Effect of agricultural media, bio-fertilizers, and spraying with potassium in the Growth of Gladiolus Plant

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ABSTRACT

This experiment was conducted in the greenhouse belonging to one of the private nurseries located near the Federal Court of Babylon for the spring season of (2017), for studying the effect of three Culture Medias of (loamy sand+ Peat Moss, loamy sand+ plant wastes, loamy sand+ sheep manures), three levels of bio-fertilizers (Without addition, Azotobacter, Mycorrhiza), spraying with Potassium sulfate and at three levels is (0, 1, 2 g.L^{-1}). The study was conducted as a factorial experiment (3 × 3 × 3) according to Randomized Complete Blocks Design (R.C.B.D), with three replicates, each replicate containing 27 treatments, and the averages were compared according to the least Significant difference test (L.S.D) below the 5% probability level. The results of this study can be summarized as follows:

The results showed that the treatment of (loamy sand+ sheep manures) was significantly excelled by giving the best values for most of the studied traits for the Gladiolus plant. The most important of these were the plant height of (139.40 cm), the leaf area of (1933.01 cm2), The percentage of dry substance in the leaves is (25.08%), the percentage of carbohydrates in leaves is (7.83%), the flowering date of (88.76 days), the flowers number on the inflorescence is (11.35 flowers / inflorescence), Flower duration on the plant of (10.20 days), vase life of (13.77 days), Corm number of (2.41 corm.plants^{-1}), the results showed that the treatment of the bio-fertilizer (Mycorrhiza) was significantly excelled on the other treatments by giving it the best values for all the studied traits. The results showed a positive role for spraying with potassium sulfate. The spraying treatment with a concentration of (2 mg.L^{-1}) was significantly excelled on all studied traits. In addition, the interaction of (loamy sand+ sheep manures+ Mycorrhiza + potassium sulfate at a concentration of 2 mg.L^{-1}) was significantly excelled than the other interaction treatment by giving the highest values in plant height of (161.44 cm), leaf area of (2749.36 cm2), percentage of dry matter in the leaves of (34.59%), percentage of carbohydrates in the leaves (10.71%), flowering date of (75.37 days), flowers number on the inflorescence (14.86 flowers / inflorescence), Flower duration on the plant of (13.77 days), vase life of (16.84 days), Corm number of (3.83 Corm.plants^{-1}).

Keywords: Gladiolus hybrida L., Mycorrhiza, Azotobacter, sheep manures, Potassium.

*Research paper from Ph.D. thesis for the first author

تأثير الاوساط الزراعية والمخصبات الحيوية و رش البوتاسيوم في نمو نبات الكلاديولس

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المستخلص

اجريت التجربة في الظلة التابعة لاحد المشاتل الخاصة الواقع بالقرب من المحكمة الاتحادية – محافظة بابل للموسم الربيعي لسنة (2017)، لدراسة تأثير ثلاثة اوساط زراعية هي (زميج +بيتموس ،زميج+ مخلفات نباتية،زميج+ مخلفات اغنام) ، وثلاثة مستويات من المخصبات الحيوية هي (بدون أضافة ،بكتريا الازوتوبكتر ،فطريات المايكورايزا) و الرش بكبريتات البوتاسيوم وبثلاث مستويات هي (0 ،1، 2) غم/لتر، ونفذ البحث كتجربة عامليه (3×3×3) وفق تصميم القطاعات العشوائية الكاملة Randomized Complete Blocks Design (R.C.B.D) بواقع ثلاثة مكررات حيث يحتوي كل مكرر على 27 معاملة، وقورنت المتوسطات حسب اختبار أقل فرق معنوي (L.S.D) تحت مستوى احتمال 5%. ويمكن تلخيص نتائج هذه الدراسة كما يلي:-

أظهرت النتائج تفوق معاملة (زميج +مخلفات اغنام) معنويا واعطت أفضل القيم لمعظم الصفات المدروسة لنبات الكلاديولس وأهمها ارتفاع النبات 139.40سم، المساحة الورقية 1933.01سم^2، النسبة المئوية للمادة الجافة في الاوراق 25.08% ،النسبة المئوية للكاربوهيدرات في الاوراق 7.83%، موعد التزهير 88.76 يوم، عدد الزهيرات على النورة الزهرية 11.35 زهيرة. نوره$^{-1}$، مدة بقاء الأزهار على النبات 10.20 يوم، العمر المزهري 13.77يوم، عدد الكورمات 2.41 كورمه .نبات$^{-1}$، كما اظهرت النتائج تفوق معاملة المخصب الحيوي المايكورايزا معنويا على باقي المعاملات واعطت افضل القيم لجميع الصفات المدروسة، في حين بينت النتائج الدور الايجابي لرش كبريتات البوتاسيوم فقد تفوقت معاملة الرش بتركيز 2ملغم/لتر معنويا في جميع الصفات المدروسة، كما تفوق التداخل الثلاثي المؤلف من (الزميج+مخلفات اغنام +المايكورايزا + كبريتات البوتاسيوم بتركيز2ملغم/لتر) معنويا على باقي معاملات التداخل واعطت اعلى القيم في ارتفاع النبات 161.44سم ، المساحة الورقية 2749.36سم^2، النسبة المئوية للمادة الجافة في الاوراق 34.59%، النسبة المئوية للكاربوهيدرات في الاوراق10.71%، موعد التزهير 75.37 يوم، عدد الزهيرات على النورة الزهرية 14.86زهيرة. نوره$^{-1}$، مدة بقاء الأزهار على النبات 13.77يوم، العمر المزهري 16.84يوم، عدد الكورمات 3.83كورمة .نبات$^{-1}$.

