

Effect of Foliar Fertilization and Seaweed Extract on Flower and Corms Production of Freesia Plant

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ABSTRACT

This study was conducted to evaluate the effect of foliar fertilization and seaweed extract on floral growth characteristics and the production of corms and cormels in *Freesia hybrid* L. under plastic house conditions during the 2023–2024 autumn season. The study, designed as a factorial experiment with a randomized complete block design and three replicates, evaluated the effects of nano-fertilizer (NPK) at concentrations of 0, 1, and 2 mg L⁻¹. It was obtained from local markets, and seaweed extract at concentrations of 0, 1, 2, and 4 mg L⁻¹ on the floral growth and yield of corms and cormels in *Freesia hybrid* L. Results revealed that fertilizer (2mg/L) and seaweed extract (4mg/L) significantly improved key traits, including floral stalk diameter, flower longevity on the plant, days to the first flower opening, and corm and cormels production. These treatments achieved the highest number of corms, the greatest corm weight, and the largest corm diameter. The results of the experiment showed that the interaction between the two treatments, specifically N2M3, significantly outperformed in most floral traits and the yield of corms and cormels.

Keywords: Foliar nutrition, npk ,ornamental bulbs, seaweed extracts.



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INTRODUCTION

Freesia (Freesia hybrida L.) is one of the most important cut flowers, valued for its beautiful blooms and diverse colors. Belonging to the family *Iridaceae*, it is distinguished by its unique and fragrant aroma, earning it the name "Colonia" as designated by Alfred in 1981. This characteristic has made it highly regarded in commercial agriculture, ornamental applications, and the perfume industry. The trade in cut flowers has become a significant aspect of the global floriculture market (Niu, et al. 2021). A temperature range of 20–22°C is ideal for the germination of *Freesia* plants. *Freesia* bulbs primarily propagate through corms, which is the most commonly used method in commercial agriculture to produce flowers within the same season. Cormels, on the other hand, are used to achieve optimal vegetative growth for subsequent corm production. For flower production, the

preferred corm weight ranges between 5–6 grams. Seed propagation is mainly employed for developing new *Freesia* cultivars (Ghasem, et al. 2021). Moreover, the global *Freesia* industry is a multi-billion-dollar enterprise with significant economic returns (Ghazi, et al. 2022). Ornamental plants are among the most renowned plants worldwide, commonly used to beautify gardens, homes, and landscapes. These plants are characterized by their aesthetic appeal and their ability to provide a sense of comfort and relaxation. Additionally, they contribute to improving air quality, reducing pollution, and enhancing environmental temperature conditions (Hanafy, et al. 2022). Foliar nutrition is an important method for supplying plants with their required nutrients by spraying them with nutrient solutions in a way that ensures comprehensive nutrition. It serves as a complementary approach to soil fertilization,

offering a more effective and economical means of providing essential macronutrients (NPK) and micronutrients to plants. Foliar application is an excellent method for delivering both macro- and micronutrients to plants (Ahmed, et al. 2024, Niu, et al. 2021) and plays a critical role in supplying nutrients that roots may struggle to provide, especially during critical growth stages (Shahrajabian, et al. 2022). Nano fertilizers are among the modern agricultural technologies aimed at improving the efficiency of nutrient absorption and are considered one of the most significant innovations of the 21st century. Experts view them as having a promising future (Faizan, et al. 2024, Lee, & Ju- Moon. 2020.). Using lower rates of nano fertilizers as a foliar application has been proven to be an environmentally friendly and economically viable alternative to the recommended rates of chemical fertilizers, leading to substantial improvements in plant productivity and quality. Additionally, nano fertilizers contribute to reducing environmental risks and represent a key approach to achieving sustainable agriculture (Abd El-Azeim, et al. 2020, Subhashani, 2021). A study by Naeij et al. (2023) on *Colchicum speciosum* L. flowers using nano fertilizers showed a significant effect on increasing corm weight and diameter at a concentration of 3 mg L⁻¹. The treated plants recorded a corm weight of 7.2 g and a diameter of 3.6 cm, compared to untreated plants. Researchers have demonstrated that the use of seaweeds of all types as biologically active organic fertilizers is superior to mineral fertilizers. Seaweeds are an eco-friendly, biodegradable, low-cost, and non-polluting natural resource that is safe for both human and animal health. In contrast, excessive use of mineral fertilizers and pesticides negatively affects soil fertility and creates numerous challenges for farmers (Ahmed, 2024.). Seaweed extracts contain all trace elements, some essential nutrients, and plant growth hormones. These extracts are rich in natural plant growth regulators such as auxins, gibberellins, and cytokinins, which significantly enhance crop productivity by improving plant metabolic functions. Additionally, seaweed extracts are a source of

