Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract on seeds germination and seedling growth of *Acacia farnesiana* L

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Abstract:

A factorial experiment was carried out in a randomized complete block design, RCBD, in Sarchnar Nursery of the Directorate of Agriculture in Sulaimani in the Kurdistan Region - Iraq. The experiment was conducted for the period between 4.4.2021 and 4.10.2021 which included three factors that were PGPR, (*pseudomonas putida* and *Bacillus Subtilis*) (P0) without inoculating seeds in PGPR, (P1) inoculating seeds in PGPR, GA3 at three concentration (G0) 0 ppm, (G1) 75 ppm and (G3) 150 ppm and foliar application with seaweed extract (Alga 600) (L0) 0 mgL^{-1}, (L1) 1.5 mgL^{-1}, and their interactions. The results showed the superiority of the PGPR (P1) in the traits (germination percentage, plant height, stem diameter, N,P,K percentage, relative chlorophyll in the leaves, fresh and dry weight of the shoot system, dry weight of the root system and Root dry matter) which recorded(68.00%, 177.00cm, 8.05mm, 1.80%, 0.33%, 2.43%, 33.42 SPAD, 164.04gm, 66.84gm, 13.40gm, and19.94) respectively, treatment with GA3 at the concentrate 75ppm (G1) showed its superiority in the characteristics of the (germination percentage, plant height, stem diameter, N,P,K percentage, relative chlorophyll in the leaves, fresh and dry weight of the root system and Root dry matter) were recorded (78.67%, 170.00cm, 13.10mm, 2.32%, 0.38%, 2.67%, 68.84gm, 13.40gm, 19.84) respectively. Whereas, foliar application with seaweed treatment (Alga 600) (L1) excelled in the traits (Germination percentage, plant height, stem diameter, N,P,K percentage, relative chlorophyll in the leaves, fresh and dry weight of the root system and Root dry matter) which were recorded (70.11%, 170.00cm, 9.19mm, 1.34%, 0.35%, 2,45%, 33.99 SPAD, 63.52gm, 12.67gm,19.73)respectively . The triple interaction treatment between PGPR inoculation, 150ppm of GA3 and foliar application with seaweed extract, P1G2L1 was superior in the traits (germination percentage, plant height, stem diameter, N,P,K percentage, relative chlorophyll in the leaves, root dry weight and root dry matter) and the values were recorded (96.33%, 204.33 cm, 15.67mm, 2.76%, 0.48%, 2.76%, 52.27 SPAD, 17.81 gm and 28.86) respectively. Whereas, the inoculation with PGPR, Gibberellic acid at 75ppm and without using seaweed extract P1G1LO treatment recorded significant superiority in the traits shoot fresh and dry weight, and it was recorded (233.24 gm and 47.41 gm) respectively.

Keywords*: Acacia farnesiana, PGPR, Gibberellin, Seaweed extract (Alga 600)*

Introduction

Acacia farnesiana L. (Sweet Acacia) belongs to the Fabaceae, This tree can be propagated by either seed or stem cutting [30]. The genus Acacia is one of the largest genera of leguminous trees ever exist in tropical and subtropical regions, comprising about 1,200 species [25]. The acacia tree has many benefits and uses. It is a major component of forest trees, a good accommodation for the soil and resistance to erosion. It can also be used as a windbreaker, in addition to the beauty of its appearance as one of the approved ornamental trees. Also, many perfume factories in Europe produce a sweet perfume in the name of Cassie, in honor of the name of the acacia tree [13].

In the last five decades, it has become common for the use of bacterial and fungal Biofertilizers to reduce the pollution of the environment, which has increased due to the excessive use of chemical fertilizers and pesticides, as nitrogen consumption has increased at a rate of (9) times

