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E-mail: tjas@tu.edu.iq

**Kana Ali
Mahmood¹ *
Afak Ibrahim
Jumma²
Danyar bahadin
Mahmood³**

¹University of
Sulaimani

²University of Bagdad

³Head of Sarchnar
Nursery

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Effect of Biofertilizer and Biostimulators on Seeds germination and Seedlings growth of *Albizia lebbeck* L.

ABSTRACT

A factorial experiment according to Randomized Complete Blocks Design (RCBD) was conducted in Serchnar Nursery of the General Directorate of Agriculture in Sulaimani /Kurdistan Region - Iraq, to study the effect of Biofertilizer (Biohealth) at three levels were using 0gmL⁻¹, seed inoculation in biohealth at level 10gmL⁻¹ of distiller water, soil inoculation with biohealth 5gm in 20 litter of water) and Biosimulator (Powhumus at two concentration 0mgL⁻¹ (0ppm) of Powhumus, irrigation with 100mgL⁻¹ (100ppm) of Powhumus), and foliar application with Biozyme TF at two concentration 0ml L⁻¹ and 1ml L⁻¹ on seeds germination and seedlings growth of *Albizia lebbeck*. It contains the individual factors and their combinations. Data were analyzed using XLSTAT software. The results showed the superiority of the Biohealth inoculation treatment of seeds in germination percentage which recorded 93.33% and soil inoculation showed superiority in (plant height, stem diameter, percentage of P, K, fresh and dry weight of the shoot system, shoot dry matter and root fresh weight) with a score of (101.92 cm, 6.73 mm, 2.38 %, 2.61 %, 139.39 gm, 30.55 gm and 21.44%) respectively. The treatment of using Powhumus showed its superiority in the characteristics of the (percentage of germination, percentage of N,P,K, fresh and dry weight of the shoot system, percentage of shoot dry matter, fresh and dry weight of the root system) which were recorded (88.89%, 2,30%, 0.33%, 2.43%, 104.71 g, 23.89 gm, 22.54%, 63.87%, 12.03 gm and 17.64%) respectively. Whereas, the Biozyme treatment excelled in the traits (plant height, stem diameter, N,P and K, relative chlorophyll in leaves, fresh and dry weight of the shoot system, fresh and dry weight of the root system) which they were recorded (80.99 cm, 5.64 mm, 2.36%, 0.31%, 2.34%, 47.20, 97.82 gm, 21.81 gm, 59.57gm, and 10.08gm respectively. In the interaction between soil inoculation with biohealth, irrigation with Powhumus and foliar application with Biozyme B2P1Z1 treatment showed its superiority in the characteristics (plant height, stem diameter, percentage of N,P and K, fresh and dry weight of the shoot system, root dry weight) which were recorded (146.50%, 8.90 mm, 2.93%, 0.49, 2.97, 119.32 gm, 44.77 gm and 25.21) respectively.

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INTRODUCTION

Albizia lebbeck L., a specific genus of legume family, consisting of several species of deciduous trees of about 150 species related to the bacterium of *Rhizobium* responsible for nitrogen fixation in the rhizosphere which effect on their growth and nutrient exchange (Qadir and Mohamad 2005). A tropical tree native to Asia and its cultivation has spread successfully in tropical and subtropical regions (Faisal et al., 2012 and Jøker 2000). Its leaves use as fodder because its taste is palatable and easy to digest by livestock compared to the leaves of other trees. Being that the percentage of crude protein in its green leaves, leaf litter and twigs is 20%, 13% and 10%,

* Corresponding author: E-mail: kana.mahmood@univsul.edu.iq

respectively (Jøker 2000). Also, the type of wood for *Albizia lebbeck* is excellent when used as fuel or used for construction or furniture purposes. Its roots, they are shallow scattered in the soil and have a great role in maintaining soil cohesion and resisting erosion [Tigabu and Od'en 2001, Khera and Singh 2005]. *A. lebbeck* is a tree with excellent medicinal value because each part of it contains medicinal compounds that are used in the treatment of many diseases (Ghaudhaeyet al. 2012). Despite problems associated with normal seed germination such as poor germination rate and rapid loss of vitality associated with a long dormancy period, sexual reproduction of seeds is the common method of *Albizia* propagation. To propagate *Albizia*, using seeds is an important way but hard, thick and impermeable to water seed coats of *Albizia*'s seed make a germination at low range (Perveen et al. 2011).