الكلمات المفتاحية: كلاديولس ، مايكورايزا ، أزوتوبكتر ،مخلفات اغنام ،بوتاسيوم

*البحث مستل من اطروحة الباحث الاول

1. INTRODUCTION

Gladiolus (*Gladiolus hybrida* L.) is considered one of the most important economic cut flowers that belong to the Iridaceae family and comprises about 92 genus and more than 300 species that are naturally spread in the Central and South Africa region, especially in the Cape of Good Hope, Asia Minor, and Southern Europe [1]. Gladiolus bulbs are an annual summer under Iraq's climatic conditions and can be cultivating it in two equestrian (autumn and spring) and can be produced throughout the year and cultivated under protected environment conditions, the importance of Gladiolus is very good flowers for cutting and it is characterized by a short period of growth, which takes between 75-120 days, as well as its multi flower colors and long vase life, and the flowers of some of its cultivars with aromatic smell [2]. It is preferable to cultivate ornamental bulbs in soils with high organic matter content. Therefore, the need to use the agricultural media rich in organic matter (sheep manure and plant wastes) has emerged as being environmentally friendly and available easily and cheaply and can provide the plant's need for nutrient elements to obtain a good product and high-quality flowers suitable for cut flowers. where Organic matter improves the traits of physical, chemical and biological soil, increases their water retention, increases the exchange capacity of positive ions, reduces pH of the soil, and contributes to the production of humic acids and Fulvic acids leading to increasing soil nutrient elements and developing the root system. and maintain the soil temperature, which is reflected in improving the quality of the agricultural product and increase the activity of microbial and fungal microorganisms and it is considered a store for macro and micronutrients necessary for growth [5, 4, 3]. The fungal and bacterial bio-fertilizers are known as the ready-made structures of microorganisms. The bio-fertilizers (fungal and bacterial) are known as the ready-made structures of microorganisms, where If the soil is treated by it, they colonize the areas around the roots and stimulate plant growth by increasing the nutrient availability or hormone production, where forming a thin layer surrounds the roots directly, in it all bio-

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functions occurred. One of the most important used bio-fertilizer is the Mycorrhiza fungus and the Azotobacter bacteria [6]. Azotobacter bacteria have the ability to stabilize nitrogen and the secretion of stimulants that help to grow roots such as Gibberellins, cytokinines, and Auxins, such as IAA, it also has an important role in the protection of plants from pathogens [7]. The Mycorrhiza fungal is also considered a useful symbiotic relationship that has an important role in the supplying of the plant with nutrient elements, especially phosphorus, nitrogen, zinc and manganese, and reduced soil pH, which increases the availability of the micro-elements needed by the plant [9,8]. For the lack of studies on the growing of Gladiolus plants in Iraq, the study was conducted with the aim of:

To determine the best combination of agricultural media to improve the growth of the Gladiolus plant, Knowing the best bio-fertilizer to improve the growth and production of Gladiolus, determining the best concentration of potassium to improve the flowers and bulbs production of the Gladiolus plant, Finding the best interaction of (agricultural media + bio-fertilizer+ Potassium Concentration) needed to improve the growth and production of Gladiolus plant.

2. MATERIALS AND METHODS

This experiment was conducted in the greenhouse belonging to one of the private nurseries located near the Federal Court of Babylon for the spring season of (2017), for studying the effect of three agricultural Media of (loamy sand+ Peat Moss, loamy sand+ plant wastes, loamy sand+ sheep manures), three levels of bio-fertilizers (Without addition, Azotobacter, Mycorrhiza), and spraying with Potassium sulfate at three levels is (0, 1, 2 $g.L^{-1}$). The Gladiolus corms (Amsterdam cultivars) from the production of Dutch company (Stoop flower), with a diameter of (2 ± 5 cm) were cultivated on 20/20/2017. In cultivation, 27 cm diameter plastic flowerpots were used to cultivate the corms.

First factor: Agricultural media

peat moss was used in the preparation of the agricultural media produced by a German company (QTS), their traits are shown in of the Table (1). The decomposed plant waste produced by the fertilizer factory belonging to the College of Agriculture, University of Kufa, was also used. Sheep manures were used after decomposing it. All the organic media were then mixed with the loamy sand and took random samples of the loamy sand, sheep manures and plant wastes for analysis in the laboratories of the Ministry of Agriculture, Directorate of Agriculture in Babylon as shown in Tables (1, 2), The agricultural media were mixed according to the following percentages:

1- Loamy sand + peat moss with the percentage of (1: 3) which is symbolized by (A1)
2- Loamy sand + plant wastes with the percentage of (1: 3) which is symbolized by (A2)
3- Loamy sand + sheep manures with the percentage of (1: 3) and symbolized by (A3)

The second factor: Bio-fertilizers

Two types of bio-fertilizers were added, which were produced in the laboratories of the Agricultural Research Department, Ministry of Science and Technology. It is Mycorrhiza fungus with Glomus mosseae species and Azotobacter chroococcum, where the bio-fertilizers were added and according to the experimental treatments with rates of (50 g per pot in the pit prepared for the cultivation of the corms, The bio-fertilizer was treated to be in direct contact with the roots of the plants when they came out of the corms [10] and the treatments were symbolized as follows:

1- without adding which is symbolized by (B1)
2- Azotobacter bacteria which is symbolized by (B2)

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3- Mycorrhiza fungi which are symbolized by (B3)

The third factor: potassium sulfate

Potassium sulfate K_2SO_4 (percentage of potassium is 48%) was used as a source of potassium after the emergence of (2-3) real leaves by spraying on the total vegetative, and the spraying was repeated at a rate of one spraying every 15 days throughout the experiment and until full wetness. The spraying process was conducted in the early morning with the addition of a few drops of Dishwashing liquid as a spreading material and to break the surface tension for the water during the spraying of the solution and according to the following concentrations:

1- distilled water which is symbolized by (C1)
2- spraying with potassium sulfate at a concentration of (1 $g.L^{-1}$) which is symbolized by (C2)
3- spraying with potassium sulfate at a concentration of (2 $g.L^{-1}$) which is symbolized by (C3)

Table 1: Some chemical and physical traits of sheep manures, plant waste, and peat moss

Traits	Unit	Sheep manures	Peat moss	Plant waste
Electrical conductivity EC	$ds.m^{-1}$	2.30	3.78	2.1
pH	---	6.70	6.20	6.7
Organic matter	$g.kg^{-1}$	323	40.36	745.1
Ratio of carbon to nitrogen	---	13.71	16.67	53.65
Total nitrogen	$g.kg^{-1}$	30.5	10.5	10.6
Total phosphorus	$g.kg^{-1}$	8.24	7.10	2.64
Total potassium	$g.kg^{-1}$	20.93	13.50	15.59

Table 2: shows some chemical and physical traits for the used soil in the experiment

Chemical and physical traits	Value	Unit
pH	7.80	
Organic matter	2.17	$g.kg^{-1}$ soil
Electrical conductivity (EC)	2.10	$ds.m^{-1}$
Nitrogen	16.80	$mg.kg^{-1}$ soil
Phosphorus	10.64	
Potassium	180.64	
Soil separates		
Sand	780.39	$g.kg^{-1}$
silt	123.25	
Clay	96.36	
Texture	**Loamy Sand**	

Experimental design:

The experiment was conducted as a factorial experiment (3×3×3) according to the Randomized Complete Blocks Design (R.C.B.D), with three replicates, where each replicate of them containing 27 treatments, the averages were compared according to the test of Least Significant Difference (LSD) under 5% probability level [11]. Data were analyzed using the ready statistical program (Genstat).