and phosphorous at a rate of (4) times [3]. A Biofertilizer is a preparation that contains beneficial microorganisms, whether they are bacteria, fungi, or both. Seeds, roots of seedlings or soil are inoculated with these inoculants, which contributes to providing part of the plant's nutrient requirements, as these organisms transform some elements from their organic forms into mineral forms that can be absorbed by the roots of the plant, in addition to the secretion of many important compounds by these organisms, and growth regulators that enrich the rhizosphere, which reflects on plant growth and increase its biological activities [21], Biofertilizers contribute to fixing atmospheric nitrogen, dissolving phosphorous and increasing the availability of microelements. Recent studies have shown that the PGPR system can act in several mechanisms directly at the same time through the atomization of atmospheric nitrogen and dissolving nutrients such as phosphorous, potassium and sulfur, or indirectly by competing with pathogens and spreading them, in addition to removing harmful bacteria that produce them. It stimulates plant growth through the production of IAA, which contributes to the emergence of roots, cell division and elongation, thus increasing the surface area of the roots, which increases the plant's ability to absorb nutrients, [18]. As well as its high ability to secrete growth regulators and produce Acc-deaminase, which limits high ethylene levels in plant tissues [22]. *Bacillus subtilis* and *Pseudomonas putida* are among the most important common bacteria that act as biocontrol as well as encouraging plant growth through the secretion of growth-promoting phytohormones such as IAA (Indole Acetic acid), [29] and auxins (Acc-deaminase). [5], it also increases the availability of phosphorus through the secretion of organic acids and phosphatase enzymes, as well as the secretion of iderophores, which chelates microelements as well as its role in bio control of pathogen resistance [27]. [20] stated that Co-inoculated *Acacia gerrardii* with B. subtilis strain and *Arbuscular mycorrhizal* fungi had a significantly greater shoot and root dry weight. *Albizia lebbeck* and *Acacia catechu* seeds inoculation with Rhizobium liquid increase the seed germination [17]. [24] Pointed out that *Acacia auriculiformis* seed inoculation with Beneficial Microorganisms at 2% lead to increase germination rate, root and shoot length, dry and wet weights of root and shoot system. *Acacia mangium* seeds inoculation with microbial 2% increase seed germination and seedling growth, dry weight of shoot and root system [28].

Gibberellins are one of the plant hormones that are produced naturally within plant tissues, and there are about 136 types of gibberellins. The effects of physiological gibberellins on the plant appear by encouraging it to divide and elongate cells and stimulating the preliminary phase of indirect division in the subapical meristem layer, reducing the period of cell division and increasing the elongation of the internodes, as well as stimulating flowering in some plants and overcoming the phenomenon of dwarfism Shortening the phalanges, where gibberellin increases the elongation of cells and affects the breaking of dormancy in seeds [7]. [30] Founded that treating *Acacia farnesiana* seeds with GA3 and IAA decreased levels of endogenous inhibiting substances. [17] Indicated that using GA3 increase seeds germination and growth in *Albizzia lebbeck*, *Acacia nilotica* and *Prosopis cineraria*.

Seaweed extracts are safe alternatives to some types of chemical fertilizers, as they contribute to reducing environmental pollution by reducing chemical fertilizers and promoting the growth of beneficial organisms, increasing seed germination and increasing the efficiency of macro and micro-nutrient uptake [10]. Seaweed extract (Alga 600) contain large amounts of compounds that affect plant growth, such as auxins that stimulate rooting, elongation and cell division, and gibberellins that promote cell division and stimulate seed germination, and increase plant tolerance to drought by improving

adaptability to osmotic pressure change. [1]. In recent years, the use of Seaweed extracts has become widespread, whose importance has emerged in improving plant growth because of the various growth regulators they contain and the nutrients in them, especially the microelements that enter into various metabolic activities, which is reflected on plant growth. [26] Showed that using seaweed extract increase Nitrogen content in leaves of *pinus pinea.* [23] confirmed that using seaweed extract increased chlorophyll content in Grapes leaves; Therefore, this study aimed to know the effect of *Pseudomonas putida, Bacillus subtilis*, gibberellin and seaweed extract and the interaction between them on seed germination and vegetative growth of *Acacia farnesiana*'s seedlings.

Materials and Methods

The study was carried out in Serchnar nursery in Sulaimani Governorate / Kurdistan Region – Iraq, for the period between 4.4.2021 and 4.10.2021 to find out the response of acacia seeds and seedlings to the effect of using *Pseudomonas putida, Bacillus subtilis*, soaking the seeds with gibberellin and the seedlings foliar application with seaweed extract.