Recent studies have tended to expand the use of bio-fertilizers because they are cheap, environmentally friendly, and have a positive impact on plant growth. The production of bio-fertilizers increased widely, including the Biohelth product, which contains *Trichoderma harzianum* and *Bacillus subtilus*. Tricoderma is belong to Deuteromycota fungi. It is located in the rhizosphere and contributes significantly to plant growth through its secretion of many organic and biochemical compounds (Hermosa et al. 2012) that enter into plant metabolism and contribute to the regulation and increase of plant growth. It also affects the formation of a dense root system, thus increasing the surface area for absorption of water and nutrients (Hartman 2000a), as well as reducing the absorption of heavy elements and salts by the roots, dismantling organic compounds in the soil and gaining the plant high resistance against pathogens and increasing the readiness of nutrients (Lee 2013), (Bhuvaneswar et al. 2013) and (Oskiera et al 2015). Many researchers have indicated that Tricoderma fungus secretes a number of enzymes that degrade plant residues in the soil, the most important of which is Cellulase enzyme. It also secretes the enzymes Chitenas and B-103- Glucalase, which contribute to the elimination of pathogenic fungi Pythium, as well as the ability of the fungus to secrete substances similar to auxin and gibberellin and its ability to increase the availability of iron and also works on Dissolving phosphorous and increasing its readiness (Al-Samerria et al. 2018). The researchers demonstrated the high ability of Bacillus bacteria to dissolve phosphorous, as it secretes organic acids that affect the lowering of soil pH, which increases the availability of some micro-nutrients and phosphorus (Sharma et al. 2012). Where these bacteria liberate phosphate ions from insoluble forms of phosphorous and convert them into dissolved ions in the soil solution, in addition to increasing the availability of some minor elements (Altomar et al. 1999) and (Adesemoye et al 2009), and through their secretion of Malonic and Oxalic acids and Fumaric and Succinic (Lee and Han 2005). Using biofertilizer at 2% increase seed germination, root and shoot length, dry weight of shoot and root in *Albizia lebbeck* (Khan et al. 2015), (Guleria et al. 2014) stated that *Albizia lebbeck* and *Acacia catechu* seeds inoculation with Rhizobium liquid increase the seed germination. (Mridha et al. 2016) Elucidated that bio-fertilizer improved the germination of *Acacia mangium*'s seeds. (Khan et al. 2006) Confirmed that using bio-fertilizer improved the fresh weight of shoot system in *Albizia saman*.

Humic acid is the main component of the decomposing organic matter in the soil and has many positive effects on plant growth and development (Ali and Shaker 218). Humic acid plays an effective role in improving the soil's physical and chemical properties and fertility, as well as increasing the readiness of some nutrients. Humic acid also has an effect on increasing the permeability of cell membranes, stimulating enzymatic reactions, improving cell division and increasing the production of enzymes in plants (El-Sharkawy and Abdel-Razzak 2010). Humic acid improves the growth of the root system and increases the number of beneficial microorganisms in the soil (Nardi et al. 2021). (Rangrudkij and Partida 2003) Point out that using Humic acid increase Avocado seedling high and Stem diameter. (Mohmad and Abdulla 2018) Showed that using powhumic increase leaves content of phosphorus and relative chlorophyll, in *Pinus pinea*. The use of growth regulators is one of the important factors in improving plant growth and increasing its productivity. Cytokinin is one of the important growth regulators that improve plant metabolism and increase its growth and production through its work on improving cell division, increasing the growth of lateral buds, and reducing the effect of apical dominance, which increases the number of

lateral branches (Al-Khafaqi 2014) and (Aggeliki et al. 2016). (Amit 2008) Showed that using Gibberellin acid and IAA promote seed germination in *Albizia lebbec*. (Ilango et al. 2003) Indicated that treating *Albizia lebbbeck's* seed with Gibberellic acid at the concentration 300ppm lead to increase the shoot length and total relative chlorophyll. (Sau et al 2015) Clarified that Applying 10ppm of Biozyme tf on *Psidium guajava* L. increased shoot high and Relative chlorophyll content. The research aimed to study the effect of using Biohelth, Powhumus and Biozyme TF on germination of Albizia seeds and seedling growth.

MATERIALS AND METHODS

A factorial experiment was carried out in a randomized complete block design RCBD to study the effect of using (Biohealth, Powhumus and Biozyme TF) and their interaction on germination of *Albizia lebbec* seeds and vegetative growth characteristics. It used plastic bags with a capacity of 7 kg and contained the cultivation medium, which was prepared from soil with peatmoss a mixture of 2: 1. Albizia seeds were used that were treated with (10 mg) of biohealth powder, which was prepared by dissolving it in a liter of distilled water for five minutes after adding a 0.5 gm of sugar and shaking the liquid culture for 30 minutes. Then the seeds were taken out from the liquid culture broth and placed in the shade with an air current for 15 minutes before planting. The 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. One treatment included 5 bags (five plants). The soil was inoculated with biohealth by dissolving 5 gm of the inoculum in 20 liters of distilled water, the seeds were irrigated, and the plants were watered 5 times, and the period between irrigation and another was 21 days. The seeds were irrigated with Powhumus 100ppm (100mg L⁻¹) and the plants were repeated watering with Powhumus solution (6 times) and the period was between one irrigation and another (20 days). The plants were sprayed in the early morning with Biozyme TF solution (1 ml L⁻¹) after the plants reached a height of (20 cm) and a diffuser (tween twenty) was added to reduce the surface tension. The foliar application process was repeated 5 times and the period between one spray and another was 15 days. 360 seeds were planted at a rate of 2 seeds per bag, distributed over the treatments (control, seed inoculation with Biohealth, soil inoculation with Biohealth, watering seeds with Powhumuc foliar application plants with Biozyme TF and their interactions, as the study included 12 treatments with three replications, thus the number of the trial is 36 units. The factorial experiment was carried out according to Randomized Complete Blocks Design (RCBD), XLSTAT (Addinsoft 2019) program was used for analyzing the data, and the averages were compared with the Duncan Multiple Range at a level probability of 5% (Al-Naaimi 2010). The parameters study were: Seed germination (%), Shoot high (cm), Stem diameter (mm), plant content of N,P,K, Relative chlorophyll (SPAD unit), shoot fresh weight (gm), shoot dry weight (gm), Shoot Dry matter (%), root fresh weight (gm), root dry weight (gm), Root dry matter (%).