The studied traits

1- **Plant height (cm)**

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It was calculated from the surface of the soil to the top of the inflorescence when the opening of four base florets using metric tap for all plants of the experimental unit and the average was then calculated for each treatment.

2- Leaf area (cm^2)

Five leaves were collected randomly from each plant of experimental units plant, the leaf area was measured using the scanner and by the Area meter type ADC Bioscientific Ltd and the result was calculated according to the following equation:

The leaf area of the plant (cm^2) = the average area of the one leaf area (cm^2) × the number of leaves per plant

3- Percentage of dry matter in leaves (%)

Five leaves were taken from the plants of the experimental unit before flowering and the fresh weight was measured firstly, it was then dry in the oven at 70 C for 48 hours and until the weight is stable. The percentage of dry matter for both plants was calculated as follows:

$$\text{The percentage of dry matter} = \frac{\text{dry weight for leaves}}{\text{fresh weight for leaves}} \times 100$$

4- Percentage of carbohydrates in leaves (%):

The total content of carbohydrate in the leaves was estimated according to the method described by [12].

5- The flowering period (day)

It was calculated by the number of days from the date of cultivation until the color appears in the basal flower of all plants of the experimental unit and the average was then calculated for each treatment.

6- Number of florets in the inflorescence ($floret.plant^{-1}$)

It was calculated when completed opening all flowers on the inflorescence and for all plants of the experimental unit and the average was then calculated for each treatment.

7- The duration of flowers on the plant (day)

It was calculated by the number of days from the appearance of color in flowers and until the loss of their flowering value.

8- Vase life (day):

It was calculated by the number of days from the appearance of color in flowers and until the loss of their flowering value, where the flowers were harvested and their lengths unified and placed in the conical bottles containing 500 ml of a preservative solution consist of (5% sucrose + 200 ($mg.L^{-1}$) 8.HQS + 200 ($mg.L^{-1}$) citric acid) and for all treatments homogenously until the end of the vase life.

9- The number of corms

The average number of corms per each plant of the experimental unit was extracted and the average was calculated for each treatment.

3. RESULTS

1) plant height (cm)

Table (3) shows the role of the agricultural media in increasing the height of the Gladiolus plant. The treatment A3 was significantly excelled on the rest of the other treatments in increasing the height of the Gladiolus plant which gave (139.40 cm), compared to the control treatment (A1), which gave the lowest plant height amounted of (128.75 cm). The results showed a positive effect for the use of bio-fertilizers, where the bio-fertilizer treatment B3 was significantly excelled in the increase the plant height which gave the highest height amounted to (141.94 cm), followed by treatment B2, which gave a height for Gladiolus amounted to (137.14 cm), respectively, compared to the control treatment B1, which

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gave the lowest height for Gladiolus amounted to (123.44 cm). The spraying with potassium sulfate has a significant effect in increasing the height of the Gladiolus plant, Table (3) shows that the treatment of C3 was significantly excelled by giving it the highest height amounted to (139.59 cm), while the control treatment gave the lowest height amounted to (128.35 cm). The bi-interaction between the agricultural media and bio-fertilizers achieved a significant increase in plant height. The A3B3 treatment recorded the highest values for plant height amounted to (149.00 cm), while A1B1 recorded the lowest average of plant height amounted to (118.28 cm), The interaction between the levels of the agricultural media and the levels of potassium sulfate showed a significant effect in increasing the height of the plant.

Table 3: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the height (cm) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate ($g.L^{-1}$) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	113.31	119.26	122.27	118.28
	B2	126.73	134.82	135.87	132.47
	B3	131.11	136.08	139.32	135.51
A2	B1	121.74	125.54	128.12	125.13
	B2	131.53	138.14	140.25	136.64
	B3	132.89	141.24	149.82	14132
A3	B1	124.22	127.01	129.48	126.90
	B2	134.23	142.93	149.76	142.31
	B3	139.42	146.15	161.44	149.00
L.S.D 0.05		**(A×B×C)= 11.47**			**6.62**
					A
Interaction AxC	A1	123.72	130.05	132.49	128.75
	A2	128.72	134.98	139.40	134.36
	A3	132.62	138.70	146.89	139.40
L.S.D 0.05		6.62			3.82
					B
Interaction BxC	B1	119.76	123.94	126.62	123.44
	B2	130.83	138.63	141.96	137.14
	B3	134.47	141.16	150.19	141.94
L.S.D 0.05		**6.62**			**3.82**
Potassium sulfate ($g.L^{-1}$) **(C)**		128.35	134.58	139.59	
L.S.D 0.05		**3.82**			

2) Leaf area (cm^2)

Table (4) shows that the agricultural media have a significant effect in increasing the leaf area of the Gladiolus plant. The treatment A3 was significantly excelled on the rest of the other treatments in increasing the leaf area of the Gladiolus plant which gave (1933.01 cm^2), compared to the control treatment (A1), which gave the lowest plant height amounted of (1513.38 cm^2). The results showed a significant excelling for the plants inoculation with bio-fertilizers, where the bio-fertilizer treatment B3 was significantly excelled in the increase the leaf area which gave the highest leaf area amounted to (2020.52 cm^2), All treatments were excelled on the control treatment, which gave the lowest leaf area amounted to (1309.43

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cm^2). The spraying treatment with potassium sulfate C3 gave the highest average of leaf area amounted to (1947.87 cm^2), while the leaf area decreased when treating it with the control treatment C1 amounted to (1461.02 cm^2). As for the interaction between agricultural media and bio-fertilizers showed that the treatment of A3B3 gave the highest values for this traits amounted to (2306.62 cm^2), treatment A1B1 recorded the lowest average of leaf area amounted to (1182.44 cm^2), respectively. As for the interaction between the agricultural media and the spraying with potassium sulfate achieved a significant increase in the leaf area for the Gladiolus. The bi-interaction treatment of A3C3 was significantly excelled by giving it the highest leaf area amounted to (2228.91 cm^2). All treatments were excelled on the control treatment (A1C1) which recorded (1331.76 cm^2). The interaction between bio-fertilizers and spraying with potassium was significantly affected, the highest leaf area for Gladiolus at treatment B3C3, which recorded (2324.70 cm^2), while the control treatment B1C1 has decreased to (1179.39 cm^2). The triple interaction treatment between study factors A3B3C3 was significantly excelled on the rest of the other treatments, the highest leaf area for the Gladiolus amounted to (2749.36 cm^2), while the control treatment A1B1C1 showed the lowest leaf area for the Gladiolus amounted to (1079.13 cm^2).