The seeds were soaked for 30 minutes in the bacterial culture, where the bacterial culture consisted of two types of bacteria, *Pseudomonas putida, Bacillus subtilis*. With inoculation density (CFU) Colony broth unite, of 1×10^8, and 10gm of Arabic glue was dissolved in a liter of warm water, 10ml was withdrawn from it and added to the bacterial culture, Arabic gum was added to it to ensure that the seeds were inoculated. Then the seeds were removed from the bacterial culture and placed in a shaded place away from the air for a 20 minutes, and they were planted in the place prepared for them. The seeds were soaked with gibberellic acid at a concentration of 75ppm and 150ppm for 24 hours, after which they were transferred to the place of cultivation. Polyethylene bags with a capacity of 7 kg were used in the study, the growth media contained a mixture of soil and peat moss at a ratio of 3:1. The seaweed extract was sprayed at a concentration of $1.5 mgL^{-1}$ (1.5 ppm) for six times after the seedlings reached a height of 10cm, where the period between one foliar application and another was 14 days.

The treatments included the following:

P0= Without PGPR **P1**= With PGPR (*Pseudomonas putida* and *Bacillus subtilis)*

G0= Without Gibberellin **G1**= 75ppm of Gibberellin **G2**= 150ppm of Gibberellin

L0= 0 mg L^{-1} of Seaweed extract (Alga 600)

L1= 1.5 mgL^{-1} of Seaweed extract (Alga 600)

288 seeds were sown on 4/4/2021 at a rate of 2 seeds per bag. The plants were thinned after germination and one plant was left for each bag. The experiment included 12 treatments with three replicates. Each unit of the experiment included 4 plants (4 bags), thus the number of experimental units were 36, and the number of plants were 144 plants.

The parameters of the study were:

Seed germination (%), Shoot high (cm), Stem diameter (mm) , plant content of N,P,K, relative Chlorophyll in the leaves (SPAD unit), shoot fresh weight (gm), shoot dry weigh (gm), Shoot Dry matter content (%), root fresh weight (gm), root dry weight (gm), Root dry matter content (%). The factorial experiment was carried out according to Randomized Complete Blocks Design (RCBD), XLSTAT program [2] was used for analyzing the data, and the averages were compared with the Duncan Multiple Range at a level probability of 5% [9].

Table 1: Some of chemical and physical characteristics of the soil

field soil characteristics	Value	
EC	1.4 dsm^{-1}	
pH	7.03	
N	43.7 $MgKg^{-1}$	
P	8.63 $MgKg^{-1}$	
K	417 $MgKg^{-1}$	
S	3.86 $MgKg^{-1}$	
MG	1.63 $MgKg^{-1}$	
Texture	Sand	510 gKg^{-1}
	Silt	280 gKg^{-1}
	Clay	210 gKg^{-1}

The soil samples were analyzed at central Laboratory in the College of Agriculture Engineering Science / University of Bagdad according to [11].

Table 2: Chemical compounds of PGPR and Seaweed extract (Alga 600)

PGPR	Alga 600	
Bacillus subtilis	**Organic matter**	**45-55% w/w**
Pseudomonas putida	**Total Nitrogen**	**0.5-0.8% w/w**
Protease	**Potassium**	**17-19% w/w**
Amylase	**Mg**	**0.04% w/w**
Chitinase and Lipase	**Ca**	**0.6%- 1.8% w/w**
Gibberellin 0.3%	**Fe**	**0.15%-0.3%w/w**
Cytokinin 0.3%	**Cu**	**7ppm**
	S	**1%- 1.5% w/w**
	I	**350ppm-650ppm**
	Amino Acids	**2560 mg/kg**

Results:

1- Germination percentage

The results of Table (3) show the significant effect of the study's treatments that outperformed all of them in this trait, as the treatments P1, G2 and L1 recorded values (68.00, 78.67 and 70.11) compared to the treatments P0, G0 and L0 which gave (62.19, 48.37 and 60.08).% respectively. The interaction between the study factors showed the superiority of the treatments P1G2, P1L1 and G2L1 by recording the values (82.17, 72.67 and 89.67%), respectively, compared to the treatments P0G0, P0L0 and G0L1, which gave (46.42, 56.83 and 47.33%), respectively. Treatment P1G2L1 achieved a significant increase of 47.93% with a value of 96.33% compared to treatment P0G0L0 which gave 46.17%.