Treatments

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 mg Kg ⁻¹
P		8.63 mg Kg ⁻¹
K		417 mg Kg ⁻¹
S		3.86 mg Kg ⁻¹
MG		1.63 mg Kg ⁻¹
Texture	Sand	510 g Kg ⁻¹
	Silt	280 g Kg ⁻¹
	Clay	210 g Kg ⁻¹

B0= (0mg L⁻¹) without inoculation

B1= (10mg L⁻¹) Seed inoculation with Biohealth

B2= Soil inoculation with Biohealth (5gm in 20 L of water).

P0= (0ppm) 0mg L⁻¹ Powhumus

P1= Irrigation with (100ppm) 100 mgL⁻¹

Powhumus

Z0= (0ml L⁻¹) foliar application with (Biozyme TF)

Z1= (1ml L⁻¹) Foliar application with (Biozyme TF).

The soil samples were analyzed at the central Laboratory in the college of Agriculture Engineering Science / University of Bagdad according to (Black 1965).

Table (2): Chemical compounds of Biohealth, Powhumus and Biozym tf

Biohealth	Pow Humus	Biozyme tf
<i>Ascomyces nodosum</i> 10%	Potassium- humates 80-85%	Gibberellins 32.2 ppm
<i>Trichoderma harzianum</i> 10 ⁶ cfu/g	Total Humic acid ½ 68-73%	Auxins (IAA) 32.2 ppm
<i>Bacillus subtilis</i> 10 ⁷ cfu/g	pH- value 9.5-10.5	Cytokining(Zeatins) 83.2ppm
Total Humates acid ½ 66-68%	Humic acid ¹ 63-67%	Magnesium 0.14%
Fulvic Acid ¹ 5-6%	Fulvic acid ¹ 5-6%	Boron 0.3%
Potassium- humates 75%	Potassium (K ₂ O) 10-12%	Zinc 0.37 %
Dry matter 83-85 %	Organic substance 68-73%	Sulfur 0.44%
Organic Substance 68-70 %	Bulk Denity 0.55-0.65 kg/L	Iron 0.49%
pH- value 9.5-10.5		Manganese 0.12%
Bulk Denity 0.55-0.65 kg/L		

RESULTS

1-Germination (%)

The results of the table (3) show the significant effect of the study treatments in this trait, as the treatment of seed inoculation with biohealth recorded its superiority effect by recording 93.33% for treatment with B1, while the soil inoculation treatment with B2 recorded a value of 75.83% significantly superior to the control treatment with B0, which recorded 71.67%. The Powhumus treatment with 88.89% was affected superiority compared to the control treatment, which gave 71.67%. The triple interaction between B1P0Z0, B1P0Z1, B1P1Z0 and B1P1Z1 showed the significant superiority 93.33% compared to the B0P0Z0 which recorded 46.67.

Table (3): Effect of biofertilizer, biostimulator and their interactions on the seed Germination

%				
B	P	Z		B×P
		Z0	Z1	
B0	P0	46.67 b	53.33 b	50.00 c
	P1	90.00 a	96.67 a	93.33 a
B1	P0	93.33 a	93.33 a	93.33 a
	P1	93.33 a	93.33 a	93.33 a
B2	P0	86.67 a	56.67 b	71.67 b
	P1	76.67 a	83.33 a	80.00 b
P×Z				P
	P0	75.56 b	67.78 b	71.67 b
	P1	86.67 a	91.11 a	88.89 a
B×Z				B
	B0	68.33 c	75.00 bc	71.67 b
	B1	93.33 a	93.33 a	93.33 a
	B2	81.67 ab	70.00 Bbc	75.83 b
	Z	81.11 a	79.44 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)

The results of the table (4) show the significant effect of the study treatments in this trait, as the treatment of soil inoculation with Biohealth recorded its superiority effect by recording 101.92 cm for treatment with B2, while the seed inoculation treatment with B1 recorded a value of 65.23 cm significantly superior to the control treatment with B0, which recorded 44.02 cm. The Z1 Biozyme treatment recorded its superiority significant by recording 80.99 cm compared to the

control treatment, which gave 59.78 cm. The interactions between the study factors showed the significant superiority of the treatments: B2P1, P1Z1, B2Z1, which recorded the values: 120.87, 96.09 and 121.93 cm, respectively. The triple interaction between B2P1Z1 showed the significant superiority 146.50 cm compared to the B0P0Z0 which recorded 30.19 cm.

