KIRKUK UNIVERSITY JOURNAL
FOR AGRICULTURAL SCIENCES

Analyzing growth Characteristics of F2 Hybrid Amaryllis Seedlings in Response to Substrates and Osmocote Fertilizers

Ashtekhwaz Ahmad Sharef [1] ashtikhwaz.sharif@univsul.edu.iq
Chnoora Ali Ahmed [2] chnwr.ahmmad@univsul.edu.iq
Hemn Abdalla Mustafa [3] hemn.abdalla@univsul.edu.iq

[1,2,3]Department of Horticulture, College of Agricultural Engineering Sciences, University of Sulaimani, Sulaimanyah, Iraq.

• Date of research received 27/12/2023 and accepted 25/01/2024

Abstract

Amaryllis plant (*Hippeastrum vittatum*) has an attractive flower with a wide range of colors and shapes, and it has a global economic value. This plant is unable to produce seeds due to the existence of two inbreeding depression protandrous flowers and heteromorphic self-incompatibility (pin flower). This study was conducted at Horticulture Department, College of Agricultural Engineering Sciences, University of sulaimani, from November 2022 to May 2023., an attempt was made to overcome self-incompatibility to obtain seeds. Subsequently, an attempt was made to find out the optimum growing condition to produce numerous bulblets of Amaryllis from seeds under the effect of various substrates and different levels of Osmocote fertilizers. Both factors are important for growing the seedling from the seeds. The seeds were obtained after manual self-pollination. The substrates were A1 (silt: peat moss 1:1), A2 (silt: peat moss: perlite 1:1:1), and A3 (silt: peat moss: perlite 1:2:1). The Osmocote levels were B1 (control), B2 (1.5 g/pot), and B3 (2.5 g/pot). Additionally, a combination of both factors was applied simultaneously. A3 substrate and B3 Osmocote fertilizer significantly affected most characteristics including leaf number (1.83), (2.22), seedling fresh weight (1.37g), (1.46 g), shoot length (8.22 cm), (8.43 cm), plant root number (4.89), (5.33) and bulblet diameter (8.55 mm), (8.33 mm) for both factors respectively. The combination of A3 with B3 had the most positive effect on the majority of aboveground and geophyte traits, followed by the integration of A2 with B3.

Key words Ornamental plant, Hippeastrum vittatum; Self incompatibility; Ornamental bulb breeding programs.
Citation: Sharef, A., Ahmed, C., & Mustafa, H. (2024). Analyzing growth Characteristics of F2 Hybrid Amaryllis Seedlings in Response to Substrates and Osmocote Fertilizers. *Kirkuk University Journal for Agricultural Sciences*, 15(1), 15-27. doi: 10.58928/ku24.15102.
Correspondence Author: Chnoora Ali Ahmed - chnwr.ahmmad@univsul.edu.iq

Introduction

Flowering bulbs are considered essential parts of ornamental plants and can be classified into two types winter and summer flowering bulbs. Amaryllis is considered a summer flowering ornamental bulb as it blooms in May and June. Amaryllis (*Hippeastrum vittatum*) belongs to the Amarylliidaceae family. It is believed that the origin country of Amaryllis is Pru and Chile. However, the plant was improved by European growers, especially in the Netherlands. Amaryllis is cultivated to be utilized as a cut flower or can be cultivated in either a garden or a pot. The bulb is a common means for the propagation of Amaryllis as it is much quicker and produces identical plants as parents. However, to obtain new cultivars sexual propagation is crucial. Unfortunately, no attempts have been made regarding breeding Amaryllis. This plant has a relatively big flower with an attractive shape and a wide range of colors. However, it has two inbreeding depression protandrous flowers and heteromorphic self-incompatibility (pin flower). Both phenomena were observed before on other plants including *Pentagonia macrophylla*, *Cyananthus delavayi*, and *Aconitum gymnandrum* and *Petunia hybrida* by [1] [2] [3] [4] respectively. Consequently, this plant cannot naturally produce seeds and requires manual pollination. The selection of appropriate substrate plays a vital role in cultivation. Typically, various ratios of substrates are employed including silt, peat moss, and perlite. Peat moss has appropriate nutrition for a while. As a result, these substrates are used in varying proportions for cultivating plants, particularly bulbs. In addition, a variety of fertilizers are utilized for plant nutrition, with NPK being the predominant and widely adopted type. Thus, different slow-release fertilizers are currently available and they are very effective for growing plants based on the experiences. For instance, Multicote and Osmocote. These slow release fertilizers in addition to macronutrients such as N, P, K, and Mg have several micronutrients. For instance, the Osmocote used in this study consists of N, P, K, Mg, B, Cu, Fe, Mn, and Mo, and Zn. Macro and micronutrients are essential for plant growth and development, each playing specific roles in different aspects of a plant's life cycle [5][6] [7][8]. Regrettably, due to the lack of researches on this topic, this study was conducted. This may be because this plant typically reproduces via bulbs, offering the advantages of quicker flowering and genetic consistency with the parent plant. The commercial production of flowering bulbs is currently unavailable, leading to expensive imports that can only be sustained for a limited period. Optimal methodologies for growing plants from seeds are aimed to be uncovered by this study, encompassing diverse approaches involving various substrates and varied fertilization levels. Subsequently, it is intended to grow seedlings derived from the seeds of a single Amaryllis plant, assessing multiple characteristics for potential application in future ornamental purposes and breeding programmers.

Materials and Methods

This study was conducted at the Horticulture Department, College of Agricultural Engineering Sciences, University of Sulaimani, from November 2022 to May 2023.To obtain seeds, Previously, self-pollination was performed on six flowers of a single plant. The mother plant was cultivated locally and produced red flowers (Figure 1A). As the plant has a protandrous flower and also has heteromorphic self-incompatibility (Pin flower) (Figures 1B and C), manual pollination was carried out after three days of stigma mature. The pod appears on the pollinated flower about 5-6 days after pollination and the seeds were harvested one month following the pollination process (Figure 1D and E). However, the flower non-pollination remains incompatible and dried out one week after flower anthesis (Figure 1F).

