analysis., 1: 69-90.

**Bakr, A., Taha, R. A., Botros, W., & Mohamed, M. A. E. (2024).** Effect of some plant growth biostimulants on growth and Volatile oils productivity of Pelargonium graveolens plants. *Journal of Modern Research*, 6(2), 75-82.

**Barbour, E. K., Sagherian, V., Talhouk, S., Talhouk, R., Farran, M. T., Sleiman, F. T., & Harakeh, S. (2004).** Evaluation of homeopathy in broiler chickens exposed to live viral vaccines and administered *Calendula officinalis* extract. *Medical Science Monitor*, 10(8), 281–285.

**Battacharyya, D., Babgohari, M. Z., Rathor, P. & Prithiviraj, B. (2015).** Seaweed extracts as biostimulants in horticulture. *Scientia horticul.*, 196, 39-48.

**Black C.A., Evans D.D., Ensminger L.E., White G.L., and Clark F.E. (1981).** Methods of Soil Analysis. Part 2, Agron. Inc. Madison. Wisc., USA.

**Blunden, G., Jenkins, T. & Liu, Y.W. (1997).** Enhanced chlorophyll levels in plants treated with seaweed extract. *Journal of Applied Phycology*, 9(6), 535–543.

**Brown, P, & Saa, S. (2015).** Biostimulants in agriculture. *Frontiers in Plant Science*, 6, 671. https://doi.org/10.3389/fpls.2015.00671

**Canellas, L. P. & Olivares, F. L. (2014).** Physiological responses to humic substances as plant growth promoter. Chemical and Biological Technologies in Agriculture, 1: 1-11.

**Clewer, A.G. & Scarisbrick, D., H. (2001).** Practical Statistics and Experimental Design for Plant and Crop Science. Wiley; Chichester, UK.

**Danielski, L., Campos, L. M. A. S., Bresciani, L. F. V., Hense, H., Yunes, R. A., & Ferreira, S. R. S. (2007).** Marigold (*Calendula officinalis* L.) oleoresin: Solubility in SC-CO2 and composition profile. *Chemical*

*Engineering and Processing: Process Intensification*, *46*(11), 99–106.

**Dawood, M.G.; El-Lethy, S.R., & Sadak, M.S. (2013).** Role of Methanol and yeast in improving growth, yield, nutritive value and antioxidants of Soybean. *World App. Sci. J.*, 26(1): 6-14

**Devi, R. P., Yamunasri, P., Balachandar, D., & Murugananthi, D. (2025).** Potentials of soil yeasts for plant growth and soil health in agriculture: A Review. *Journal of Pure & Applied Microbiology*, 19(1).

**du Jardin, P. (2015).** Plant biostimulants: Definition, concept, main categories and regulation. *Scientia Horticulturae*, 196, 3–14.

**Elansary, H. O., Skalicka-Woźniak, K. & King, I. W. (2016).** Enhancing stress growth traits as well as phytochemical and antioxidant contents of Spiraea and Pittosporum under seaweed extract treatments. Plant Physiology and Biochemistry., 105: 310-320.

**El-Nashar, Y. I. (2021).** Effect of levels of humic acid at different times on improvement of the growth of calendula (*Calendula officinalis* L.) plant. *Alexandria Science Exchange Journal*, 42(3), 665–675.

**Essaa, W. M. (2023).** Effect of spraying with humic acid and active yeast suspension on the growth indicators and active substances of *Calendula officinalis* L. *IOP Conference Series: Earth and Environmental Science*, 1262, 042041.

**Featonby-Smith, B. C. & Van Staden J. (1984).** The effect of seaweed concentrates and fertilizer on growth and the endogenous cytokinin content of *Phaseolus vulgaris*. *South African Journal of Botany*. 3:375–379.

**Harhash, M. M. M., Weheda, B., Gaber, M. K. & Eldeb, H. F. (2023).** Effect of foliar application of seaweed extract and some plant growth regulators on the productivity and quality of dahlia (*Dahlia variabilis* L.) plants. *Scientific Journal of Flowers and Ornamental Plants*, 10(2), 137-149.

**Hasan, A. M. (2019).** Effect of foliar application of humic acid and benzyladenine on growth and flowering of pot marigold (*Calendula officinalis* L.). *Journal of Duhok University*, 22(1), 69–77.

**Ibrahim, O. H. M. & Tawfik, O. H. (2021).** Stimulative effects of seaweed and active yeast extracts as foliar treatments on growth and productivity of *Gladiolus grandiflorus* Andrews 'White Prosperity'. *Scientific Journal of Flowers and Ornamental Plants*, 8(4), 471-481.

**Ichwan, B., Suwignyo, R. A. & Hayati, R. (2017).** Response of red chilli varieties under drought stress. *Russian Journal of Agricultural and Socio-Economic Sciences*, 66(6), 361-368.