Table (4): Effect of biofertilizer, biostimulator and their interactions on the plant high (cm)

B	P	Z		B×P
		Z0	Z1	
B0	P0	30.19 g	45.53 ef	37.86 d
	P1	44.47 ef	55.90 e	50.18 c
B1	P0	38.84 fg	54.82 e	46.83 c
	P1	81.38 c	85.87 bc	83.63 b
B2	P0	68.59 d	97.37 b	82.98 b
	P1	95.23 b	146.50 a	120.87 a
P×Z				P
P0		45.87 d	65.90 c	84.89 a
P1		73.70 b	96.09 a	55.89 b
B×Z				B
B0		37.33 f	50.71 f	44.02 c
B1		60.11 d	70.34 c	65.23 b
B2		81.91 b	121.93 a	101.92 a
Z		59.78 b	80.99 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.

3-Stem diameter (mm)

The result of the table (5) show the significant effect of treatments soil inoculation with Biohealth which gave 6.73 mm compared to the control treatment B0 which recorded 2.54 m, while P1 gave 3.93mm. Compared to P0 which recorded the value 5.87 mm. And treatment Z1 recorded 5.64mm significantly superior to the treatment Z0 which gave 4.15mm. The interaction between the factors of the study showed the significant superiority of the treatments B2P1, B2Z1 and P1Z1 by recording values (7.98, 7.67 and 6.64mm) respectively. The stem diameter increase by 7.53% in the treatment B2P1Z1 which recorded 8.90mm within the triple interaction treatment compared to B0P0Z0 that recorded the lowest value and it was 0.67mm.

Table (5): Effect of biofertilizer, biostimulator and their interaction on the stem diameter (mm)

B	P	Z		B×P
		Z0	Z1	
B0	P0	0.67 h	1.73 g	1.20 e
	P1	2.93 f	4.83 e	3.88 d
B1	P0	4.47 e	5.77 cd	5.12 c
	P1	5.27 de	6.20 c	5.73 b
B2	P0	4.50 e	6.43 bc	5.47 bc
	P1	7.07 b	8.90 a	7.98 a
P×Z				P
P0		3.21 d	4.64 b	5.87 a
P1		5.09 b	6.64 a	3.93 b
B×Z				B
B0		1.80 e	3.28 d	2.54 c
B1		4.87 c	5.98 b	5.43 b
B2		5.78 b	7.67 a	6.73 a
Z		4.15 b	5.64 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 content (%)

The results of the table (6) indicate the significant superiority of the study factors in this trait, as the treatment of inoculation of seeds and soil with Biohealth B1 and B2 recorded values of 2.38% and 2.34% for its superiority over the control treatment B0, which gave 1.80%. And the treatment of Powhumus P1 recorded a value of 2.30%, significantly outperforming treatment P0, which recorded 2.04%, and the treatment with Biozyme Z1 gave the value of 2.36%, outperforming treatment Z0, which recorded 1.98%. The interactions between the study factors showed the superiority of the treatments B2P1, B1P1, P1Z1, B2Z1 and B2Z1, which recorded (2.58, 2.44, 2.53 2.59 and 2.59 %), respectively. The plant content of N% increased by 53.24% for the treatment B2P1Z1 which recorded 2.93% compared to the control treatment B0P0Z0 which gave 1.56%.

Table (6): Effect of biofertilizer, biostimulator and their interactions on the Nitrogen content (%)

B	P	Z		B×P
		Z0	Z1	
B0	P0	1.56 f	1.87 def	1.72 d
	P1	1.80 ef	1.96 def	1.88 cd
B1	P0	2.20 cde	2.42 bc	2.31 ab
	P1	2.16 cde	2.71 ab	2.44 a
B2	P0	1.93 def	2.2 cd	2.09 bc
	P1	2.22 cde	2.93 a	2.58 a
P×Z		P		
P0		1.90 c	2.18 b	2.04 b
P1		2.06 bc	2.53 a	2.30 a
B×Z		B		
B0		1.68 c	1.92 bc	1.80 b
B1		2.18 b	2.56 a	2.38 a
B2		2.08 b	2.59 a	2.34 a
Z		1.98 b	2.36 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 content (%)

The results of the table (7) indicate the significant superiority of the study factors in this trait, as the treatment of soil inoculation with biohealth B2 recorded values of 0.38% for its superiority over the control treatment B0, which gave 0.23%. And the treatment of Powhumus P1 recorded a value of 0.33%, significantly outperforming treatment P0, which recorded 0.27%, and the treatment with biozyme Z1 gave the value of 0.31%, outperforming treatment Z0, which recorded 0.28%. The interactions between the study factors showed the superiority of the treatments B2P1, B2Z1 and P1Z1, which recorded (0.43, 0.41 and 0.36%), respectively. The plant content of P% increased by 42.85% for the treatment B2P1Z1 which recorded 0.49% compared to the control treatment B0P0Z0 which gave 0.21%.