Figure (1) Illustration of Amaryllis flower in different stages. (A) Anthesis Flower, (B) Unmatured stigma, (C) both stigma and stamen matured, (D) Seed set after self-pollination, (E) The matured pod is ready for harvest, and (F) Dried pod non-pollination.

I

nitially, the seeds were floated in the water for about two weeks. After germination, they were transferred to pots. The plants were cultivated within a greenhouse environment, maintaining temperatures at 24°C during the day and 22°C at night, with a light cycle of 16 hours of daylight and 8 hours of darkness The substrate of pots was mixed with different ratios of silt, peat moss, and perlite including A1: Silt: Peat Moss (1:1), A2: Silt: Peat Moss: Perlite (1:1:1), and A3: Silt: Peat Moss: Perlite (1:2:1), ingredients of the substrates was analyzed in college of science’s laboratory at university of Baghdad and summarized in Table 1. Moreover, different doses of Osmocote at B1: control, B2: 1.5, and B3: 2.5 g/pot were applied to each pot, the contents of Osmocote were depicted in Table 2

.

Table (1) Chemical analysis of the different Substrates.

Substrates	Ec ms/cm	pH	O.M %	N (ppm)	P (ppm)	K (ppm)	Zn (ppm)	Fe (ppm)
Silt: Peat Moss (V:V) (1:1)	2.0	7.43	10.6	8.0	2.1	427	1.5	0.6
Silt: Peat Moss: Perlite (V:V:V) (1:1:1)	2.4	7.41	13.3	14.2	2.1	490	0.5	1.00
Silt: Peat Moss: Perlite (V:V:V) (1:2:1)	2.7	7.25	14.0	15.0	3.5	507	0.1	3.3

*O.M: Organic Matter

Table (2) The percentage of Osmocote contents based on the manufacturer label.

Nutrient Content	Percentage %	Nutrient Content3	Percentage %
Nitrogen (N)	14.0 %	Boron (B) of which 0.01% is water soluble	0.015%
Nitric nitrogen (N)	6.00 %	Total Copper (Cu) of which 0.022% is water soluble	0.04%
Ammoniacal nitrogen (N)	8.00 %	Total Iron (Fe), chelated by EDTA of which 0.06% is water soluble	0.35%
Phosphorus pentoxide (P2Os) soluble in neutral ammonium citrate and in water	9.0% (3.9% P)	Total Manganese (Mn)	0.05%
Phosphorus pentoxide (P2O5) soluble in water	6.7% (2.9% P)	Total Molybdenum (Mo) of which 0.01% is water soluble	0.015%
Potassium oxide (KO) soluble in water	11.0% (9.1% K)	Total Zinc (Zn)	0.012%
Magnesium oxide (MgO)	2.0% (1.2 % mg)		

**Osmocote (UK/Rol Fertiliser Declaration) (NPK (Mg) Fertiliser blend 14-9(4)-11(9) with micronutrients*

Seven months later, the seedlings were carefully cleansed using tap water and allowed to dry. Seedling phenotypic parameters were recorded, including seedling weight, shoot length, root length, bulblet diameter, bulblet length, and leaf chlorophyll intensity content was measured using a Monitor chlorophyll meter (SPAD 502 PLUS).

Randomized Complete Block Design (RCBD) was employed in triplicate for each treatment and three pots for each experimental unit were grown.

Statistical analysis: ANOVA, multiple correlation tests, and principal component analysis (PCA) were analysed using XLSTA software, version 2019.2.2. Also, the means were compared depending on Duncan´s multiple ranges test at P ≤ 0.05.

Results: In this study, manual pollination was attempted to overcome self-incompatibility in Amaryllis plants, as well as applying the various substrates and different doses of Osmocote to enhance optimal bulblet growth. The obtained results are summarized in the following figures.

The effect of various ratios of substrates on the growth and development of Amaryllis seedlings.

The data in Figure (2) explained a significant influence of the substrates on plant phenotype as indicated by the analysis of variance (ANOVA). As depicted in Figure 2A, substrates A2 and A3 had a significant effect on leaf number compared to A1. However, all substrates have no significant effect on seedling fresh weight. The highest leaf number per plant (1.83) was obtained from A3 and the same trend was observed in A2. Also, the best weight of the seedling (1.37 g) was obtained in A3. Inversely, A1 recorded the lowest leaf number (1.22) and seedling fresh weight (0.85 g). Based on the results illustrated in Figure 2B, chlorophyll intensity statistically had no affected under various substrates.