Table 4: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the leaf area (cm^2) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	1079.13	1139.37	1328.83	1182.44
	B2	1372.58	1714.94	1746.72	1611.42
	B3	1543.55	1805.46	1889.82	1746.28
A2	B1	1191.16	1326.83	1498.40	1338.80
	B2	1581.49	1885.32	2045.41	1837.41
	B3	1590.75	2100.30	2334.90	2008.65
A3	B1	1267.88	1437.08	1516.13	1407.03
	B2	1643.16	2191.76	2421.22	2085.38
	B3	1879.44	2291.05	2749.36	2306.62
L.S.D 0.05		**(A×B×C)= 211.08**			**121.87**
					A
Interaction AxC	A1	1331.76	1553.26	1655.13	1513.38
	A2	1454.47	1770.82	1959.57	1728.29
	A3	1596.83	1973.30	2228.91	1933.01
L.S.D 0.05		**121.87**			**70.36**
					B
Interaction BxC	B1	1179.39	1301.1	1447.79	1309.43
	B2	1532.41	1930.67	2071.12	1844.73
	B3	1671.25	2065.61	2324.70	2020.52
L.S.D 0.05		**121.87**			**70.36**
Potassium sulfate (g.L^{-1}) **(C)**		1461.02	1765.80	1947.87	
L.S.D 0.05		**70.36**			

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3) Percentage of dry matter in leaves (%)

Table (5) shows that the agricultural media had a significant effect on the increase in the percentage of dry matter in the leaves of the Gladiolus, where the treatment of A3 was significantly excelled by giving it the highest percentage of the dry matter in the leaves amounted to (25.08%). As for the A1 treatment recorded the lowest percentage of dry matter in the leaves amounted to 20.76%. The use of bio-fertilizers also showed a significant increase in the percentage of dry matter in the leaves of the Gladiolus, where the treatment B3 was significantly excelled by giving it (25.00%) compared to the control treatment which recorded (19.67%). while the spraying treatment with potassium sulfate significantly increased the percentage of dry matter in the leaves, where the treatment C3 was significantly excelled in increasing the percentage of dry matter in the leaves of the Gladiolus which gave 24.79%, compared to the control treatment C1 which gave 19.75%. The bi-interaction between the agricultural media and bio-fertilizers showed significant differences between the treatments, where The percentage of dry matter in Gladiolus leaves amounted their highest averages 28.96% at A3B3 treatment, while the A1B1 treatment gave 19.78%. The interaction between the agricultural media and the spraying with potassium sulfate was significantly excelled in increasing the percentage of dry matter in the leaves of the Gladiolus. where the A3C3 treatment recorded the highest values of this trait in the Gladiolus leaves amounted to 27.78, compared to the control treatment A1C1, which recorded the lowest values for the percentage of dry matter in leaves amounted to 19.32% , The results of the bi-interaction between the bio-fertilizers and the spraying with potassium showed a significant superiority of the B3C3 treatment, which recorded the highest values for this trait the Gladiolus leaves, which amounted to 29.67%, with significant difference from the B2C3 and B3C2 treatment, which recorded a percentage of dry matter amounted to (26.17, 25.79%), respectively, the percentage of dry matter in Gladiolus leaves decreased (19.35%) when treating it with the control treatment B1C1. the triple interaction between the study factors, treatment A3B3C3 recorded the highest values for the percentage of dry matter in the Gladiolus leaves amounted to 34.59%. The percentage of dry matter in the leaves decreased at the control treatment A1B1C1, which gave 17.61%.

3) Percentage of carbohydrates in leaves (%)

Table (6) shows that the agricultural media was significantly excelled in increasing the percentage of carbohydrates in leaves (%). The treatment A3 recorded the highest values for this trait, which gave 7.83%. All treatments excelled on the control treatment, which gave the lowest percentage of carbohydrates in leaves amounted to 6.44%. The results showed that bio-fertilizers had an important role in increasing the percentage of carbohydrate in the leaves. All bio-fertilizer treatments were excelled on the control treatment, which gave the lowest percentage of carbohydrates in leaves amounted to 5.64%, While treatment B3 gave the highest values for carbohydrates in the Gladiolus leaves amounted to 8.15%. The treatment of spraying with Potassium sulfate significantly affected in increasing the percentage of carbohydrate in the leaves, The C3 treatment was significantly excelled by giving it the highest percentage of carbohydrate in leaves amounted to 7.76%, while the percentage of carbohydrate in the Gladiolus leaves decreased at the control treatment C1, which gave 6.39%. The interaction between agricultural media and bio-fertilizers has an important role in increasing the percentage of carbohydrates in the leaves. The interaction treatments differed among themselves as shown in table (6), all of them were excelled on the control treatment A1B1 which recorded the lowest percentage of carbohydrates in the leaves amounted to 5.03%, While the A3B3

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treatment was significantly excelled the other interaction treatments by giving it the highest percentage of carbohydrates in the leaves amounted to 9.20%. The interaction between the agricultural media and the spraying with potassium sulfate achieved a significant increase in this trait. where the A3C3 treatment recorded the highest percentage of carbohydrate in the Gladiolus leaves amounted to 8.76%, while the interaction treatment A1C1 recorded the lowest percentage of carbohydrate in the leaves amounted to 5.80%. While the interaction treatments between bio-fertilizers and spraying with potassium sulfate showed a significant increase in the percentage of carbohydrate in the Gladiolus leaves. The results showed the excelling of interaction treatment B3C3 significantly in the increasing the percentage of carbohydrate which amounted to (9.00%), excelling on the interaction treatment B1C1, which gave the lowest percentage of carbohydrates in Gladiolus leaves amounted to 5.14%. The triple interaction treatment A3B3C3 was significantly excelled on other interaction treatments by giving it the highest percentage of carbohydrate in the leaves amounted to (10.71%), while the A1B1C1 treatment recorded the lowest percentage of carbohydrates in the Gladiolus leaves amounted to 4.70%.