**Karimi, E., Shirmardi, M., Dehestani Ardakani, M., Gholamnezhad, J., & Zarebanadkouki, M. (2020).** The effect of humic acid and biochar on growth and nutrients uptake of calendula (*Calendula officinalis* L.). *Communications in Soil Science and Plant Analysis*, 51(12), 1658–1669.

**Karmakar, S., Sahu, J. K., Sharma, V., Das, D., & Tirki, K. (2023).** Effects of varying doses and timing of humic acid application on growth and flowering of *Zinnia elegans*. *International Journal of Environment and Climate Change*, 13(9), 632–638.

**Khan, I. U., Amin, N. U., Shah, S. H. A., Khan, M., Ahmad, S., & Shah, S. A. A. (2020).** Response of zinnia cultivars to different levels of humic acid. *Sarhad Journal of Agriculture*, 37(2), 706-713.

**Khan, W., Rayirath, U. P., Subramanian, S., Jithesh, M. N., Rayorath, P., Hodges, D. M., & Prithiviraj, B. (2009).** Seaweed extracts as biostimulants of plant growth and development. *Journal of plant Growth Regulation*, 28, 386-399

**Kisvarga, S., Farkas, D., Boronkay, G., Neményi, A. and Orlóci, L. (2022).** Effects of biostimulants in horticulture, with emphasis on ornamental plant production. Agronomy, 12: 1043.

**Laribi, B., Annabi, H. A., & Bettaieb, T. (2023).** Effects of *Ulva intestinalis* (Linnaeus) seaweed liquid extract on plant growth, photosynthetic performance and water status of two hydroponically grown Lamiaceae species: Peppermint (*Mentha*× *piperita* L.) and purple basil (*Ocimum basilicum* var. purpurascens Benth.). South African Journal of Botany., 158: 63-72.

**Laten, H. M. (1995).** Cytokinins affect spore formation but not cell division in the yeast Saccharomyces cerevisiae. *Biochimica et Biophysica Acta (BBA)-Molecular Cell Research*, 1266 (1), 45-49.

**Mohamed, N. H., El Sayed, A. A., Botros, S., & Mohmed, M. A. H. (2025).** Effect of type and method of application of humic substances on *Melissa officinalis* plants. Minia Journal of Agricultural Research and Development, 45(3), 433–448.

**Mancuso S., Azzarello E., Mugnai S. & Briand X. (2006).** Marine bioactive substances (IPA extract) improve foliar ion uptake and water stress tolerance in potted *Vitis vinifera* plants. *Advances Horticultural Sciences*, 20:156–161.

**Mannino, G., Campobenedetto, C., Vigliante, I., Contartese, V., Gentile, C. & Bertea, C. M. (2020).** The application of a plant biostimulant based on seaweed and yeast extract improved tomato fruit development and quality. *Biomolecules*, 10(12), 1662.

**Mead R., Currow, R.N., & Harted, A.M. (1993).** Statistical Methods In: Agricultural and Experimented Biology 2nd Ed. Chapman and Hall, London, UK. pp 472.

**Memon, S.A., Baloch, M.H., & Baloch R.A. (2014).** Influence of humic acid and macronutrients ($MgSa_4$) application on growth and yield of petunia (*Petunia milliflora*). *Journal Agric. Tech*., 10(6):1501-1516

**Mutlu, A., & Tas, T. (2022).** Foliar application of humic acid at heading improves physiological and agronomic characteristics of durum wheat (*Triticum durum* L.). *Journal of King Saud University-Science*, 34(8), 102320.

**Nazarova, A. A., Fadkin, G. N., Cherkasov, O. V., Borychev, S. N., &** Shemyakin, A. V. (2022). The influence of highly dispersed humic acids on the growth and decorative qualities of *Tagetes patula* L. In: *IOP Conference Series: Earth and Environmental Science*, 1045(1) p. 012007). IOP Publishing.

**Parrado, J., Bautista, J., Romero, E. J., García-Martínez, A. M., Friaza, V., & Tejada, M. (2008).** Production of a carob enzymatic extract: Potential use as a biofertilizer. *Bioresource Technology*, 99(7), 2312–2318.

**Preethi, K. C., Kuttan, G., & Kuttan, R. (2006).** Antioxidant potential of *Calendula officinalis* flowers *in vitro* and *in vivo*. *Pharmaceutical Biology, 44*(9), 691–697.

**Richardson, A.D., Duigan, S.P., & Berlyn, G.P. (2002).** An evaluation of noninvasive methods to estimate foliar chlorophyll content. Phytol,153**:**185-194.

**Tel, D. A., & Hagarty, M. (1984).** Soil and Plant Analysis. IITA/University of Guelph. 277 pp.

**Whapham, C. A., Blunden, G., Jenkins, T. & Hankins, S.D. (1993).** Significance of betaines in the increased chlorophyll content of plants treated with seaweed extract. J. Appl. Phycol., 5: 231–234.