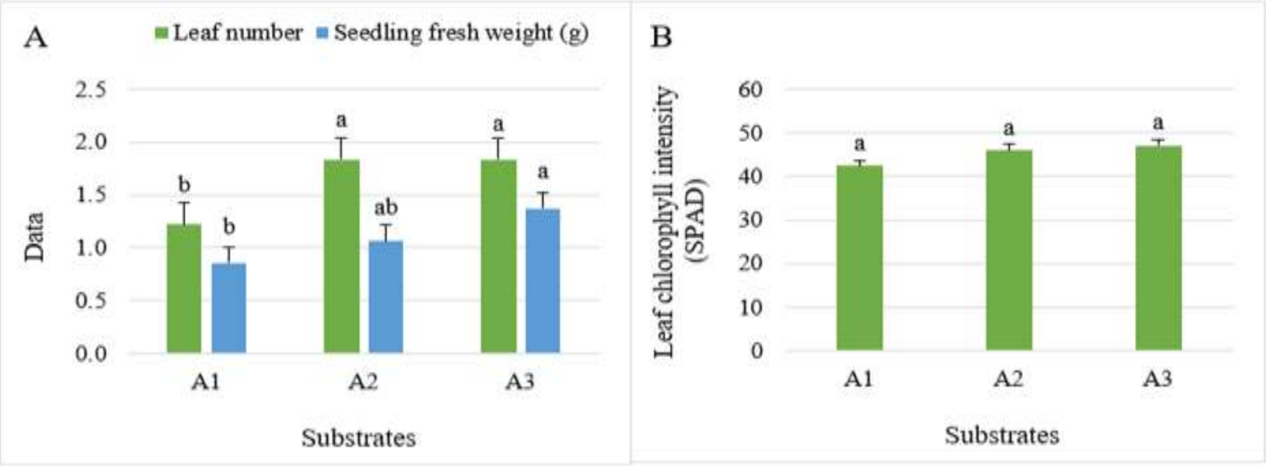

Figure (2) Effect of various ratios of substrates including A1: silt: peat moss (1:1), A2: silt: peat moss: perlite (1:1:1), and A3: silt: peat moss: perlite (1:2:1) on (A) leaf number and seedling fresh weight, and (B) leaf chlorophyll intensity of Amaryllis seedling plants. Each bar indicates a mean ± SE (n=3) and different letters explained significant statistical differences $P \leq 0.05$ range. According to Duncan's test.

Figure 3 illustrates that the various ratios of substrates had a significant effect on plant morphology. Notably, the highest shoot length (8.22 cm) was observed in treatment A3 and the lowest (6.09 cm) was recorded in A1. Moreover, the application of different levels of substrates did not result in any statistically significant differences in root length. Considering plant root number, A2 and A3 gave significantly different in comparison with A1. growing the plants in an A3 substrate resulted in the best root number (4.89). In contrast, the least number (3.50) roots were detected in the A1 substrate. As illustrated in Figure 3B, only the A3 treatment had a significant effect on bulblet diameter (8.55 mm). However, the A1 exhibited the lowest diameter (7.55 mm). Nonetheless, it is important to note that all types of substrates did not have a statistically significant effect on bulblet length.

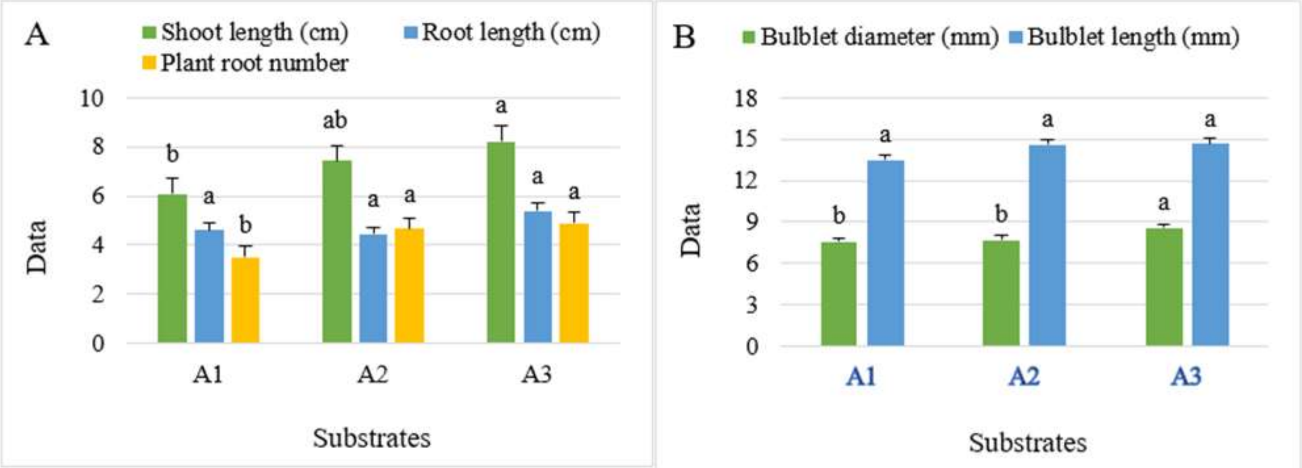

Figure (3) Effect of various ratios of substrates including A1: silt: peat moss (1:1), A2: silt: peat moss: perlite (1:1:1), and A3: silt: peat moss: perlite (1:2:1) on (A) shoot length, root length, and plant root number, and (B) bulblet diameter and length of Amaryllis seedling plants. Each bar indicates a mean ± SE (n=3) and different letters explained significant statistical differences $P \leq 0.05$ range. According to Duncan's test.

The effect of different doses of Osmocote fertilizer on the growth and development of Amaryllis plants

The results obtained pertaining to the utilization of different concentrations of Osmocote are depicted in Figure (4). The treatments involving B3 demonstrated the most substantial significant increases in leaf number (2.22) and seedling fresh weight (1.46 g). Conversely, untreated plants achieved the lowest values of leaf number (1.17) and seedling fresh weight (0.85 g) Figure (4A). In comparison to the control, the application of Osmocote levels did not show any significant differences in chlorophyll intensity Figure (4B).