Table 5: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the percentage of the dry matter in the leaves (%) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	17.61	19.08	22.66	19.78
	B2	23.76	19.96	21.21	21.65
	B3	16.58	21.82	24.13	20.84
A2	B1	18.80	23.26	15.62	19.23
	B2	17.99	24.13	25.85	22.65
	B3	18.72	26.55	30.30	25.19
A3	B1	21.62	21.03	17.32	19.99
	B2	19.40	28.03	31.44	26.29
	B3	23.28	28.99	34.59	28.96
L.S.D 0.05		**(A×B×C)= 2.51**			**1.45**
					A
Interaction AxC	A1	19.32	20.29	22.67	20.76
	A2	18.50	24.65	23.92	22.36
	A3	21.44	26.02	27.78	25.08
L.S.D 0.05		**1.45**			**0.84**
					B
Interaction BxC	B1	19.35	21.13	18.53	19.67
	B2	20.38	24.04	26.17	23.53
	B3	19.53	25.79	29.67	25.00
L.S.D 0.05		**1.45**			**0.84**
Potassium sulfate (g.L^{-1}) **(C)**		19.75	23.65	24.79	
L.S.D 0.05		**0.84**			

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Table 6: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the percentage of the dry matter in the leaves (%) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	4.70	4.96	5.41	5.03
	B2	5.94	7.28	7.52	6.91
	B3	6.76	7.50	7.86	7.37
A2	B1	5.11	5.82	6.42	5.78
	B2	6.91	7.69	7.94	7.51
	B3	7.05	8.11	8.43	7.86
A3	B1	5.61	6.12	6.62	6.12
	B2	7.21	8.32	8.96	8.16
	B3	8.25	8.65	10.71	9.20
L.S.D 0.05		**(A×B×C)= 1.44**			**0.83**
					A
Interaction AxC	A1	5.80	6.58	6.93	6.44
	A2	6.35	7.21	7.60	7.05
	A3	7.02	7.70	8.76	7.83
L.S.D 0.05		**0.83**			**0.48**
					B
Interaction BxC	B1	5.14	5.63	6.15	5.64
	B2	6.68	7.76	8.14	7.53
	B3	7.35	8.09	9.00	8.15
L.S.D 0.05		**0.83**			**0.48**
Potassium sulfate (g.L^{-1}) **(C)**		6.39	7.16	7.76	
L.S.D 0.05		**0.48**			

4) Flowering period (day)

Table (7) shows a significant difference for the agricultural media at the flowering period. As for the control treatment A1, the flowering started after 98.24 days. The addition of the bio-fertilizer (Mycorrhiza and Azotobacter) contributed to a significant increase in this trait, where treatment B2 recorded the lowest flowering period for Gladiolus plant amounted to 89.68 days, While the flowering date for the Gladiolus was delayed to 98.64 days at the control treatment B1. The results of the same table showed that the spraying with potassium sulfate had a significant effect on the early flowering of the plants. where the spraying treatment of C3 was significantly excelled in the early flowering date which amounted to 88.27 days, while the C1 treatment recorded the longest flowering date amounted to 99.97 days.

The interaction between the agricultural media and the bio-fertilizers improved the flowering date of the Gladiolus. The bi-interaction treatment A2B2 gave a flowering date for the of the Gladiolus flowers amounted to 83.29 days, while the flowering period was delayed at the interaction treatment A1B1 which flowered after 101.87 days. While the bi-interaction between the levels of the agricultural media and levels of potassium sulfate showed a significant effect in this trait. The A2C3 treatment recorded a flowering period amounted to 83.15 days for the Gladiolus, while the interaction treatment A1C1, the flowering period amounted to 103.75 days. The interaction between the bio-fertilizers and the spraying with potassium sulfate was significantly excelled in the flowering period. where the flowering period for the Gladiolus amounted to 82.82 days at the treatment of B2C3, while the flowering period

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was significantly delayed at B1C1, which gave 103.14 days for the Gladiolus. The results of the triple interaction between the experiment factors showed a significant effect on the improvement of the flowering period for the Gladiolus. The treatment A2B2C3 recorded the lowest flowering date amounted 75.37 days, while the flowering date for the Gladiolus was delayed at A1B1C1 treatment which amounted to 105.01 days.

Table 7: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the Flowering period (day) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate ($g.L^{-1}$) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	105.01	102.45	98.16	101.87
	B2	104.23	92.97	88.72	95.31
	B3	102.00	97.16	93.46	97.54
A2	B1	101.28	93.14	90.38	94.94
	B2	90.80	83.70	75.37	83.29
	B3	93.80	86.66	83.70	88.05
A3	B1	103.14	99.11	95.13	99.12
	B2	98.81	88.17	84.39	90.46
	B3	100.65	91.79	85.11	92.51
L.S.D 0.05		**(A×B×C)= 7.91**			**4.57**
					A
Interaction AxC	A1	103.75	97.53	93.45	98.24
	A2	95.29	87.83	83.15	88.76
	A3	100.87	93.02	88.21	94.03
L.S.D 0.05		**4.57**			**2.64**
					B
Interaction BxC	B1	103.14	98.23	94.56	98.64
	B2	97.95	88.28	82.82	89.68
	B3	98.82	91.87	87.42	92.70
L.S.D 0.05		**4.57**			**2.64**
Potassium sulfate ($g.L^{-1}$) **(C)**		99.97	92.79	88.27	
L.S.D 0.05		**2.64**			

5) Number of florets on the inflorescence (florets.inflorescence^{-1})

Table (8) shows that the A3 treatment is significantly excelled on the rest of the other treatments which recorded the highest average number of florets on the inflorescence amounted to (11.35 florets.inflorescence^{-1}), while the number of florets decreased in the control treatment A1 which gave (9.62 florets.inflorescence^{-1}) for the Gladiolus plant. As noted from the results of the same table, the excelling of the B3 treatment significantly in increasing the number of florets on the inflorescence for the Gladiolus which gave (11.86 florets.inflorescence^{-1}) compared to the control treatment B1, which gave the lowest number of florets on the inflorescence for the Gladiolus which amounted to (8.40 florets.inflorescence^{-1}). The spraying treatment with potassium sulfate (C3) led to a significant increase in the number of florets on the inflorescence for the Gladiolus which gave (11.47 florets.inflorescence^{-1}), while the number of florets decreased at treatment C1, which gave (9.40 florets.inflorescence^{-1}) for the Gladiolus plant. The bi-interaction between the agricultural media and the bio-fertilizers

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showed a significant superiority for this trait. The treatment of A3B3 has significantly excelled on the other interaction treatment which recorded the highest values for the number of florets on the inflorescence for the Gladiolus which gave (12.93 florets.inflorescence^{-1}) compared to the control treatment A1B1 in which decreased the number of florets on the inflorescence for the Gladiolus and amounted to (7.65 florets.inflorescence^{-1}). The bi-interaction between the agricultural media and the spraying with potassium sulfate showed a significant increase in the number of florets on the inflorescence for the Gladiolus. where the interaction treatment of A3C3 recorded the highest values for this trait amounted to (12.76 florets.inflorescence^{-1}) for the Gladiolus plant, while the A1C1 interaction treatment gave the lowest number of florets on the inflorescence for the Gladiolus amounted to (8.77 florets.inflorescence^{-1}). While the interaction treatments between bio-fertilizers and spraying with potassium sulfate showed a significant superiority in this trait. The results showed that the treatment of B3C3 was significantly excelled in increasing the number of florets on the inflorescence for the Gladiolus which gave (13.19 florets.inflorescence^{-1}), the control treatment B1C1 recorded the lowest average number of florets on the inflorescence, which amounted (7.80 florets.inflorescence^{-1}). The interaction between the experiment factors showed a significant increase in the number of florets on the inflorescence. The A3B3C3 treatment was significantly excelled on the other interaction treatments which gave the highest number of florets on the inflorescence for the Gladiolus and amounted to (14.86 florets.inflorescence^{-1}), As for the control treatment (A1B1C1), it gave the lowest average number of florets on the inflorescence for the Gladiolus and amounted to (7.13 florets.inflorescence^{-1}).