essential vitamins, minerals, and antioxidants. Consequently, experts have increasingly adopted organic extracts as alternatives to chemical compounds in plant nutrition (Alharbi, et al. 2025, Saleh, & Bader. 2023). Furthermore, these extracts are effective in mitigating the adverse effects of high temperatures on plant growth during summer months (Hanafy, et al. 2021). Khalaf and Saeed (2020.) reported that spraying Freesia plants with seaweed extract resulted in significant differences in floral growth traits. The treatment with 1.5 mg L⁻¹ of seaweed extract outperformed the other treatments, achieving a flowering duration of 127.85 days, 3.50 florets per plant, a floret diameter of 6.41 cm, and a floral stalk length of 30.12 cm. Regarding corm growth traits, the treatment with 3 mg L⁻¹ produced the highest results, with 5.16 corms per plant and a corm diameter of 20.58 mm. Chaudhary et al. (2023) found that using a 4 mg L⁻¹ concentration of seaweed extract improved both the number and weight of corms, making it a potential alternative to reduce the use of conventional fertilizers and mitigate environmental impacts. Similarly, Kanbar (2022), in a study on *Gladiolus* plants of the cultivar (*Cartago*), reported significant improvements in corm growth and production when foliar spraying with 1 g L⁻¹ of seaweed extract and chelated iron was applied. This treatment resulted in the highest number of corms (1.23 corms per plant) and cormels (4.56 cormels per corm), along with the greatest fresh weight of corms (60.93 g) and cormels (9.06 g), and the largest corm diameter (6.70 cm). Given the importance of Freesia flowers as globally recognized cut flowers and their use in perfume extraction, as well as the need to enhance the production of corms and cormels as their primary propagation source, this study aims to investigate the effect of spraying with nano fertilizer and seaweed extract on floral growth traits and the marketable yield of corms and cormels in *Freesia* plant.

MATERIALS AND METHODS

A field experiment was conducted in a greenhouse located at Research Station B, affiliated with the College of Agricultural Engineering Sciences, University of Baghdad,

Jadriyah, during the 2023–2024 academic year. The experiment aimed to investigate the effect of spraying with nano fertilizer and seaweed extract on the floral growth traits and the yield of corms and cormels in *Freesia hybrid* L. The experiment was initiated by plowing and leveling the soil of the greenhouse, preparing planting beds with an area of 1×1 m, and installing irrigation pipes. A soil analysis was conducted before planting to determine some of its physical and chemical properties. *Freesia* corms (*Freesia hybrid* L.), obtained from a private supplier in the Iraqi Kurdistan Region, were selected for planting. The corms had diameters ranging from 19.5 to 30.20 mm and weights between 4 and 16 g. Planting was carried out on 9 November 2023, with corms randomly placed near the irrigation pipe openings at a depth of 5 cm. All necessary cultivation practices were performed throughout the growth period. When the plants reached the stage of the fourth leaf emergence, they were sprayed with *Nano energy*, a nano NPK fertilizer. The first spraying with the *Nano energy* nano NPK fertilizer was conducted 45 days after planting. Two days after applying the first treatment, the plants were sprayed with *Equilibrium*, a seaweed extract. The second spray was applied one month after the first spray, coinciding with the early emergence of the floral spike, and the same timing was followed for the second treatment. The third spray was conducted after harvesting the floral spikes to enhance the number, weight, and diameter of the corms (Al-Rubaye, 2015.). The field experiment was conducted using a Randomized Complete Block Design (R.C.B.D) with three replicates, each comprising 12 experimental units containing 10 plants, resulting in a total of 360 planted corms. The factorial experiment (3×4) included two factors: nano NPK fertilizer applied at three concentrations (0, 1, and 2 mg L⁻¹) designated as (N₀ = control, N₁ = 1 mg/L, and N₂ = 2 mg/L); It was obtained from local markets. and seaweed extract applied at four concentrations (0, 1, 2 and 4 mg L⁻¹), designated as M₀ represents the control, M₁ = 1 mg/L, M₂ = 2 mg/L, and M₃ = 4 mg/L. Data were analyzed using the GenStat statistical software, and the means of measured

parameters were compared using the Least Significant Difference (L.S.D.) test at a 5% significance level. The studied traits included floral growth parameters and corm and cormel indicators. Floral growth traits comprised the diameter of the floral stalk (mm), flowering duration (days), and the number of days from planting to the opening of the first floret. Corm and cormel indicators included the number of corms per plant, weight and diameter of the resulting corms (g and mm, respectively), the number of cormels per corm, and the weight of cormels (g).