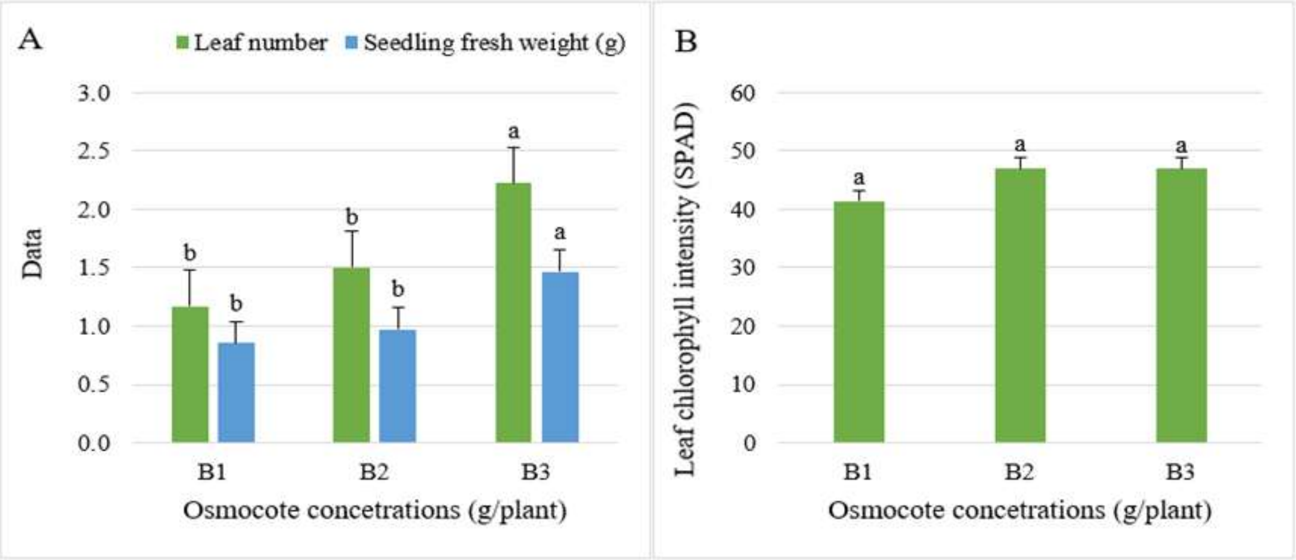

Figure (4) Effect of different doses of Osmocote including B1: control, B2: 1.5, and B3: 2.5 g/pot (A) on leaf number and seedling fresh weight, and (B) leaf chlorophyll intensity of Amaryllis plant. Each bar indicates a mean ± SE (n=3) and different letters explained significant statistical differences P ≤ 0.05 range. According to Duncan's test.

Moreover, various levels of Osmocote had a significant impact on other traits of Amaryllis's plants (Figure 5). For instance, the longest shoot (8.43cm) was recorded in B3, while the shortest (6.53cm) was found under B2. Surprisingly, it was observed that all doses of Osmocote statistically had no significant effect on root length. Concerning root numbers, Osmocote at the B3 level significantly elevated root numbers more than B1 and B2 levels (Figure 5A). The highest number of roots (5.33) was measured after the treatment of the plants with B3, but the minimum root numbers were recorded for B1 and B2 treatments which were (3.61 and 4.11) respectively. As illustrated in (Figure 5B), the seedlings growing in B3, B2 and B1 treatments gave a bulblet diameter (8.33,8.12 and 7.35 mm) respectively, and B2 and B3 treatments have a significant effect compared to Control B1. Furthermore, B3 gave the longest bulblet (15.77 mm), which was significantly different compared to B1 and B2 (12.83 mm and 14.09 mm) respectively.

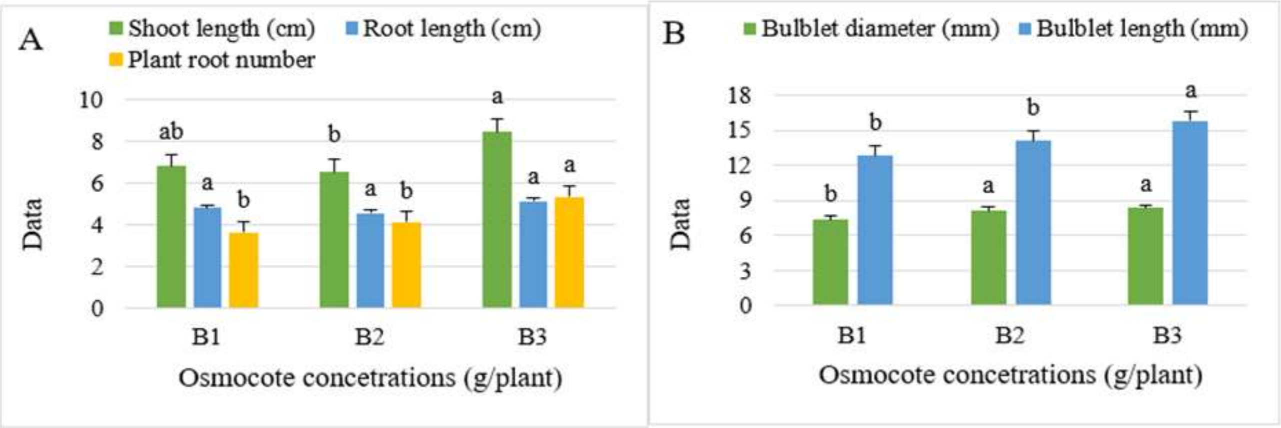

Figure (5) Effect of different doses of Osmocote including B1: control, B2: 1.5, and B3: 2.5 g/pot on (A) shoot length, root length, and plant root number, and (B) bulblet diameter and length of Amaryllis plant. Each bar indicates a mean ± SE (n=3) and different letters explained significant statistical differences P ≤ 0.05 range. According to Duncan's test.

The effect of co-application of various ratios of substrates and different doses of Osmocote fertilizer on the growth and development of Amaryllis plants.