Table 8: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the Number of florets on the inflorescence (florets.inflorescence^{-1}) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	7.13	7.65	8.17	7.65
	B2	9.50	10.62	10.85	10.32
	B3	9.68	11.12	11.86	10.89
A2	B1	7.98	8.59	9.13	8.57
	B2	9.97	11.69	12.07	11.24
	B3	10.19	12.27	12.86	11.77
A3	B1	8.30	8.85	9.78	8.98
	B2	10.40	12.42	13.65	12.16
	B3	11.46	12.63	14.86	12.93
L.S.D 0.05		**(A×B×C)= 1.15**			**0.66**
					A
Interaction AxC	A1	8.77	9.80	10.29	9.62
	A2	9.38	10.85	11.35	10.53
	A3	10.05	11.24	12.76	11.35
L.S.D 0.05		**0.66**			**0.38**
					B
Interaction BxC	B1	7.80	8.36	9.03	8.40
	B2	9.96	11.58	12.19	11.24
	B3	10.44	11.95	13.19	11.86
L.S.D 0.05		**0.66**			**0.38**
Potassium sulfate (g.L^{-1}) **(C)**		9.40	10.63	11.47	
L.S.D 0.05		**0.38**			

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6) Duration of flowers on the plant (day)

Table (9) shows the role of the agricultural media in increasing the duration of flowers on the Gladiolus plant, where the A3 treatment was significantly excelled by giving it the highest duration for the flowers on the Gladiolus plant amounted to (10.20 days), excelling on the control treatment which gave 8.85 days for the Gladiolus flowers. The adding of bio-fertilizers has also significantly affected on this trait, Table (9) shows a significant superiority of B3 treatment in this trait for Gladiolus plant which gave 10.73 days, while the duration of flowers on the Gladiolus plant at treatment B1, which gave 7.78 days. Spraying with potassium sulfate led to prolonging the duration of flowers on the Gladiolus plant, where the spraying treatment C3 was significantly excelled by giving it the highest duration of flowers on the Gladiolus plant amounted to (10.44 days), while the control treatment gave the lowest duration of flowers on the Gladiolus plant amounted to (8.37 days). It is noted from the data of the bi-interaction between the agricultural media and bio-fertilizers a positive effect in increasing the duration of flowers on the Gladiolus plant, where the bi-interaction treatment A3B3 was significantly excelled on the rest of the other interaction treatments, which gave 11.97 days, While the duration of flowers on the Gladiolus plant at the interaction treatment A1B1, which gave the lowest duration of this trait amounted to (7.87 days). As for the interaction between the agricultural media and spraying with potassium sulfate, the results of Table (9) showed that the bi-interaction treatment A3C3 was significantly excelled on the rest of the other treatments in this trait, which gave 11.30 days, whereas the duration of flowers on the Gladiolus plant decreased at the treatment A1C1 which gave 7.85 days. The results showed that the interaction between bio-fertilizers and spraying with potassium sulfate had a significant effect on the duration of the flowers on the Gladiolus plant. The B3C3 treatment recorded the highest average for this trait amounted to (12.00 days), while the control treatment gave the lowest average amounted to (7.19 days). The results showed that the triple interaction between the agricultural media, bio-fertilizers, and spraying with potassium sulfate was significantly affected the prolong the duration of flowers on the Gladiolus plant, where the triple interaction treatment A3B3C3 achieved the highest duration of flowers on the Gladiolus plant amounted to (13.77 days). The duration of flowers on the Gladiolus plant decreased when treated with A1B1C1 treatment, which gave (7.06 days) for the Gladiolus flowers.

3) Vase life (day)

The trait of vase life is considered an important trait that determines the duration of flowering in a vase after cut flowers, which depends on the amount of nutrients absorbed by the plant, environmental conditions and fertilization prior to cutting. The results of Table (10) showed excelling the treatment of the agricultural media A3 was significantly excelled on the rest of the other treatments by giving the highest vase life for the Gladiolus flowers which amounted to 13.77 days, compared to the control treatment A1, which gave the lowest vase life amounted to 12.30 days. The data also show the significant effect of bio-fertilizers in the prolong the vase life of the Gladiolus flowers. where the B3 treatment was significantly excelled which gave the lowest vase life for the flowers amounted to (14.22 days), compared to the plants that were not inoculated with bio-fertilizer B1, which gave the lowest vase life amounted to (1.28 days) for the Gladiolus. The results showed a significant effect for the spraying with potassium sulfate on the prolong the vase life of the Gladiolus flowers. The C3 treatment was significantly excelled on the rest of the other treatments, which gave 13.84 days, compared to the control treatment C1, which

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gave 12.06 days for the Gladiolus. The bi-interaction between the agricultural media and the bio-fertilizers had a significant effect on the increasing the vase life of the Gladiolus flowers, The bi-interaction treatment A3B3 was significantly excelled, which recorded the highest vase life for the Gladiolus flowers amounted to (15.16 days), while the vase life of flowers decreased at the treatment A1B1 which gave 10.69 days. The A3C3 treatment was significantly excelled by giving it the lowest vase life amounted to (14.92 days). While the control treatment A1C1 gave the lowest vase life for Gladiolus flowers amounted to 11.44 days. Bi-interaction treatment between bio-fertilizers and spraying with potassium sulfate B3C3 was significantly excelled by recording it the highest vase life amounted to 15.27 days, while the interaction treatment B1C1 gave the lowest vase life amounted to (10.77 days). The results of Table (10) showed that the triple interaction between the three experiment factors had a significant effect on the vase life of the Gladiolus flowers. where the interaction treatment A3B3C3 showed the highest vase life amounted to 16.84 days, while the vase life for flowers decreased at the control treatment A1B1C1, which gave 10.21 days.