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 (7): Effect of biofertilizer, biostimulator and their interactions on the phosphorus content (%)

B	P	Z		B×P
		Z0	Z1	
B0	P0	0.21 h	0.22 gh	0.21 d
	P1	0.24 fg	0.25 ef	0.24 c
B1	P0	0.25 ef	0.27 de	0.26 c
	P1	0.29 d	0.33 c	0.31 b
B2	P0	0.32 c	0.32 c	0.32 b
	P1	0.37 b	0.49 a	0.43 a
P×Z				P
P0		0.26 c	0.27 c	0.27 b
P1		0.30 b	0.36 a	0.33 a
B×Z				B
B0		0.22 e	0.23 e	0.23 c
B1		0.27 d	0.30 c	0.29 b
B2		0.35 b	0.41 a	0.38 a
Z		0.28 b	0.31	

6-Potassium contents (%)

The results of the table (8) show the effect of K% content of the study parameter. It increased significantly in the B2 soil inoculation treatment with Biohealth, which recorded 2.61%, to outperform the control treatment B0, which gave 1.81%. The K% content increased by 85.18% in the Powhumus P1 treatment, which recorded 2.43% that significantly outperform the treatment P0, which gave 2.07%. And treatment Z1 recorded a value of 2.34%, significantly superior to treatment Z0, which recorded 2.16%. The interaction between the factors of the study showed the significant superiority of the treatments B2P1, B2Z1 and P1Z1 by recording the values (2.85, 2.70 and 2.53%) respectively. The triple interaction between the treatments B2P1Z1 recorded 2.97%, while treatment B0P0Z0 recorded the lowest value and it was 1.60%.

Table (8): Effect of biofertilizer, biostimulator and their interactions on the Potassium content%

B	P	Z		B×P
		Z0	Z1	
B0	P0	1.60 g	1.63 g	1.62 e
	P1	1.85 f	2.17 de	2.01 d
B1	P0	2.11 e	2.37 cd	2.24 c
	P1	2.40 c	2.44 c	2.42 b
B2	P0	2.29 cde	2.43 c	2.36 bc
	P1	2.74 b	2.97 a	2.85 a
P×Z				P
P0		1.99 d	2.14 c	2.07 b
P1		2.33 b	2.53 a	2.43 a
B×Z				B
B0		1.73 e	1.90 d	1.81 c
B1		2.25 c	2.41 b	2.33 b
B2		2.51 b	2.70 a	2.61 a
Z		2.16 b	2.34 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

7-Relative chlorophyll in leaves (SPAD unit)

The results of the table (9) show the significant effect of Biozyme treatment in this trait, as treatment Z1 recorded the value 47.20 SPAD unit to outperform treatment Z0, which gave 39.99 SPAD unit, and the interference treatment P1Z1 which recorded 52.64 SPAD unit outperformed compared to treatment P0Z0, which gave 39.02 SPAD unit. The treatment BOP1Z1 which is among the triple interference treatment recorded a value of 58.00 SPAD unit, which significantly outperform the treatment BOP0Z0, which gave 32.47 SPAD unit.

Table (9): Effect of biofertilizer, biostimulator and their interactions on the Relative chlorophyll in the leaves. (SPAD unit)

B	P	Z		B×P
		Z0	Z1	
B0	P0	32.47 c	38.87 bc	35.67 a
	P1	38.37 bc	58.00 a	48.18 a
B1	P0	42.60 ab	44.40abc	43.50 a
	P1	42.17abc	48.67abc	45.42 a
B2	P0	42.00abc	42.00abc	42.00 a
	P1	42.33abc	51.27ab	46.80 a
P×Z				P
P0		39.02 b	41.76 b	40.39 a
P1		40.96 b	52.64 a	46.80 a
B×Z				B
B0		35.42b	48.43 a	41.92 a
B1		42.38ab	46.53ab	44.46 a
B2		42.17ab	46.63ab	44.40 a
Z		39.99 b	47.20 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 level

8-Shoot fresh weight (gm)

The results of the table (10) show the effect of the shoot fresh weight of the study parameters.

Table (10): Effect of biofertilizer, biostimulator and their interactions on the shoot fresh weight (gm)

B	P	Z		B×P
		Z0	Z1	
B0	P0	41.94 f	18.54g	30.24 e
	P1	49.91 f	115.15c	82.53 c
B1	P0	95.46 d	76.13 e	85.79 c
	P1	75.69 e	65.82 e	70.76 d
B2	P0	101.65 d	134.25b	117.95 b
	P1	144.67 b	177.00 a	160.83 Aa
P×Z				P
P0		79.68 c	76.31 c	77.99 b
P1		90.09b	119.32 a	104.71a
B×Z				B
B0		45.93 e	66.85 d	56.39 c
B1		85.56 c	70.96 d	78.28 b
B2		123.16 b	155.63 a	139.39 a
Z		84.89 b	97.82 a	