Table (3) indicates the results obtained from the interaction between applying A3 with B3 and A2 with B3 proved to be a significant treatment regarding leaf numbers (2.50) compared to the rest of the treatments for this trait. Moreover, the maximum fresh weight of the seedling (2.10 g) was recorded from the interaction between A3 with B3. This finding was statistically significant compared to the other treatment combinations. The longest shoot (9.93cm) was obtained by integrating A3 with B3, which was significantly different from the other treatments, especially A1 with B1. On the other hand, all treatments did not have any significant effect on the leaf chlorophyll intensity

Table (3) The interaction effect of various ratios of substrates and different Osmocote fertilizer doses on vegetative growth of *Amaryllis plant*

Treatments	Plant leaf number	Seedling fresh weight (g)	Shoot length (cm)	Leaf chlorophyll intensity (SPAD)
A1×B1	1.00 ± 0.00 d	0.85 ± 0.10 b	5.62 ± 0.43 b	39.28 ± 1.61 a
A1×B2	1.00 ± 0.00 d	0.84 ± 0.07 b	5.97 ± 0.78 b	47.33 ± 3.92 a
A1×B3	1.67 ± 1.17 bc	0.87 ± 0.14 b	6.68 ± 0.41 ab	40.45 ± 2.91 a
A2×B1	1.33 ± 0.33 bcd	0.92 ± 0.25 b	8.00 ± 1.44 ab	42.72 ± 5.44 a
A2×B2	1.67 ± 0.17 bc	0.84 ± 0.14 b	5.63 ± 1.09 b	45.03 ± 5.65 a
A2×B3	2.50 ± 0.29 a	1.43 ± 0.17 ab	8.68 ± 0.96 ab	49.93 ± 2.54 a
A3×B1	1.17 ± 0.17 cd	0.79 ± 0.09 b	6.73 ± 0.22 ab	42.33 ± 4.53 a
A3×B2	1.83 ± 0.17 b	1.24 ± 0.11 ab	7.98 ± 1.04 ab	48.60 ± 3.51 a
A3×B3	2.50 ± 0.29 a	2.10 ± 0.80 a	9.93 ± 1.92 a	50.38 ± 3.47 a

Various ratios of substrates including A1: silt: peat moss (1:1), A2: silt: peat moss: perlite (1:1:1), and A3: silt: peat moss: perlite (1:2:1). Different doses of Osmocote at B1: control, B2: 1.5, and B3: 2.5 g/pot. Different letters explained significant statistical differences P ≤ 0.05 range according to Duncan's test. Values in the columns are represented by means ± standard error.

Significant differences in geophyte attributed to the impact of the combination of the various ratios of substrates and different doses of Osmocote (Table 4). The combination of A3 with B3 significantly resulted in the best root number (6.33), bulblet diameter (8.69 mm), and bulblet length (17.29 mm). However, the combination of A1 with B1 showed the lowest number of roots (3.00), and bulblet diameter (6.69 mm). Besides, the shortest bulblet (11.29 mm) was measured at the combination of A3 with B1. On the other hand, none of the treatments had a significant effect on root length.

Table (4) The interaction effect of various ratios of substrates and different Osmocote fertilizer doses on geophyte growth of Amaryllis plant

Treatments	Number of roots per plant	Root length (cm)	Bulblet diameter (mm)	Bulblet length (mm)
A1×B1	3.00 ± 0.00 d	4.53 ± 0.79 a	6.69 ± 0.34 c	13.32 ± 0.34 cd
A1×B2	3.33 ± 0.17 cd	4.60 ± 0.08 a	7.93 ± 0.37 abc	13.78 ± 1.11 bcd
A1×B3	4.17 ± 0.60 bcd	4.70 ± 0.83 a	8.02 ± 0.53 abc	13.28 ± 1.03 cd
A2×B1	4.33 ± 0.88 bcd	4.58 ± 0.63 a	7.14 ± 0.28 bc	13.88 ± 0.79 bcd
A2×B2	4.17 ± 0.33 bcd	3.88 ± 0.12 a	7.69 ± 0.53 abc	13.16 ± 1.19 cd
A2×B3	5.50 ± 0.50 ab	4.87 ± 0.34 a	8.29 ± 0.37 ab	16.75 ± 0.65 ab
A3×B1	3.50 ± 0.50 cd	5.27 ± 0.29 a	8.22 ± 0.21 ab	11.29 ± 0.83 d
A3×B2	4.83 ± 0.17 bc	5.20 ± 0.27 a	8.73 ± 0.41 a	15.34 ± 0.54 abc
A3×B3	6.33 ± 0.44 a	5.75 ± 1.30 a	8.69 ± 0.74 a	17.29 ± 1.68 a

Various ratios of substrates including A1: silt: peat moss (1:1), A2: silt: peat moss: perlite (1:1:1), and A3: silt: peat moss: perlite (1:2:1). Different doses of Osmocote at B1: control, B2: 1.5, and B3: 2.5 g/pot. Different letters explained significant statistical differences P ≤ 0.05 range. According to Duncan's test. Values in the columns are represented by means ± standard error

Multivariate Analysis

Pearson's correlation analysis was conducted to illustrate the relationships among the depicted variables in Figure 6. The findings indicated a strong correlation between leaf number and various plant parameters, including seedling fresh weight ($r2 = 0.84$ and $p = 0.00$), shoot length ($r2 = 0.80$ and $p = 0.01$), root number ($r2 = 0.95$ and $p = <0.0001$), bulblet length ($r2 = 0.84$ and $p = 0.00$), and leaf chlorophyll intensity ($r2 = 0.71$ and $p = 0.03$). Moreover, seedling fresh weight was confirmed to exhibit a positive association between shoot length ($r2 = 0.88$ and p = 0.00), root number (r2 = 0.91 and p = 0.00), root length (r2 = 0.70 and p = 0.04), bulblet length (r2 = 0.89 and p = 0.00), and leaf chlorophyll intensity (r2 = 0.74 and p = 0.02). Also, a statistically significant positive correlation was observed between shoot length with root number (r2 = 0.91 and p = 0.00), root length (r2 = 0.75 and p = 0.02), and bulblet length (r2 = 0.80 and p = 0.01). Root number displayed a positive correlation with bulblet length (r2 = 0.87 and p = 0.00), and leaf chlorophyll intensity (r2 = 0.75 and p = 0.02). Notably, a strong positive association was found between bulblet diameter and length with leaf chlorophyll intensity (r2 = 0.73 and 0.79, p = 0.02 and 0.01), respectively.