**Yildirim, E. (2007).** Foliar and soil fertilization of humic acid affect productivity and quality of tomato. *Acta Agriculturae Scandinavica Section B-Soil and Plant Science*, 57(2), 182-186.

**Youssef, S. M., Abdella, E. M., Al-Elwany, O. A., Alshallash, K. S., Alharbi, K., Ibrahim, M. T., & Elkelish, A. (2022).** Integrative application of foliar yeast extract and gibberellic acid improves morpho-physiological responses and nutrient uptake of *Solidago virgaurea* plant in alkaline soil. *Life*, 12(9), 1405.

**Yucedag, C., & Cicek, N. (2024).** The use of seaweed in the production of ornamental plants. *Theoretical and Applied Forestry*, 4(1), 15-21.

**Zaky, A. A. (2012).** Improving production quality of lily flowers by using arbuscular mycorrhizal fungi and yeast as a viable alternative to ethylene inhibitors. *Egyptian Journal of Agricultural Research*, 90(1), 339-351.

**Zolfaghari, A., Adeli, A., Mozafarian, V., Babaei, S., & Habibi-Bibalan, G. H. (2013).** Identification of medicinal plants and indigenous knowledge of local people Arasbaran. *J Med Arum Plants*, 28(3), 534-550.

**Zulfiqar, F., Younis, A., Finnegan, P. M., & Ferrante, A. (2020).** Comparison of soaking corms with moringa leaf extract alone or in combination with synthetic plant growth regulators on the growth, physiology and vase life of sword lily. *Plants,* 9(11), 1590.

**الملخص العربى**

# تأثير حمض الهيوميك ومستخلص الأعشاب البحرية والخميرة الجافة النشطة في نباتات الاقحوان

**محمود عبد الحكيم محمود[1]، ايمن عبد النبي رشوان [2]، ثروت احمد الامين [3] هناء رمضان عبد العزيز احمد[2]**
[1]قسم البساتين، كلية الزراعة، جامعة المنيا
[2] قسم البساتين، كلية الزراعة، جامعة جنوب الوادى
[3] قسم الوراثة، كلية الزراعة، جامعة جنوب الوادى

الاقحوان نبات عشبي حولى يستعمل للزينة والطب. تم معاملة البذور بحمض الهيوميك بمعدل 0 و3 و6 جم/لتر أو مستخلص الأعشاب البحرية أو الخميرة الجافة النشطة لكل منهما بمعدل (0 و1 و2 جم/لتر). أدت العوامل المدروسة إلى زيادة كبيرة في وزن النبات الطازج والجاف وكذلك وزن الأزهار الطازجة والجافة مع تفاعلات معنوية بينهما. ومع ذلك، كان لنباتات المقارنة أقل وزن جاف بشكل معنوى وعلاوة على ذلك، كانت أعلى قيمة (78.60 جم/نبات) عند 2 جم/لتر من معاملة 6 جم/لتر من حامض الهيومك جم/لتر +2 جم/لترمن مستخلص الأعشاب البحرية. وكان أقل محصول طازج للزهور للنباتات غير المعاملة، ومع ذلك، فإن النباتات المعاملة بـ 3 أو 6 جم / لتر من حامض الهيومك بالإضافة 2 جم/لتر من مستخلص الأعشاب البحرية أو الخميرة النشطة كان لها أعلى محصول (494.5 و 512.0 جم/نبات). كان للنباتات غير المعاملة أقل محصول من أوزان الزهور الجافة 52.17 جم / نبات. في حين أن النباتات المعاملة بـ 3 جم/لتر من حامض الهيومك + 2 جم/لترمن مستخلص الأعشاب البحرية كان لها أعلى محصول (141.35 و 135.72 جم/نبات على التوالي). كان للنباتات غير المعاملة أقل محتوى من الكلوروفيل وهو 38.44 ملجم/جم. ومع ذلك، كانت أعلى قيمة للنباتات المعاملة بـ 3 جم/لتر من حامض الهيومك وبالإضافة إلى 1 جم/لتر من مستخلص الاعشاب. زاد محتوى النبات من عناصر النتروجين والفسفور والبوتاسيوم بشكل معنوى بسبب المعاملة بحامض الهيومك وكذلك مستخلص الأعشاب والخميرة النشطة مع تفاعل معنوى بينهما. بشكل عام، لم يكن هناك فرق كبير بين 3 و 6 جم/لتر من حامض الهيومك وكانت النباتات المعالجة بـ (3 جم/لتر من حامض الهيومك بالإضافة إلى 2 جم/لتر من مستخلص الأعشاب البحرية أو الخميرة النشطة تحتوي على أعلى محتوى من هذه العناصر. لذلك، يوصى بمعالجة نباتات الاقحوان بـ 3 جم/لتر من حامض الهيومك بالإضافة إلى 2 جم/لتر من مستخلص الأعشاب البحرية أو الخميرة النشطة لتحقيق أعلى محصول من أوزان الزهور الطازجة والجافة.