Table 3: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on seeds Germination percentage of *Acacia farnesiana*

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	46.17 E	46.67 E	46.42 D
	G_1	57.00 DE	73.00 BC	65.00 C
	G_2	67.33 CD	83.00 B	75.17 AB
P_1	G_0	52.67 E	48.00 E	50.33 D
	G_1	69.33 CD	73.67 BC	71.50 BC
	G_2	68.00 CD	96.33 A	82.17 A
L × P				P
P_0		56.83 C	67.56 AB	62.19 B
P_1		63.33BC	72.67 A	68.00 A
G × L				G
G_0		49.42 D	47.33 D	48.37 C
G_1		63.17 C	73.33 B	68.25 B
G_2		67.67 BC	89.67 A	78.67 A
L		60.08B	70.11 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

2- Plant high (cm)

It is clear from the results of table (4) the significant effect of the treatments P0,G2 and L1 which registering (157.70, 177.00 and 170.00)cm respectively, compared to the treatments P1, G0 and L0 which gave (140.39, 115.33 and 127.89)cm, respectively. The transactions P1G2, P1L1 and G2L1 achieved their superiority by recording the values (189.83, 174.00 and 199.33)cm. And treatment P1G2L1 outperformed by registering 204.33 cm compared to treatment P0G0L0 which gave 72.67cm.

Table 4: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' high (cm)

(PGPR)	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	72.67 G	138.33 DE	105.50 E
	G_1	137.67 DE	165.33 BC	151.50 C
	G_2	134.00 E	194.33 A	164.17 B
P_1	G_0	95.67 F	154.67 C	127.17 D
	G_1	152.00 CD	163.00 BC	157.50 BC
	G_2	175.33 B	204.33 A	189.83 A
L × P				P
P_0		114.78 C	166.00 A	157.70 A
P_1		141.00 B	174.00 A	140.39 B
G × L				G
G_0		84.17 D	146.50 C	115.33 C
G_1		144.83 C	164.17 B	154.50 B
G_2		154.67 BC	199.33 A	177.00A
L		127.89 B	170.00 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels

3- Stem diameter (mm):

The study treatments achieved their significant effect in this trait and this is indicated by the results of the table (5). The treatments P1, G2 and L1 recorded values of (8.05, 13.10 and 9.19) mm respectively compared to treatments P0, G0 and L0 which gave (6.47, 1.38 and 5.32) mm respectively. In the interaction, between the study factors, treatments P1G2, P1L1 and G2L1 excelled by registering (13.27, 9.73 and 6.48) mm respectively compared to treatments P0G0, P0L0 and G0L0 which gave (1.18, 4.28 and 1.18) mm respectively. Treatment P1G2L1 recorded its significant superiority by registering 15.67 mm compared to treatment P0G0L0 which gave 0.93 mm.

Table 5: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' stem diameter (mm)

(PGPR)	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	0.93 E	1.43 DE	1.18 D
	G_1	3.33 D	7.23 C	5.28 C
	G_2	8.57 C	17.30 A	12.93 A
P_1	G_0	1.43 DE	1.74 DE	1.59 D
	G_1	6.80 C	11.80 B	9.30 B
	G_2	10.87 B	15.67 A	13.27 A
L × P				P
P_0		4.28 D	8.66 B	6.47 B
P_1		6.37 C	9.73 A	8.05 A
G × L				G
G_0		1.18 D	1.58 D	1.38 C
G_1		5.07 C	9.52 B	7.29 B
G_2		9.72 B	6.48 A	13.10 A
L		5.32 B	9.19 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

4- Nitrogen %

It is clear from the results of Table (6) the significant effect of the treatments P1, G2 and L1, which registering (1.80, 2.32 and 1.34%) respectively, compared to the treatments P0, G0 and L0 which gave (1.60, 1.37 and 1.56)%, respectively. The transactions P1G2, P1L1 and G2L1 achieved their superiority by recording the values (2.55, 1.89 and 2.64)% compared to the interactions P0G0, P0L0 and G0L0 which recorded (1.32, 1.42, 1.33)%, respectively. And treatment P1G2L1 outperformed by registering 2.76% compared to treatment P0G0L0 which gave 1.26%.