	LN	SFW	SL	RN	RL	BD	BL
SFW	0.84						
SL	0.80	0.88					
RN	0.95	0.91	0.91				
RL	0.43	0.70	0.75	0.55			
BD	0.64	0.59	0.59	0.65	0.66		
BL	0.84	0.89	0.80	0.87	0.45	0.47	
LCI	0.71	0.74	0.66	0.75	0.43	0.73	0.79

Figure (6) Pearson's correlation analysis (P ≤ 0.05) was conducted for all the examined variables, along with information regarding the direction and significance threshold of the correlations. Variables include SFW: seedling fresh weight, SL: shoot length, RN: root number, RL: root length, BD: bulblet diameter, BL: bulblet length, LCI: leaf chlorophyll intensity.

A Principal Component Analysis (PCA) was conducted to assess the associations between substrates and the variables related to plant growth and development of the Amaryllis plant (Figure 7). The first and second principal components, labeled as F1 and F2, respectively, jointly accounted for 100 % of the observed variables. F1, in the horizontal axis, explained 85.34 % of the variables. While, F2, represented on the vertical axis, carried 14.66 % of the variables. Based on the PCA results, A3 at both positive sides of F1 and F2 is closely linked to seedling fresh weight (SFW), bulblet diameter (BD), and root length (RL). A2 had an association with shoot length (SL), chlorophyll intensity (LCI), plant root number (PRN), bulblet length (BL), and leaf number (LN). However, A1 had an adverse correlation with all variables. Also, a strong correlation was found among SL, LCI, PRN, BL, and LN

.

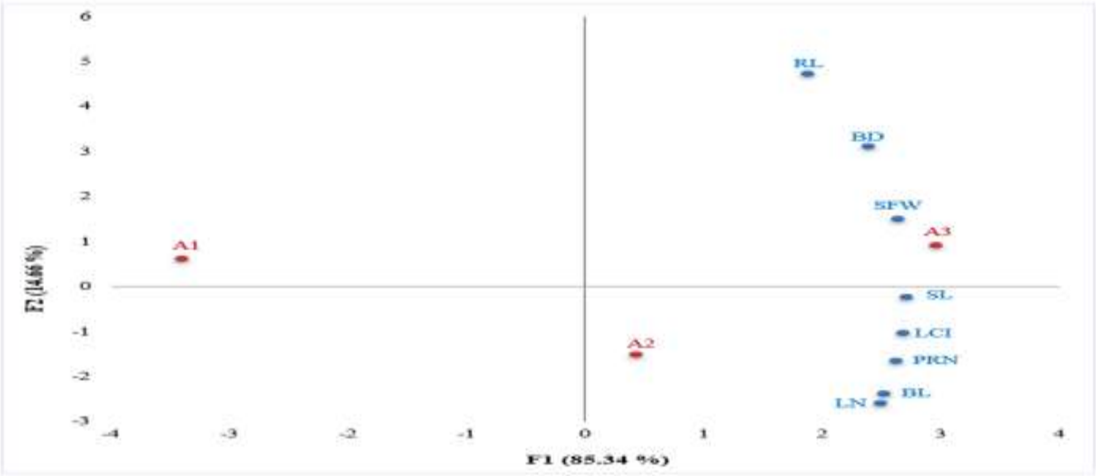

Figure (7) The PCA biplot visually depicts the distribution of various ratios of substrates including A1: silt: peat moss (1:1), A2: silt: peat moss: perlite (1:1:1), and A3: silt: peat moss: perlite (1:2:1) across the study variables, SFW: seedling fresh weight, SL: shoot length, RN: root number, RL: root length, BD: bulblet diameter, BL: bulblet length, LCI: chlorophyll intensity.

A Principal Component Analysis (PCA) was performed to examine the connections between different Osmocote fertilizer levels and the taken parameters (Figure 8). It is obvious that F1 and F2 collectively explained 100 % of the variations. F1, displayed along the x-axis, exhibits 82.62 % of the variations. While, F2, at the y-axis, comprised 17.38 % of the variations. Accordingly, B3 had a close connection with SFW, PRN, LN, BL, and SL. B2 is negatively linked with LN, BL, BD, and LCI. Similarly, B1 had an adverse relationship with RL, SL, SFW, and PRN. In addition, positive correlations were found among SFW, PRN, LN, and BL.