It increased significantly in the B2 soil inoculation treatment with Biohealth, which recorded 139.39 gm, while the seed inoculation treatment B1 recorded 78.28 gm to outperform the control treatment B0, which gave 56.39 gm. The fresh weight of the shoot increased by 74.48% in the Powhumus P1 treatment, which recorded 104.71g that significantly outperform the treatment P0, which gave 77.99 gm. And treatment Z1 recorded a value of 97.82 g, significantly superior to treatment Z0, which recorded 84.89 g. The interaction between the factors of the study showed the significant superiority of the treatments B2P1, P1Z1 and B2Z1 by recording the values (160.83, 119.32 and 155.63) gm, respectively. The fresh weight increased by 10.47% in treatment B2P1Z1 which recorded 177.00 gm within the triple interaction treatments, while treatment B0P0Z1 recorded the lowest value and it was 18.54gm.

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)

Table (11) indicates the significant superiority of soil inoculation with Biohealth, B2 recorded the value 30.55g compared to the treatment B0 which gave 10.52 also the use of Powhumus as the treatment P1 recorded the value 23.89g compare to the treatment P0 which recorded 14.88. The treatment of Z1 recorded the value 21.81g outperforming the treatment Z0 which recorded the value 16.96g. In the interaction treatment B2P1, P1Z1 and B2Z1 recorded their significant superiority as they gave 38.01, 28.13 and 36.02 gm) respectively. And the treatments B2P1Z1 outperformed by registering 44.77g compared treatment B0P0Z1 which gave 2.71gm.

Table (11): Effect of biofertilizer, biostimulator and their interactions on the shoot dry weight (gm)

B	P	Z		B×P
		Z0	Z1	
B0	P0	4.77 gh	2.71 h	3.74 d
	P1	10.54fg	24.06 cd	17.30 c
B1	P0	19.13de	16.46 ef	17.79 c
	P1	17.17 e	15.56ef	16.36 c
B2	P0	18.93 de	27.27 bc	23.10 b
	P1	31.24 b	44.77 a	38.01 a
P×Z				P
P0		14.28 c	15.48 c	14.88 b
P1		19.65 b	28.13 a	23.89a
B×Z				B
B0		7.66 e	13.38 d	10.52 c
B1		18.15 c	16.01 cd	17.08 b
B2		25.09 b	36.02 a	30.55 a
Z		16.96 b	21.81 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

10-Shoot Dry matter (%)

The results of the table (12) indicate the significant superiority of the study treatments in this trait, as treatment B1 recorded the highest value of 21.92, which did not differ significantly from treatment B2, which in turn was significantly superior the control treatment B0, which gave 17.01, and treatment P1 gave 22.54 to be significantly superior the treatment P0, which recorded 17.71. And treatment Z1 recorded its significant superiority with 21.02 compared to the control treatment Z0, which gave 19.22. The interaction showed that the treatment B2P1 was significantly superior, as it recorded 23.46, compared to treatment B0P0, which gave 12.97. And treatment P1Z1 outperformed by registering 23.24 compared to treatment P0Z0, which gave 16.61. Treatment B2Z1 recorded a value of 22.74 compared to treatment B0Z0 which gave 16.29. The percentage of dry matter of the vegetative mass increased by 45.18% in treatment B2P1Z1 which recorded 25.21 compared to treatment B0P0Z0 which gave 11.39.

Table (12): Effect of biofertilizer, biostimulator and their interactions on the shoot dry matter (%)

B	P	Z		B×P
		Z0	Z1	
B0	P0	11.39 e	14.57 de	12.97 c
	P1	21.19abc	20.90abc	21.05 ab
B1	P0	19.89 bc	21.56abc	20.73 ab
	P1	22.61abc	23.62ab	23.11 a
B2	P0	18.56cd	20.27 bc	19.41 b
	P1	21.71abc	25.21 a	23.46 a
P×Z				P
P0		16.61 b	18.80 b	17.71 b
P1		21.84 a	23.24 a	22.54 a
B×Z				B
B0		16.29 c	17.74 bc	17.01 b
B1		21.25 a	22.59 a	21.92 a
B2		20.13 ab	22.74 a	21.44 a
Z		19.22 b	21.02 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 results of the table (13) showed that the fresh weight of the roots increased significantly in the B1 and B2 seed and soil inoculation treatment with biohealth, which recorded 55.02 and 56.64 g respectively to outperform the control treatment B0, which gave 43.88 gm. The root fresh weight increased by 62.36% in the Powhumus P1 treatment, which recorded 63.87gm that significantly outperform the treatment P0, which gave 39.83 gm. And treatment Z1 recorded a value of 59.57 g, significantly superior to treatment Z0, which recorded 44.12 g. The interaction between the factors of the study showed the significant superiority of the treatments B0P1, B1P1 and P1Z1 by recording the values (64.05, 62.54 and 71.12gm), respectively. The fresh weight increased by 19.98% in treatment B0P1Z1 which recorded 92.99 gm within the triple interaction treatments, while treatment B0P0Z0 recorded the lowest value and it was 18.58gm.