Table 6: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Nitrogen percentage in the leaves

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	1.26 D	1.37 D	1.32 C
	G_1	1.34 D	1.46 CD	1.40 C
	G_2	1.66 C	2.52 AB	2.09 B
P_1	G_0	1.39 CD	1.44 CD	1.42 C
	G_1	1.38 D	1.47 CD	1.43 C
	G_2	2.34 B	2.76 A	2.55 A
L × P				P
P_0		1.42 C	1.78 AB	1.60 B
P_1		1.70 B	1.89 A	1.80 A
G × L				G
G_0		1.33 C	1.41 C	1.37 B
G_1		1.36 C	1.47 C	1.43 B
G_2		2.0 B	2.64 A	2.32 A
L		1.56 B	1.34 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels

5- Phosphorus %

The results of Table (7) indicate the significant effect of the study's treatments in this trait, as the treatments P1, G2 and L1 recorded values (0.33, 0.38 and 0.35) %, respectively, compared to the treatments P0,G0 and L0, which gave (0.27, 0.24 and 0.25) % respectively. The interactions showed the superiority of the treatments P1G2, P1L1 and G2L1 as they recorded (0.40, 0.39 and 0.46) %, respectively, compared to the treatments P0G0, P0L0 and G0L0, which gave (0.21, 0.23 and 0.22) %, respectively.The treatment P1G2L1 excelled in the triple interaction between the study factors, as it scored 0.48% compared to the treatment P0G0L0, which gave 0.20%.

Table 7: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' phosphorus percentage in the leaves.

PGPR	Gibberellin	Alga 600		G× P
		L_0	L_1	
P_0	G_0	0.20 E	0.21 E	0.21 D
	G_1	0.23 E	0.31 CD	0.27 C
	G_2	0.27 DE	0.43 AB	0.35 B
P_1	G_0	025 DE	0.31 CD	0.28 C
	G_1	0.25 DE	0.37 BC	0.31 BC
	G_2	0.32 CD	0.48 A	0.40 A
L × P				P
P_0		0.23 D	0.32 B	0.27 B
P_1		0.27 C	0.39 A	0.33 A
G × L				G
G_0		0.22 D	0.26 D	0.24 C
G_1		0.24 D	0.34 B	0.29 B
G_2		0.30 BC	0.46 A	0.38 A
L		0.25 B	0.35 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

6- Potassium %

It is clear from the results of Table (8) the significant effect of the treatments P1, G2 and L1, which registering (2.43, 2.67 and 2.49%) respectively, compared to the treatments P0, G0 and L0 which gave (2.29, 1.94 and 2.22)%, respectively. The interaction between treatments P1G1, P1L1 and G2L1 achieved their superiority by recording the values (2.71, 2.60 and 2.73)% compared to the interactions P0G0, P0L0 and G0L0 which recorded (1.79, 2.19 and 1.68)%, respectively. And treatment P1G2L1 outperformed by registering 2.76% compared to treatment P0G0L0 which gave 1.59%.

Table 8: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Potassium percentage in the leaves

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	1.59 F	1.99 E	1.79 D
	G_1	2.44 CD	2.45 CD	2.44 B
	G_2	2.54 BC	2.70 AB	2.62 A
P_1	G_0	1.77 F	2.39 CD	2.08 C
	G_1	2.32 D	2.66 AB	2.49 B
	G_2	2.66 AB	2.76 A	2.71 A
L × P				P
P_0		2.19 C	2.38 B	2.29 B
P_1		2.35 C	2.60 A	2.43 A
G × L				G
G_0		1.68 E	2.19 D	1.94 C
G_1		2.38 C	2.55 B	2.47 B
G_2		2.60 A	2.73 A	2.67 A
L		2.22 B	2.49 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