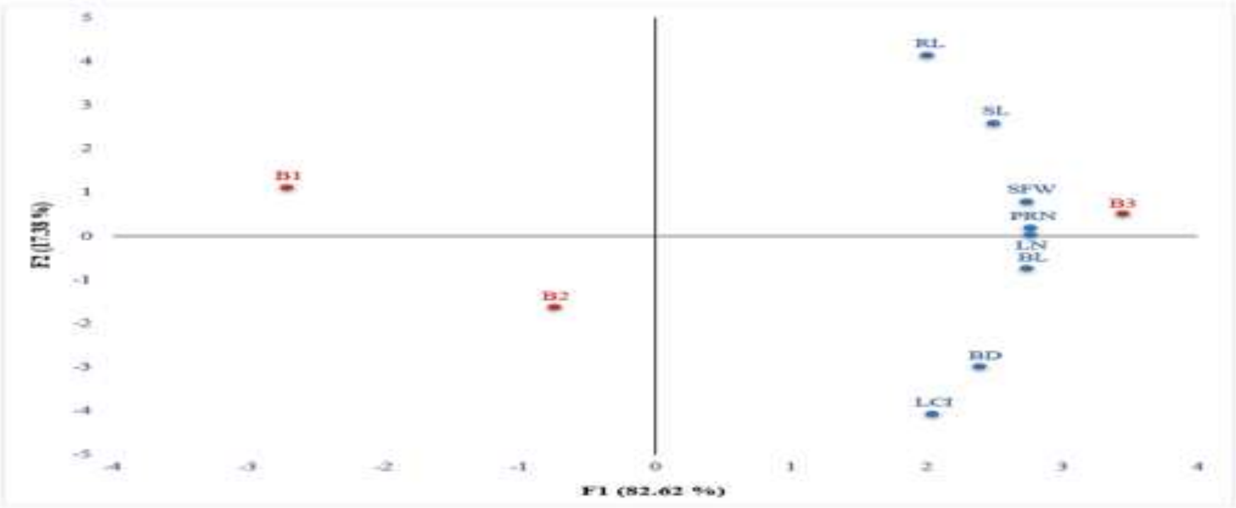

Figure (8) The PCA biplot visually demonstrates the distribution of different doses of Osmocote at B1: control, B2: 1.5, and B3: 2.5 g/pot across the study variables, SFW: seedling fresh weight, SL: shoot length, RN: root number, RL: root length, BD: bulblet diameter, BL: bulblet length, LCI: leaf chlorophyll intensity.

Discussion

The Amaryllis plant used in this study had a red flower bearing two types of inbreeding depression protandrous flowers and heteromorphic self-incompatibility (pin flower). This phenomenon had not been reported in this plant in an academic paper. This phenomenon previously was observed in several plants including Pentagonia macrophylla, Cyananthus delavayi, Aconitum gymnandrum, and several commercial lines of Petunia hybrida [1][2][3][4]. Flowering bulbs usually propagate through bulbs. However, to obtain the new cultivars sexual propagation needs to be considered through either self or crossed pollination to obtain seeds. Consequently, it is very important to obtain and expand our knowledge about overcoming the incompatibility barrier and how to grow the collected seeds after pollination. The combination of these factors encouraged the study to combine breeding and ornamental purposes. The seeds were obtained after self-pollination which means that this plant can produce seeds and has both heteromorphic self-incompatibility and protandrous flowers. The effect of substrates used in the current study revealed that A3 (silt: peat moss: perlite 1:2:1) influenced on growth and development of the Amaryllis plant as demonstrated in Figures 2 and 3. The results showed A3 had a strong effect on the growth and development of Amaryllis plants. According to the results obtained by [9] and [10], the different substrates have a positive effect on the different vegetative traits of *Hippeastrum vittatum* and Gladiolus grandifloras. Moreover, Perlite is a type of substrate with unique closed-cell structures, causing water to adhere only to its surface. It does not absorb water like peat moss, contributing to the enhancement of these traits for better growth [11]. Maximum bulblet length observed in three substrates containing peat moss may also have attributed to adequate organic matter content which increased its water-holding capacity to absorb more nutritional value of the substrates helping the plants to prepare more food. This result agrees with the results of [12].

The Osmocote fertilizer at B3 (2.5 g/pot) significantly improved the growth and development of the Amaryllis plant as explained in Figures 4 and 5. This was supported by [13], [14] and [15] who mentioned that NPK does have a positive role in plant growth. Furthermore, the rate of B3 (2.5 g/pot) Osmocote fertilizer had a significant effect on vegetative growth. These results were in accordance with those obtained by [9] who mentioned that increasing rates of fertilizer increased vegetative and root growth in *Hippeastrum vittatum* L. In addition, B2 (1.5 g/pot) and B3 (2.5 g/pot) greatly influenced bulblet diameter and length, which was consistent with the results obtained by [16] on *Hippeasrum vittatum*. Increasing growth and development resulting from the application of Osmocote fertilizer might be due to the enhancement of several important traits including, photosynthesis, cell division, and cell enlargement as it consists of a wide range of elements as illustrated in Tables 1 and 2.

Conclusion

Two inbreeding depression was observed in this particular red cultivar, protandrous flower and heteromorphic self-incompatibility mechanism. To address this, manual self-pollination was used and seed was obtained. The effect of the substrates has a significant effect and the A3 substrate favorably improved most traits of the Amaryllis plants. At the same time, Osmocote fertilizer at B3 was the best dose to enhance the growth and development of Amaryllis plants. Besides, the consequences of the interaction between substrates and Osmocote levels clarified that the A3 substrate with B3 level was outstanding to upgrade the measured characteristics of Amaryllis plants. The results obtained in this study can be used to build future breeding programs regarding this plant by involving more cultivars and obtaining more seeds through self and cross-pollination.

References

[1]Mcdade, L.A. (1986). Protandry, synchronized flowering and sequential phenotypic unisexuality in neotropical *Pentagonia macrophylla* (Rubiaceae). Oecologia, 68 :218-223.

[2] Wang, H., Barrett, S.C., Li, X.Y., Niu, Y., Duan, Y.W., Zhang, Z.Q. and Li, Q.J. (2021). Sexual conflict in protandrous flowers and the evolution of gynodioecy. Evolution, 75(2): 278–293.

[3] Hou, M. and Zhao, Z.G. (2023). Effects of floral traits on geitonogamous selfing rates and reproductive success in a protandrous species. Journal of Plant Ecology, 16(5): rtad011.

[4] Sharef, A.A. (2023). Phenotypic analysis of Petunia hybrida commercial varieties. Passer Journal of Basic and Applied Sciences, 5(2): 335-341.

[5] Cakmak, I. and Kirkby, E.A. (2008). Role of magnesium in carbon partitioning and alleviating photooxidative damage. Physiologia plantarum, 133(4): 692-704.