Table (13): Effect of biofertilizer, biostimulator and their interactions on the Root fresh weight (gm)

B	P	Z		B×P
		Z0	Z1	
B0	P0	18.58 h	28.86 g	23.72 c
	P1	35.12 fg	92.99 a	64.05 a
B1	P0	42.27 f	52.72 e	47.49 b
	P1	56.09 de	68.99 c	62.54 a
B2	P0	34.04 fg	62.50 cd	48.27 b
	P1	78.62 b	51.39 e	65.01a
P×Z				P
P0		31.63 d	48.03 c	39.83 b
P1		56.61 b	71.12 a	63.87 a
B×Z				B
B0		26.85 c	60.92 a	43.88 b
B1		49.18 b	60.86 a	55.02 a
B2		56.33 a	56.94 a	56.64 a
Z		44.12 b	59.57 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

12-Root dry weight (gm)

Table (14) indicates the significant superiority of the use of Powhumus, as the treatment P1 recorded the value 12.03 gm compared to the treatment P0, which gave 5.34 g. Treatment Z1 recorded 10.08 gm, outperforming treatment Z0, which recorded 7.29 gm. In the interaction, the treatments B0P1, P1Z1 and B0Z1 recorded their significant superiority, as they gave (13.16, 14.02 and 12.54gm), respectively. And treatment B0P1Z1 outperformed by registering 20.98 gm compared to treatment B0P0Z0 which gave 2.68 gm.

Table (14): Effect of biofertilizer, biostimulator and their interactions on the Root dry weight (gm)

B	P	Z		B×P
		Z0	Z1	
B0	P0	2.68 f	4.09 ef	3.38 d
	P1	5.34 def	20.98 a	13.16 a
B1	P0	4.24 ef	7.65 d	5.94 c
	P1	7.71 d	14.55 c	11.13 b
B2	P0	6.68 de	6.71 de	6.69 c
	P1	17.07 b	6.52 de	11.79 ab
P×Z				P
P0		4.53 d	6.15 c	5.34 b
P1		10.04 b	14.02 a	12.03 a
B×Z				B
B0		4.01 c	12.54 a	8.27 a
B1		5.97 b	11.10 a	8.54 a
B2		11.87 a	6.61 b	9.24 a
Z		7.29 b	10.08 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 the table (15) show the significant effect of treatment P1, which gave 17.64 compared to treatment P0, which recorded 14.07. The interactions between the study factors showed the significant superiority of the treatments BOP1, P1Z1, B2Z0, which recorded (18.38, 18.71 and 20.78), respectively,

Table (15): Effect of biofertilizer, biostimulator and their interactions on the Root dry matter %

B	P	Z		B×P
		Z0	Z1	
B0	P0	14.81 b	14.39 b	14.60 bc
	P1	15.13 b	22.52 a	18.83 a
B1	P0	10.09 b	14.49 b	12.29 c
	P1	12.89 b	21.04 a	16.96 ab
B2	P0	19.88 a	10.75 b	15.31 bc
	P1	21.68 a	12.56 b	17.12ab
P×Z				P
P0		14.93bc	13.21 c	14.07 b
P1		16.57 ab	18.71 a	17.64 a
B×Z				B
B0		14.97 b	18.46 a	16.71 a
B1		11.49 c	17.76 ab	14.63 a
B2		20.78 a	11.65 c	16.22 a
Z		15.75 a	15.96 a	

compared to the treatments B1P0, P0Z1 and B1Z0, which recorded (12.29, 13.21 and 11.49), respectively. The dry matter in the roots increased by 44.80% in treatment B0P1Z1 which recorded 22.52 compared to treatment B1P0Z0 within the triple interference treatments which recorded 10.09.