Table 9: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the Duration of flowers on the plant (day) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	7.06	7.13	9.41	7.87
	B2	7.79	9.34	9.65	8.92
	B3	8.71	9.96	10.60	9.76
A2	B1	7.22	7.58	8.17	7.66
	B2	8.80	10.54	10.63	9.99
	B3	8.90	10.87	11.63	10.47
A3	B1	7.30	7.94	8.20	7.81
	B2	9.21	11.32	11.92	10.82
	B3	10.30	11.83	13.77	11.97
L.S.D 0.05		**(A×B×C)= 0.52**			**0.30**
					A
Interaction AxC	A1	7.85	8.81	9.87	8.85
	A2	8.31	9.67	10.14	9.37
	A3	8.94	10.36	11.30	10.20
L.S.D 0.05		**0.30**			**0.17**
					B
Interaction BxC	B1	7.19	7.55	8.60	7.78
	B2	8.60	10.40	10.73	9.91
	B3	9.30	10.89	12.00	10.73
L.S.D 0.05		**0.30**			**0.17**
Potassium sulfate (g.L^{-1}) **(C)**		8.37	9.61	10.44	
L.S.D 0.05		**0.17**			

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Table 10: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the Vase life (day) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	10.21	10.61	11.26	10.69
	B2	11.64	13.14	13.36	12.72
	B3	12.47	14.04	13.93	13.48
A2	B1	10.99	11.47	11.94	11.47
	B2	12.64	13.86	14.26	13.59
	B3	12.78	14.31	15.03	14.04
A3	B1	11.11	11.72	12.21	11.68
	B2	12.93	14.75	15.72	14.46
	B3	13.77	14.86	16.84	15.16
L.S.D 0.05		**(A×B×C)= 1.10**			**0.63**
					A
Interaction AxC	A1	11.44	12.60	12.85	12.30
	A2	12.14	13.22	13.74	13.03
	A3	12.60	13.78	14.92	13.77
L.S.D 0.05		**0.63**			**0.37**
					B
Interaction BxC	B1	10.77	11.27	11.81	11.28
	B2	12.41	13.92	14.45	13.59
	B3	13.01	14.40	15.27	14.22
L.S.D 0.05		0.63			0.37
Potassium sulfate (g.L^{-1}) **(C)**		12.06	13.20	13.84	
L.S.D 0.05		**0.37**			

4) Number of corms (corms.plant^{-1})

The agricultural media has achieved a significant increase in the number of corms for the Gladiolus plant, Table (11) shows the excelling the treatment of the agricultural media A3 was excelled by giving it the highest number of corms for the Gladiolus plant amounted to (2.41 corms.plant^{-1}). As for the control treatment, it gave the lowest number of corms amounted to (1.71 corms.plant^{-1}). The results also indicated the significant effect for the bio-fertilizers in increasing the number of corms, where the bio-fertilizer treatment B2 has significantly excelled on the rest of the other treatments in increasing the number of corms for Gladiolus amounted to (2.61 corms.plant^{-1}), while the control treatment B1 gave the lowest number of corms amounted to (1.39 corms.plant^{-1}). The spraying treatment of the Gladiolus plants with potassium sulfate led to obtaining a significant increase in this trait. Table (11) shows that the treatment of C3 was significantly excelled in increasing the number of corms by giving it (2.46 corm.plant^{-1}), while the number of corms decreased at the treatment C1, which gave (1.62 corm.plant^{-1}). The interaction between the agricultural media and the bio-fertilizers showed a significant superiority of this trait. The A3B2 treatment was significantly excelled on the other interaction treatments by recording it the highest average the number of corms amounted of (3.10 corms.plant^{-1}) compared to the A1B1 treatment, which gave the lowest number of corms amounted to (1.25 corms.plant^{-1}). Bi-interaction between the agricultural media and spraying with potassium sulfate showed a significant increase in the number of corms,

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where the A3C3 treatment recorded the highest average number of corms amounted to (2.90 corms.plant^{-1}), while the bi-interaction treatment A1C1 recorded the lowest average for the number of corms amounted to (1.43 corms.plant^{-1}), while the interaction treatments between bio-fertilizers and spraying with potassium sulfate indicated to a significant increase in this trait. The results showed that the treatment of B2C3 was significantly excelled in increasing the number of corms amounted to (3.22 corms.plant^{-1}), excelling on the interaction treatment B1C1, which gave the lowest number of corms amounted to (1.25 corms.plant^{-1}). As for the triple interaction, The results showed the significant effect of the agricultural media, bio-fertilizers and spraying with potassium sulfate in increasing the number of corms. The triple treatment A3B2C3 has significantly excelled on the rest of the other treatments by giving it the highest number of corms amounted to (3.83 corms.plant^{-1}), while the average of this trait decreased to the lowest values at the control treatment A1B1C1, which recorded the lowest number of corms amounted to (1.17 corms.plant^{-1}).

Table 11: Effect of agricultural media, Bio-Fertilizers and Potassium sulfate and their Interaction in the Number of corms (corms.plant^{-1}) of Gladiolus Plant

Agricultural media (A)	**Bio-Fertilizers (B)**	**Potassium sulfate (g.L^{-1}) (C)**			**AxB**
		C1	C2	C 3	
A1	B1	1.17	1.25	1.33	1.25
	B2	1.63	2.17	2.53	2.11
	B3	1.50	1.83	1.97	1.77
A2	B1	1.25	1.52	1.63	1.47
	B2	1.73	2.83	2.30	2.62
	B3	1.75	2.43	2.70	2.30
A3	B1	1.33	1.42	1.62	1.47
	B2	2.33	3.10	3.83	3.10
	B3	1.83	2.97	3.25	2.69
L.S.D 0.05		**(A×B×C)= 0.52**			**0.30**
					A
Interaction AxC	A1	1.43	1.75	1.94	1.71
	A2	1.58	2.26	2.54	2.13
	A3	1.83	2.50	2.90	2.41
L.S.D 0.05		**0.30**			**0.17**
					B
Interaction BxC	B1	1.25	1.39	1.53	1.39
	B2	1.90	2.70	3.22	2.61
	B3	1.69	2.41	2.64	2.25
L.S.D 0.05		**0.30**			**0.17**
Potassium sulfate (g.L^{-1}) **(C)**		**1.62**	**2.17**	**2.46**	
L.S.D 0.05		**0.17**			

4. DISCUSSION

The results of the tables (3-11) showed that the agricultural media (loam + sheep manures) was significantly excelled on the rest of the media in all the studied traits. This is due to the role of sheep manures in improving soil fertility and increase the availability of nitrogen, phosphorus, potassium, iron, and magnesium and increase its absorption by the plant. It affects various bio-functions such as the cells division forming the membranes and their elongation, building proteins and nucleic acids,