7

- **Relative chlorophyll in the leaves (SPAD unit).**

It is clear from the table (9) the significant superiority of the PGPR, as treatment P1 recorded 33.42 SPAD unit compared to treatment P0, which gave 30.48 SPAD unit. Treatment G2 outperformed treatments G0 and G1 as it scored 43.95 SPAD unit, and treatment L1 showed its significant superiority by recording 33.99 SPAD compared to treatment L0, which gave 29.91 SPAD unit. The interaction showed the significant superiority of the treatments P1G2, P1L1 and G2L1 which recorded the values (47.48, 35.50 and 48.77) SPAD unit respectively, and the treatment P1G2L1 achieved its superiority by recording 52.27 SPAD unit compared to the treatment P0G0L1 which gave 22.33 SPAD unit.

Table 9: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Relative Chlorophyll content in the leaves (SPAD)

PGPR	Gibberellin	Seaweed (Alga600)		G× P
		L_0	L_1	
P_0	G_0	24.87 DE	22.33 E	23.60 D
	G_1	25.0 DE	29.83 D	27.42 C
	G_2	35.57 C	45.27 B	40.42 B
P_1	G_0	25.77 DE	27.13 DE	26.45 CD
	G_1	25.57 DE	27.10 DE	26.33 CD
	G_2	42.70 B	52.27 A	47.48 A
L × P				P
P_0		28.48 C	32.48 B	30.48 B
P_1		31.34 B	35.50 A	33.42 A
G × L				G
G_0		25.32 CD	24.73 D	25.03B
G_1		25.28 CD	28.47 C	26.87 B
G_2		39.13 B	48.77 A	43.95 A
L		29.91 B	33.99 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

8- Shoot fresh weight (gm)

The results of Table (10) show that this trait was not affected by the individual study treatments Gibberellin and Alga600 but P1 showed the significant superiority which recorded value 164.04 gm outperforming the treatment P0 which gave 120.13g, while the interaction showed the significant superiority of the treatments P1G0, P1L0 and G0L0 which recorded values of (209.85, 201.48 and 200.91) gm, respectively. The interaction treatment P1 G1L0 recorded a value of 233.24 gm.

Table 10: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' shoot fresh weigh (gm).

PGPR	Gibberellin	Seaweed(Alga 600)		G× P
		L_0	L_1	
P_0	G_0	177.55 BC	145.49 CD	161.52 B
	G_1	114.71 DE	47.46 G	81.09 E
	G_2	132.75 DE	102.80 EF	117.77 D
P_1	G_0	224.27 A	195.42 AB	209.85 A
	G_1	233.24 A	74.51 FG	153.87 BC
	G_2	146.92 CD	109.91 DEF	128.41 CD
L × P				P
P_0		141.67 B	98.58 C	120.13 B
P_1		201.48 A	126.61 B	164.04 A
G × L				G
G_0		200.91 A	170.45 B	185.68 A
G_1		173.97 B	60.98 E	117.50 B
G_2		139.83 C	106.35 D	123.09 B
L		171.57 A	112.59 B	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

9- **Shoot dry weight (gm)**

The results of table (11) show that this trait was not affected by the individual study treatments Gibberellin and Alga600 but P1 showed the significant superiority which recorded value 33.44 g outperforming the treatment P0 which gave 23.98g, while the interaction showed the significant superiority of the treatments P1G0, P1L0 and G0L0 which recorded values of (22.67, 41.24 and 38.51) gm, respectively. The interaction treatment P1 G1L0 recorded a value of 47.41 gm.

Table 11: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' shoot dry weight (gm).