RESULTS AND DISCUSSION

1. Effect of nano fertilizer and seaweed extract spraying on floral growth: The results indicated significant differences in the effect of treatments on the diameter of the floral stalk Table (1). All treatments outperformed the control. The treatment with nano fertilizer at a concentration of 2 mg L⁻¹ recorded the highest floral stalk diameter of 5.53 mm compared to the control, which recorded 4.22 mm. Similarly, the treatment with seaweed extract at a concentration of 4 mg L⁻¹ resulted in the largest floral stalk diameter of 5.27 mm, compared to 4.71 mm in the control. The treatment (N₂M₃) showed a significant effect by producing the largest floral stalk diameter of 5.67 mm, while the control treatment recorded the smallest diameter at 4.01 mm. The same table also indicates significant differences in flower longevity on the plant. The N₂ treatment outperformed all other treatments, achieving flower longevity of 19.25 days, whereas the control treatment for nano fertilizer recorded the shortest flower longevity of 13.417 days. The treatment with seaweed extract at a concentration of 4 mg L⁻¹ (M₃) recorded the highest flower longevity on the plant, reaching 18.556 days, compared to the control treatment (M₀), which recorded 14.333 days. The interaction between the two factors also had a significant effect on flower longevity. The N₂M₃ treatment outperformed all other combinations, achieving the longest flower longevity of 21.667 days, whereas the N₀M₀ treatment recorded the shortest duration of 11.000 days. The results indicate a significant effect of the treatments on flowering duration,

with all spraying treatments outperforming the control (no spray) by reducing the days required for flowering. The treatment with 2 mg L⁻¹ of nano fertilizer (N₂) recorded the shortest flowering duration at 141.17 days, compared to the control treatment (N₀), which required 146.42 days. Similarly, the seaweed extract treatments significantly influenced flowering duration, with the M3 treatment (4

mg L⁻¹) achieving the shortest duration of 142.44 days, compared to 145.56 days in the control (M₀). The interaction between the two factors further demonstrated the superiority of the N₂M₃ treatment, which recorded the shortest flowering duration of 139.67 days, compared to 148.67 days for the N₀M₀ treatment.

Table 1. Effect of nano fertilizer and seaweed extract spraying on floral growth traits of Freesia plant – effect of N

Treatments	Floral Stalk Diameter (mm)	Flowering Duration (Days)	Days from planting to first floret opening
N0	4.22	13.417	146.42
N1	5.27	17.083	143.75
N2	5.53	19.250	141.17
LSDN	0.0618	0.505	0.666
M Effect			
M0	4.71	14.333	145.56
M1	4.96	16.111	144.33
M2	5.09	17.333	142.78
M3	5.27	18.556	142.44
LSD M	0.0713	0.583	0.769

M*N effect

	M0	4.01	11.000	148.67
N0	M1	4.11	12.333	147.33
	M2	4.16	14.333	145.00
	M3	4.61	16.000	144.67
	M0	4.86	15.333	145.33
N1	M1	5.26	17.333	144.00
	M2	5.45	17.667	142.67
	M3	5.54	18.000	143.00
	M0	5.26	16.667	142.67
N2	M1	5.52	18.667	141.67
	M2	5.66	20.000	140.67
	M3	5.67	21.667	139.67
LSD NM		0.123	1.010	1.332