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

The superiority of individual treatments and most of the binary and triple interactions among the study factors may be due to the effect of individual treatments. The effect of biohealth on vegetative growth characteristics is evident, which may be due to its containing *Trichoderma harzinum*, *Bacillus subtilis* and humic acid, where *Trichoderma* fungi colonize the root zone and secrete many organic acids that contributes to lowering soil PH, which increases the availability and absorption of nutrients, especially iron, zinc and manganese (Hermosa et al 2012), as well as its positive effect on the formation of a dense root hair density, which increases the surface area for absorption of water and nutrients (Hartman 2000b) and this is reflected in the vegetative growth indicators, where this effect was represented by the height of the plant and the diameter of the stem as well as the plant's content of nutrients N, P and K, and these results agree with (Saaed et al 2011) and (Al-Shamarrey 2007), and the reason for the improvement in vegetative growth indicators may be due to the high ability of *Bacillus* bacteria to dissolve phosphorous through its secretion of many of organic acids as well as an increase in the availability of some nutrients, especially the macro elements (Sharma et al. 2012), and thus this effect was reflected on the increase in the root system and its increased absorption of nutrients and water, which contributed to increasing plant growth, which is represented in increasing plant height, stem diameter, fresh and dry weight of the vegetative and root system. It was represented in the increase in plant height, stem diameter, increase in relative chlorophyll pigment intensity, fresh weight, dry weight and percentage of dry matter of the vegetative and root system, as humic acids improve the chemical and physical properties of the soil as it improves soil aeration and increases its fertility by increasing availability of some elements and increasing the activity of microorganisms. The beneficial effect in the rhizosphere of the soil and encouraging its colonization of the root zone (Willer and Lernoud 2019), the positive effect of the biozyme spray may be due to the fact that it contains growth regulators, especially cytokinin, which makes up 83% of its composition, the effect of cytokine is known to stimulate cell division and break the apical dominance, as it works to increase the growth of buds. Transverse and lateral stimulation of plant elongation by increasing cell elongation and stomata opening in some plant species, (Verma and Verma 2010). The effect of cytokines is known to increase and influence cell division in what is known as Phytogerontology, which directs plant sap to sites of cytokine accumulation (Carey 2008) and (Al-Sady and Al-Kheekany 2019), as it is considered a factor in encouraging the movement and transfer of nutrients and has a role in encouraging the formation of relative chlorophyll and stimulating the formation of chloroplasts. (George et al. 2008) as well as its role in stimulating roots to increase soil absorption of water and nutrients. (Bba Khani et al. 2013). The increase in relative chlorophyll accumulation table (9) led to increase in plant height in table (4) which led to an increase in carbon-building products and this led to an increase in stem diameter as well as an increase in wet weight and the dry weight of the vegetative system and the root, then increasing the percentage of dry matter in the vegetative and roots system.

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تأثير المخصب الحيوي و المنشطات الحيوية في انبات البذور و نمو شتلات *Albizia lebbeck L*

كانا علي محمود¹ افاق ابراهيم جمعة² دانيار بهاءالدين محمود³
1 جامعة السليمانية 2 جامعة بغداد 3 مدير مشتل سرجنار

الخلاصة

اجريت تجربة حقلية وفق تصميم القطاعات العشوائية الكاملة RCBD و بثلاثة عوامل في مشتل سرجنار التابع لدائرة الزراعة في محافظة السليمانية/ اقليم كردستان، لدراسة تأثير استخدام المخصب الحيوي (Biohealth) بثلاث مستويات صفر غم اتر 1- و تلقيح البذور ب 10غم لتر-1 ماء مقطر و تلقيح التربة 5غم في 20لتر ماء المقطر ، و المنشطات الحيوية (Powhumus and Biozyme) اذ استخدم Powhumus بمستويين صفر ملغم لتر-1 و 100ملغم لتر-1)، ورش المجموع الخضري ب Biozyme TF بتركيزين صفر مل لتر- و 1 مل لتر-1 و تداخلاتها في انبات البذور و نمو شتلات الالبيزيا. و بذلك يكون عدد المعاملات 36 معاملة موزع على ثلاث مكررات، وضمت الوحدة التجريبية 5 نباتات. حلت البيانات وفق برنامج XLSTAT . اظهرت النتائج التأثير المعنوي لمعاملة التلقيح البذور بالمخصب الحيوي في نسبة انبات البذور اذ سجلت 93.33% فيما تفوقت معاملة تلقيح التربة في صفات (ارتفاع النبات، قطر الساق، و نسبة K,P في النبات والوزن الطري و الجاف للمجموع الخضري، و نسبة المادة الجافة في الاوراق) على التوالي اذ سجلت (101.92 سم و 6.73 ملم و 139.39 غم و 30.55 غم و 21.44%) للصفات على التوالي. سجلت معاملة Powhumus تفوقها المعنوي في صفات (نسبة الانبات، نسبة N,P,K، الوزن الطري و الجاف للمجموع الخضري، نسبة المواد الجافة، الوزن الطري و الجاف للمجموع الجذري) اذ سجلت (88.89 و 2.30 و 0.33 و 2.43 و 104.71 غم و 23.89 غم و 22.54 و 63.87 و 12.03 غم و 17.64) للصفات على التوالي. و تفوقت معاملة الرش ب Biozyme TF في صفات (ارتفاع النبات، قطر الساق، و نسبة N,P,K في الاوراق، نسبة الكلوروفيل في الاوراق، الوزن الطري و الجاف للمجموع الخضري ، وزن الطري و الجاف للمجموع الجذري) على التوالي تسجلها القيم (80.99 سم و 5.64 ملم و 2.36 و 0.31 و 2.34 و 47.20 و 97.82 غم و 21.81 غم و 59.57 غم و 10.08) للصفات على التوالي. و تفوقت المعاملة B2P1Z1 ضمن التداخل الثلاثي اذ سجلت القيم (146.50 سم و 8.90 ملم و 2.93 و 0.49 و 2.97 و 119.32 غم و 44.77 غم و 25.21 غم) على التوالي للصفات (ارتفاع النبات، قطر الساق، و نسبة N,P,K في الاوراق، الوزن الطري و الجاف للمجموع الخضري ، وزن الجاف للمجموع الجذري) حيث سجلت على التوالي.

الكلمات المفتاحية:
البيزيا، المخصب الحيوي،
المنشطات الحيوية.