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	30.60C	28.95 C	29.78 BC
	G_1	26.62 CD	9.79 F	18.21 E
	G_2	25.23 CD	2.67 D	23.95D
P_1	G_0	46.41 A	37.72 B	22.67 A
	G_1	47.41 A	16.57 E	31.98 B
	G_2	29.91 C	22.65 D	26.27 CD
L × P				P
P_0		27.49 B	20.47 C	23.98 B
P_1		41.24 A	25.64 B	33.44 A
G × L				G
G_0		38.51 A	33.33 B	35.92 A
G_1		37.02 AB	13.18 E	25.1 B
G_2		27.57 C	22.66D	25.11 B
L		34.36 A	23.06 B	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table 12: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Shoot dry matter %

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	17.26 B	19.98 AB	18.62 B
	G_1	18.08 B	20.83 AB	19.45 AB
	G_2	19.12 AB	20.33 AB	19.72 AB
P_1	G_0	19.96 AB	19.26 AB	19.61 AB
	G_1	20.81 AB	22.38A	21.60 A
	G_2	20.25 AB	20.62 AB	20.43 AB
L × P				P
P_0		18.15 B	20.38 A	19.26 A
P_1		20.34 A	20.75 A	20.54 A
G × L				G
G_0		18.61 B	19.62 AB	19.13 A
G_1		19.44AB	21.61 A	20.53 A
G_2		19.69 AB	20.47 AB	20.08 A
L		19.25 A	20.57 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

11- Root fresh weight (gm).

The fresh weight of the roots was affected by the study treatments table (13), as the treatments P1, G2 and L1 were superior by recording (63.88, 66.84 and 63.52) gm, respectively, compared to the treatments P0 (50.73) gm, G1 (50.31) and LO (51.09) gm. The treatments P1G2, P1L1 and G1L1 were superior by giving them (76.82, 69.65 and 83.36) gm, respectively, and the POG1L1 treatment achieved its significant superiority by registering 97.16 gm, compared to the treatment P0G1L0 which gave 28.06 gm with an increase of 28.87%.

Table 13: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Root fresh weight (gm).

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	42.64 E	22.83 F	32.73 C
	G_1	28.06 F	97.16 A	62.61 B
	G_2	61.55 C	52.17 D	56.86 B
P_1	G_0	92.26 A	61.33 C	76.79 A
	G_1	6.48 G	69.56 BC	38.02 C
	G_2	75.56 B	78.08 B	76.82 A
L × P				P
P_0		44.08 C	57.39 B	50.73 B
P_1		58.10 B	69.65 A	63.88 A
G × L				G
G_0		67.45 B	42.08 C	54.76 B
G_1		17.27 D	83.36 A	50.31 C
G_2		68.55 B	65.12 B	66.84 A
L		51.09 B	63.52 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

12

- Root dry weight (gm)

It is clear from the results of Table (14) the significant effect of the treatments P1, G1 and L1 which registering (12.81, 16.31 and 12.67) gm respectively, compared to the treatments P0, G1 and L0 which gave (9.16, 9.69 and 9.30)gm, respectively. The interaction between the treatments P1G2, P1L1 and G1L1 achieved their superiority by recording the values (16.20, 14.86 and 16.31)gm compared to the interactions P0G0, P0L0 and G1L0 which recorded (5.66, 7.84 and 3.08)gm, respectively. And treatment P1G2L1 outperformed by registering 17.81g compared to treatment P0G0L1 which gave 3.90gm.

Table 14: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Root dry weight (gm).

PGPR	Gibberellin	Seaweed(Alga 600)		G× P
		L_0	L_1	
P_0	G_0	7.43 E	3.90 F	5.66 E
	G_1	4.93 F	17.49 AB	11.21 C
	G_2	11.17 D	10.03 D	10.60 C
P_1	G_0	16.44 BC	11.65 D	14.04B
	G_1	1.23 G	15.13 BC	8.18 D
	G_2	14.58 C	17.81 A	16.20 A
L × P				P
P_0		7.84 C	10.47 B	9.16 B
P_1		10.75 B	14.86 A	12.81 A
G × L				G
G_0		11.93 C	7.78 D	9.85 B
G_1		3.08 E	16.31 A	9.69 B
G_2		12.88 BC	13.92 B	13.40 A
L		9.30 B	12.67 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

13-

Root dry matter %

The results of table (15) indicate the significant superiority of the study treatments, as the treatments P1, G2 and L1 recorded values (19.94, 19.84 and 19.73) gm respectively. The interaction showed the superiority of the P1G2, P1L1 and G2L1, which gave (21.07, 21.26 and 20.97) gm, respectively. The treatment P1G2L1 achieved its superiority by registering 28.86 gm compared to the treatment P0G0L0 which recorded 17.27 gm.