From the results of Table (1) which demonstrated superiority in floral growth indicators (floral stalk diameter, flowering duration, and the number of days from planting to the opening of the first floret), the observed improvement could be attributed to the role of the essential nutrients present in the nano NPK fertilizer. These nutrients promoted robust vegetative growth by enhancing the solubility and availability of nutrients, thereby increasing nutrient uptake by the plant. This likely boosted photosynthesis, which in turn positively impacted floral growth traits. Additionally, the nitrogen in the nano fertilizer

may have contributed to the enhanced synthesis of materials within the leaves. Nitrogen plays a critical role in improving the plant's efficiency in performing photosynthesis, particularly in conjunction with phosphorus. Moreover, nitrogen stimulates the production of auxin, which promotes cell division and elongation. Potassium in the nano fertilizer also plays a positive role in increasing the diameter of the floral stalk by influencing the division and elongation of vascular cambium cells and enhancing the synthesis of proteins and carbohydrates. This contributes to the robust

growth of the floral stalk, aligning with the findings of Faker and Obaid (2020) and AL-Shareefi et al. (2019). The role of the seaweed extract is evident in the significant improvement of floral growth traits Table (1). This effect may be attributed to the extract's content of essential nutrients for plants, including macronutrients (N, P, K) and micronutrients (Fe, B, Mg, Zn, Mo, Cu). Micronutrients are, in fact, as crucial as macronutrients in promoting growth, yield, and quality in plants. This effect may also be due to the organic compounds in seaweed extract, which include growth regulators such as auxins, cytokinins, gibberellins, and amino acids. When applied to plants, these compounds stimulate growth by enhancing vegetative development through increased photosynthesis, respiration, cell division, protein synthesis, enzyme activity, and hormone production. These factors collectively improve plant growth traits (Arioli, et al. 2024, Kularathne, et al. 2021). These findings are consistent with the results of Ahmed (2024).

2. Effect of nano fertilizer and seaweed extract on Corm and Cormel Production:

The results in Table (2) indicate a significant increase in the number, weight, and diameter of corms with increasing concentrations of the studied factors. The treatments with 2 mg L⁻¹ of nano fertilizer and 4 mg L⁻¹ of seaweed extract, as well as their interaction, recorded the highest values: 1.35 corms per plant, 13.21

g, and 39.00 mm for nano fertilizer; 1.22 corms per plant, 11.54 g, and 36.00 mm for seaweed extract; and 1.43 corms per plant, 14.36 g for the interaction, except for corm diameter, where the N₂M₂ treatment significantly outperformed others with 42.00 mm. In contrast, the control treatments recorded the lowest values across all parameters: 1.00 corm per plant, 6.93 g, and 31.25 mm for the control nano fertilizer; 1.07 corms per plant, 8.53 g, and 32.78 mm for the control seaweed extract; and 1.00 corm per plant, 5.82 g, and 30.33 mm for their interaction. The results indicate that the studied treatments significantly affected cormel traits. The treatment with 2 mg L⁻¹ of nano fertilizer (N₂) achieved the highest number and weight of cormels, recording 33.67 cormels per corm and 46.43 g, which were significantly higher than the control treatment (11.67 cormels per corm and 20.48 g). Similarly, the seaweed extract treatment had a significant impact on increasing the number and weight of cormels, with the 4 mg L⁻¹ concentration outperforming the control. This treatment recorded 27.00 cormels per corm and 38.70 g, compared to the control, which had the lowest values of 16.44 cormels per corm and 26.83 g. The interaction between the two factors (N₂M₃) exhibited a clear significant effect, yielding 41.33 cormels per corm and 54.07 g, while the control interaction (N₀M₀) recorded the lowest values of 10.33 cormels per corm and 17.42 g.

Table 2. Effect of nano fertilizer and seaweed extract spraying on the yield of corms and cormels in Freesia plant

Treatment	Number of Corms (Corms per Plant)	Weight of Individual Corm (g)	Diameter of Individual Corm (mm)	Number of Cormels (Cormels per Corm)	Weight of Cormels (g)
N0	1.00	6.93	31.25	11.67	20.48
N1	1.10	10.01	34.08	20.58	31.78
N2	1.35	13.21	39.00	33.67	46.43
LSD	0.0309	0.319	0.690	0.966	0.796
M effect					
M0	1.07	8.53	32.78	16.44	26.83
M1	1.12	9.62	34.00	20.56	30.92
M2	1.18	10.50	36.33	23.89	35.16
M3	1.22	11.54	36.00	27.00	38.70
LSD	0.0357	0.368	0.797	1.115	0.920