[6] Cakmak, I., and A.M. Yazici. (2010). Magnesium: A Forgotten Element in Crop Production. Better Crops 94(2): 23–25.

[7] Gerendás, J. and Führs, H. (2013). The significance of magnesium for crop quality. Plant and Soil, 368(1–2): 101–128.

[8] Shireen, F., Nawaz, M.A., Chen, C., Zhang, Q., Zheng, Z., Sohail, H., Sun, J., Cao, H., Huang, Y. and Bie, Z. (2018). Boron: Functions and approaches to enhance its availability in plants for sustainable agriculture. International journal of molecular sciences, 19(7): 1856.

[9] El-Naggar, A.H. and El-Nasharty, A.B. (2009). Effect of growing media and mineral fertilization on growth, flowering, bulbs productivity and chemical constituents of *Hippeastrum vittatum*. Herb., American-Eurasian J. of Agric. & Environ. Sci. 6(3): 360–371.

[10] Jabbar. A., Tehranifar, A., Shoor, M., &Nemati, S.H. (2018). Effect of Different Media on Some Growth, Flowering and Biochemical Parameters of Two Cultivars of Gladiolus (Gladiolus grandiflorus L.) under Soilless Conditions. Journal of Ornamental Plants ,8(3):205–215.

[11] Sardoei, A.S. and Rahbarian, P. (2014). Effect of different media on growth indexes of ornamental plants under system mist. European Journal of Experimental Biology, 4(2):361-365.

[12] Tahir, A., Khattak, A. M., and Khan, M. A. 2011. Effect of growing media on the cormelization of freesia under the agro-climatic conditions of Peshawar. Sarhad Journal of Agriculture., 27(1): 33-38.

[13] Ye, T., Li, Y., Zhang, J., Hou, W., Zhou, W., Lu, J., Xing, Y. and Li, X. (2019). Nitrogen, phosphorus, and potassium fertilization affects the flowering time of rice (Oryza sativa L.). Global Ecology and Conservation, 20: 1-9.

[14] Wang, Y., Chen, Y.F. and Wu, W.H., 2021. Potassium and phosphorus transport and signalling in plants. Journal of Integrative Plant Biology, 63(1):34-52.

[15] Khan, F.U., Jhon, A.Q., Khan, F.A. and Mir, M.M (2006). Effect of NPK and Zn on growth, flowering and bulb production in tulip under polyhouse conditions in Kashmir. Journal of Horticultural Sciences,1(2): 129-134.

[16] Youssef, A. and Abd El-Aal, M. (2014) Effect of Kinetin and Mineral Fertilization on Growth Flowering, Bulbs Productivity, Chemical Compositions and Histological Features of Hippeastrum Vittatum. Journal of Plant Production, 5(3):357–381.

Kirkuk University Journal for Agricultural Sciences, Vol. 15, No. 1, 2024 (15-27)
Online ISSN: 2958-6585

مجلة جامعة كركوك للعلوم الزراعية

تحليل خصائص النمو لشتلات الأمارلس الهجينة F2 واستجابتها لأوساط الزراعة والأسمدة الأسموكوتية

اشتيخواز احمد شريف [1] **جنور علي احمد** [2] **هيمن عبدالله مصطفى** [3]
ashtikhwaz.sharif@univsul.edu.iq chnwr.ahmmad@univsul.edu.iq hemn.abdalla@univsul.edu.iq

[3،2،1] قسم البستنة، كلية هندسة العلوم الزراعية، جامعة السليمانية، السليمانية، العراق.

• تاريخ استلام البحث 2023/12/27 وتاريخ قبوله 2024/01/25.

الخلاصة

يتميز النبات الأمارلس (*Hippeastrum vittatum*) بأزهارها الجذابة ذات الألوان والأشكال المتنوعة، كما أنها ذو قيمة اقتصادية على مستوى العالم. لوحظ بأن هذا النبات غير قادر على إنتاج البذور بسبب وجود نوعين من عدم التوافق بين الزهور البروتاندرية وعدم التوافق الذاتي المتغاير (الزهرة الدبوسية). أجريت هذه الدراسة في قسم البستنة، كلية علوم الهندسة الزراعية، جامعة السليمانية، خلال الفترة من تشرين الثاني 2022 الى أيار2023. وقد اجريت محاولة للتغلب على عدم التوافق الذاتي للحصول على البذور. و معرفة دراسة ظروف النمو المثلى لإنتاج العديد من بصيلات نبات الأمارلس من البذور المنتجة تحت تأثير مستويات مختلفة من الاوساط الزراعية وتراكيز مختلفة للسماد الأسموكوت. كانت االاوساط الزراعية كاالآتي: A1 (التربة المزيجية: البتموس 1:1)، A2 (التربة المزيجية: البتموس: البيرلايت 1:1:1)، و A3 (التربة ا المزيجية: البتموس: البيرلايت 1:2:1). وكانت تراكيز السماد الأسموكوت B1 (معاملة المقارنة)، B2 (1.5 غم/سندانة)، و B3(2.5 غم/سندانة). أثرت كل من الوسط الزراعي A3 وتركيز السماد B3 معنوياً على معظم الصفات بما في ذلك عدد الاوراق (1.83)، (2.22)، الوزن الطري للشتلات (1.37 غم)، (1.46 غم)، طول الشتلة (8.22 سم)، (8.43 سم)، عدد جذور النبات (4.89)، (5.33) وقطر البصيلة (8.55 ملم)، (8.33 ملم) لكلا العاملين على التوالي. بالإضافة إلى ذلك، كان لتداخل A3 مع B3 و تداخل A2 مع B3 التأثير الأكثر إيجابية على أغلبية الصفات.

الكلمات المفتاحية: نبات الزينة، *Hippeastrum vittatum*، عدم التوافق الذاتي، برامج التربية لابصال الزينة.