Table 15: Influence of seeds inoculation with PGPR, Gibberellic acid and Seaweed extract and their interactions on *Acacia farnesiana* seedlings' Root dry matter %

PGPR	Gibberellin	Seaweed(Alga600)		G× P
		L_0	L_1	
P_0	G_0	17.27 C	17.49 C	17.38 C
	G_1	17.49 C	17.98 C	17.73 C
	G_2	18.13 C	19.09 BC	18.61 BC
P_1	G_0	17.77 C	19.05 BC	18.41 BC
	G_1	18.81 BC	21.88 AB	20.35 AB
	G_2	19.29 BC	28.86 A	21.07 A
L × P				P
P_0		17.63 B	18.19 B	17.91 B
P_1		18.62 B	21.26 A	19.94 A
G × L				G
G_0		17.52 C	18.27 BC	17.89 B
G_1		18.15 BC	19.93 AB	19.04 AB
G_2		18.71 ABC	20.97 A	19.84 A
L		18.13 B	19.73 A	

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Discussion:

It is clear from the results of the vegetative growth tables that most of the study indicators were affected by the individual treatments of the study and their interactions, as soaking the seeds with gibberellin affected the characteristics of vegetative growth, and the reason may be due to its physiological effect as it leads to cell division and elongation, reducing the period of cell division and increasing the elongation of the internodes.[7], which increased the permeability of the roots to nutrients and water and contributed to the increase in the transport of nutrients from the source to the Sink, as well as the increase in the transfer of carbon-building products, which increased the activities of building proteins and had an effect on increasing the building of chlorophyll and improving the characteristics of vegetative growth [6] These results agree with [12]. The increase in biomass was reflected in the accumulation of carbonaceous products, which in turn was reflected in the increase in the percentage of dry matter in the shoot and root system [8]. The treatment of bacteria *Bacillus putida* and *psudomonus putida* showed a clear effect, which may be due to the role of bacteria in influencing the balance of growth regulators, improving the nutritional status of plants, producing Siderophore chelating compounds, and producing organic and amino acids. The PGPR system has the ability to produce Siderophores [19], secretion of growth regulators and the production of ACC-deaminase compound that works to reduce high levels for ethylene and plant tissues [22]. The effect of the activities of Siderophores and Bacillus bacteria was reflected in improving the properties of the rhizosphere and increasing the nutrients concentrations in it, which was reflected in the increase in the root activity in increasing the absorption of nutrients and thus led to an improvement in the process of carbon building and an increase in its products that appeared in the increase of chlorophyll table (9)

and then the increase in the height of the plant table (4) Its diameter is a table (5) and consequently the increase in the fresh weight of the shoot and root system and the percentage of dry matter in the shoot and root system. These results agree with [16]. The results of the vegetative growth tables indicate the significant effect of seaweed treatment (Alga 600), which may be due to the seaweed extract containing growth regulators and some vital compounds, which was reflected in the increase and improvement of vegetative growth characteristics. Glycinebetaine, 4-amino butyric acid and 6- Amino valeric acid, all of these are vital stimulants for the construction of chlorophyll, which increased in plant leaves Table (9) contributed to the increase in photosynthesis products and was reflected in the increase in plant height Table (4) and the stem diameter Table (5) and the fresh and dry weight for the shoot and root system, these results are in agreement with [31] and [4]. The positive interaction of the study factors is evident through the binary and triple interactions, which achieved the best values in the vegetative growth indicators that show the positive synergy of the study factors, as the gibberellin led to an increase in cell activity, division and expansion, which increased the growth of roots and thus increased the absorption area. The rhizosphere with secretions of *Psudomonus putida* and *Bacillus subtilis* bacteria worked to reduce soil PH, which increased the readiness of micro-nutrients as well as its role in the secretion of the chelating Siderophores compound, which works to chelate micro-nutrients, especially iron, while seaweed extract increased the activities of vital metabolism because it contains growth regulators and vital compounds Which contribute to improving plant metabolism.

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