M*N effect

N0	M0	1.00	5.82	30.33	10.33	17.42
	M1	1.00	6.29	30.67	11.33	19.39
	M2	1.00	7.18	31.67	12.00	21.86
	M3	1.00	8.43	32.33	13.00	23.26
N1	M0	1.00	8.48	31.33	14.33	24.76
	M1	1.06	9.55	33.00	18.00	28.58
	M2	1.13	10.18	35.33	23.33	35.02
	M3	1.23	11.82	36.67	26.67	38.77
N2	M0	1.23	11.30	36.67	24.67	38.30
	M1	1.30	13.01	38.33	32.33	44.78
	M2	1.43	14.16	42.00	36.33	48.59
	M3	1.43	14.36	39.00	41.33	54.07
LSD		0.0619	0.638	1.380	1.931	1.593

The results show a significant effect on corm and cormel indicators Table (2) with all studied treatments outperforming the control in measured traits. This improvement may be attributed to the role of potassium in the nano fertilizer, which actively facilitates the transport of photosynthetic products from the vegetative parts of the plant (leaves, the primary site of food synthesis) to the storage organs, namely the corms, thereby increasing their weight and diameter (Subhashani, 2021). This finding aligns with the results of Raheem et al. (2023). The results also highlight significant higher levels of nutrients, contributing to an increased number and weight of cormels. The superiority of corm and cormel traits when treated with seaweed extract, as shown in Table (2) may be attributed to the extract's content of various elements, including potassium, which plays a crucial role in transporting nutrients from the upper parts of differences in cormel traits due to nano fertilizer application, which may be due to the larger size of the corms resulting from the treatments. These larger corms likely stored the plant to the lower parts (corms and cormels), thereby increasing their number and size. Seaweed extract contains macro- and micronutrients, amino acids, organic compounds, growth-enhancing substances such as vitamins and sugars, as well as auxins, gibberellins, and cytokinins (Al-Ealayawi, & Al-Dulaimy. 2023). These findings are consistent with those of Khalaf et al. (2020). It can be concluded that spraying with nano fertilizer at a concentration of 2 mg L⁻¹ achieved the highest values for floral growth traits as well as corm and cormel traits,

including diameter, weight, and number, compared to the control plants, which recorded the lowest values. Similarly, spraying with seaweed extract at a concentration of 4 mg L⁻¹ had a significant positive effect on floral growth traits and corm and cormel characteristics. Additionally, the two-way interaction between nano fertilizer and seaweed extract resulted in a significant increase across all studied trait

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

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تأثير التسميد الورقي ومستخلص الطحالب البحرية في إنتاج الأزهار والكورمات لنبات الفريزيا

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قسم البستنة وهندسة الحدائق، كلية علوم الهندسة الزراعية، جامعة بغداد، العراق

المستخلص

اجريت هذه الدراسة لتقييم تأثير التسميد الورقي ومستخلص الطحالب البحرية في صفات النمو الزهري ونتاج الكورمات وكُريّمات نبات الفريزيا *Freesia hybrid L.* في ظروف البيت البلاستيكي اثناء الموسم الخريفي للعام 2023-2024. طبق البحث ضمن تجربة عاملية وفق تصميم القطاعات الكاملة العشوائية وبثلاثة مكررات وتضمن البحث عاملين: العامل الأول: السماد النانوي NPK بثلاث تراكيز (0، 1، 2) ملغم لتر⁻¹، وتم الحصول عليه من الاسواق المحلية والعامل الثاني مستخلص الطحالب البحرية وبأربعة تراكيز هي (0، 1، 2، 4) ملغم لتر⁻¹. واطهرت النتائج ان تأثير الرش بالسماد NPK كان معنويا في اغلب صفات النمو الزهري ونتاج الكورمات وكُريّمات النبات حيث تفوقت معاملة التسميد N2 ومعاملة مستخلص الطحالب M3 في قطر حامل النورة الزهرية ، مدة بقاء الازهار على النبات ، عدد الايام من تاريخ الزراعة حتى تفتح اول زهيرة ، انتاج الكورمات والكُريّمات واعطت اعلى قيمة لعدد الكورمات واعلى وزن للكورمة الواحدة واكبر قطر للكورمة الناتجة ، ومن نتائج التجربة اعلاه تبين ان التداخل بين المعاملتين تفوقت معنويا للمعاملة N2M3 في اغلب الصفات الزهرية والحاصل للكورمات والكُريّمات.

كلمات مفتاحية: تغذية ورقية، NPK، ابصال زينة، مستخلصات بحرية، سماد..