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thus forming good vegetative growth [13]. Organic matter works to form a good root mass and is an important source for the ions necessary for plant growth. where carbon is transformed into CO2, which can dissolve in water and turn into carbonic acid, which turns into ammonium ion, which enters into many of the bio-processes within the plant and directly enters the formation of the chlorophyll molecule [14] which increases photosynthesis product and nutrient accumulation, Proteins needed to form flower buds and to increase the activity of organisms that produce enzymes such as Phosphatase and Protease that improve plant growth and root activity in soil nutrient absorption, which improve plant growth and root activity in nutrient absorb of soil as well as containing animal manures on many organic and nitrogenous compounds that can be absorbed by the plant and improve flowering traits such as alanine, glycine, vanillic acid, contain vitamins and hormones [16,15]. The organic matter has an important role in increasing the exchange potential of the soil (CEC), thus increase the absorption of nutrient elements, especially nitrogen and potassium, which have an important role in increasing the corms through their role in the photosynthesis process, the transfer of carbohydrate materials and the lack of these elements (N, K) leads to a small number of formed corms [17], where the nitrogen element accelerates the activity of the Meristematic cells for the plant, thus increases the number and size of the cells [18]. The organic matter works on chelating of the calcium and increase the absorption of potassium by activating the plants roots, thus increase the efficiency of the roots absorption and the accumulation of these elements in the storage areas such as corms, increase the abundance of nutrients and absorption it by the efficiency of the total root lead to an increase in the amount of photosynthesis in the plant, Which is positively reflected on the manufacture of nutrient materials, especially carbohydrates and their accumulation in leaves [20,19], thus increase the studied traits as shown in tables (3-11). Bio-fertilizers have an important role in increasing the studied traits as shown in (3-11), where the bio-fertilizer treatment B3 (Mycorrhiza) was significantly excelled, this superiority is due to the role of the Mycorrhiza in penetrating the roots wherever emerge and forming a network of fungus hyphae inside the soil and facilitates the absorption of nutrient elements as well as the Mycorrhiza has the ability to secrete growth-stimulating substances such as auxins, which increase cell division and expansion and elongation of plant tissues [22,21], Increases plant height and leaf area as shown in Table (3, 4). The inoculation with Mycorrhiza also increased growth Indicators due to symbiotic symbiosis between fungi and plants, improve the growth of the root system and increase the efficiency of elements absorption, thus increase the growth of the host plant, which is equipped with carbonate compounds and thus increase the accumulation of nutrient elements in the leaves [23], increasing the percentage of dry matter and carbohydrates in the leaves as shown in Table (5, 6). The early date of flowering as shown in table (7) may be due to the effect of Mycorrhiza directly on plant growth through its secretion of growth-stimulating substances and It also indirectly enters through improving the formation of the soil through its secretion of Globlen materials, which works to hold soil particles and increase their water retention [24]. This increase can be attributed to its role in the efficient absorption for the main elements necessary for growth, which leads to increase the vegetative growth of the plant and increases the plant's ability to manufacture nutrients and increase its accumulation in flowers where flowers are attractive sources of manufactured materials in the plant [25], thus increasing the number of formed flowers on the inflorescence as shown in Table (8), The increase in the activity of the root system and total vegetative is reflected in the activity of total flowering, Mycorrhiza also has the ability to reduce the effectiveness of the peroxidase enzyme and increase the Super oxidase dismutase (SOD)

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enzyme at the beginning of the petals senescence for the Gladiolus flowers, which prolongs its age [26], As well as an increase in the ability of the ACC-Deaminase enzyme, which analyzes the composite ACC compound which is considered an initiator for the construction of ethylene [27], thus increases the duration of flowers on the plant as shown in Table (9). The ability of bio-fertilizers to produce plant hormones such as Gibberellins and auxins and their role in improving plant growth and the efficiency of the root system in increasing the absorption of nutrient elements from the soil, which affects the increase of manufactured carbohydrates and storage of sufficient nutrient for flowers after the cut flowers. Cytokinin plays an important role in delaying the senescence of flowers and in improving the traits and appearance of flowers [28]. which affect in increasing the vase life for the Gladiolus flowers as shown in Table (10). The results showed that the spraying with potassium sulfate at a concentration of (2 $mg.L^{-1}$) has an important role in increasing most of the studied traits as shown in Tables (3-11), where the potassium works on the growth and development of the plant for its contribution as a catalyst in many bio-processes and activates the enzymes of the manufacture of proteins and also plays an effective role in regulating the Osmotic pressure within the plant cells, which helps to increase the absorption of nutrient elements that participate in the formation of proteins and increase the efficiency of photosynthesis as well as It also has an important role in the synthesis of nucleic acids and increasing cell division [21, 29]. Since potassium encouraged vegetative growth represented by plant height and leaf area as shown Table (3, 4), this, in turn, led to an increase in root growth, which was reflected in the increase of the number of corms as shown in Table (11). The increase of carbohydrates in the leaves as shown in Table (6) may be due to the role of potassium in improving vegetative growth and increase the efficiency of photosynthesis in the production of carbohydrates where it was found that the lack of potassium reduces the efficiency of this process as well as increased respiratory rates, which causes a lack of carbohydrates and accumulation in the leaves [30], This is evidence of the role of potassium in increasing the content of carbohydrates in leaves. This is due to the role of potassium in increasing the leaf area, the content of carbohydrates in the leaves, increase the activity of enzymes, the transfer of sugars, regulate the Osmotic pressure and increase the absorption of elements [31], leading to early of a flowering date. Potassium is also important in the photosynthesis process and the transfer of sugars from source to sink, it plays an important role in the composition of protein and the accumulation of these manufactured materials in flowers leads to the rising the Osmotic pressure [32], it leads to an increase in the number of flowers and florets and it also introduces in the activation of enzymes that lead to delaying the flowers senescence [33], thus increases the duration of flowers on the plant and increases the vase life as shown in Table (9, 10).

5. CONCLUSIONS

The use of the agricultural media led to achieving the best results in the studied traits, where the agricultural media (loamy sand + sheep manures) has significantly excelled by giving it the highest values for most of the studied traits, and the bio-fertilizers (Mycorrhiza and Azotobacter) have a significant role in increasing the studied traits for the Gladiolus plant, where the treatment of Mycorrhiza was significantly excelled by achieving it the highest values of growth indicators, while the results showed the significant effect for the levels of spraying with potassium sulfate in the growth traits, where the studied traits increased significantly with increasing levels of spraying.

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