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Effect of organic and bio fertilizers on some growth and productivity traits of cotton line 124 (*Gossypium hirsutum* L.)

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Abstract
The research was conducted in 2018 growing season at Jeb Ramleh Research Station – Al-Ghab Research Center - General Authority of Scientific Agricultural Research. The objective was to investigate the variation of some Physiological and Productivity Traits of Cotton Line 124 (*Gossypium hirsutum* L.) depending on three types of organic and biological fertilizers (*Bacillus*, Humic acid and amino acids). *Bacillus* had three fertilization methods, While each of Humic acid and each type of Humic fertilizers had four fertilization methods (Without, Soaking seeds, Plant irrigation and Leaf spraying). Studied traits included: Plant Wet Weight (g/plant), Plant Dry Weight (g/plant), Plant Growing Rate (g/m^2/week), First Pick Percentage (%) and Cotton Yield (g/plant). Split plot design was used. First factor (*Bacillus*) occupied the main plots, while the second factor (Humic acid) occupied the split plots, and the third factor (amino acids) occupied the split plots. Results showed no significant differences between single fertilizers additions comparing to the control, whereas there was significant superiority of the interaction between *Bacillus* plant irrigation×Humic acid plant irrigation Amino acids leaf spraying comparing to the control in terms of all studied traits, and gave maximum values (PWW 201.05g/plant), (PDW 78.91g/plant), (PGR 64.79 g/m^2/week) and (FPP 71.23%).

Keywords: Cotton *Gossypium hirsutum* L., growth traits, productivity traits, *Bacillus*, humic acid and amino acids

Introduction
Cotton belongs to *Malvaceae* Family and *Gossypium* genus (which includes 42 wild and cultivated species) (wild species with low production per ha, short or fluffy fibers, completely bare seeds, but it has resistant to diseases, insect infections or environmental stresses), so they are important assets for genetic improvement [3], and cultivated species are categorized into five genuses in the commercial field (American medium fiber *hirsutum*, Egyptian long fiber *barbadense*, Asian short fiber *aboreum*, African short fiber *herbaceum* and medium fiber *tricospedatium*). It is the most important natural fiber crop in the world, and its uses varies in the industrial, food, medical and household sectors [6]. Plant Growth Promoting Bacteria (PGPR) are exists in the soil on and around the root surface with directly or indirectly promote of plant growth and development through production and release of many chemicals near the root surfaces [1], and includes many genuses (*Agbacterium*, *Alcaligenes*, *Arthrobacter*, *Actinoplanes*, *Azotobacter*, *Bacillus*, *Pseudomonas* and *Rhizobium*) [12]. *Azotobacter* genus plays an important role in the nitrogen cycle in nature and possess many metabolic functions, as nitrogen fixation and producing some amino acids (thiamine, riboflavin), and plant hormones (IAA, gebrelines and cytokines) [4]. Humic substances are components of organic decomposition, which are natural organic compounds that considered to be 50-90% of peat, alginate, sapropel and the inorganic matter of soil and water ecosystems [11]. Humic acids play an important role in increasing the resistance of the rice plant to water stress. It reduces the activity of peroxidase enzymes and maintains high permeability of the cell membrane. It is a natural and safe alternative to plant protection from oxidative stress due to drought [7]. Bio stimulants include many plant-stimulating microorganisms which increasingly used and expanded, and are expected to reach global revenues of 2.241 million$ by 2018 at an annual growth rate of 12.5% [5]. Close microorganisms to root surfaces interact with each other, their symbiotic relationships varies, and bio-fertilizers contain microorganisms added to the soil or fertilized with seeds [8].

The effect of inoculation using a combination of *Azotobacter* and *Mycorrhiza* was significantly higher in wheat (*Triticum aestivum* L.) in terms of yield and production components. The protein content in grains increased by 13% compared to the control. Using of ammonium nitrate was also significant in the yield index The protein content in the grains is 19% higher than the control [2].

Materials and Methods

Cotton Line 124 was cultivated.

Location: The research was carried out at Jeb Ramleh Research Station – Al-Ghab Research Center - General Authority of Scientific Agricultural Research, at 36 ° 25'22.6 "E and 35 ° 12'31.6" N and 188 m above sea level.

Cultivation date: Research was carried out during 2018 growing season and planting date was in 20/4/2018.

Soil analysis: Soil Mechanical and Chemical soil analysis showed that it had an appropriate phosphor and potassium amount for cultivation, moderate soil acidity, medium Electric conductivity and low organic matter content, as shown in table (1):

Table 1: Mechanical and Chemical soil analysis

Depth	Mechanical Analysis			Chemical Analysis							
0-30 cm	Sand%	Silt%	Clay%	N%	P PPM	K PPM	pH	EC	$CaCo_3$	Effective lime	Organic Matter
	26	14	60	0.16	22.61	487.32	6.84	2.35	12.20	3.95	4.84

Studied treatments: Three types of organic and biological fertilizers was used:

1. *Bacillus* Fertilizer under one of three fertilization methods (Without, Plant irrigation and Leaf spraying).
2. Humic acid Fertilizer under one of four fertilization methods (Without, Soaking seeds in 2000 PPM water solution before cultivation, Leaf spraying with $1.6cm^3.L^{-1}$ and Plant irrigation with $4L.h^{-1}$).
3. Amino acids Fertilizer under one of four fertilization methods (Without, Soaking seeds in 2000 PPM water solution before cultivation, Leaf spraying with $1.6cm^3.L^{-1}$ and Plant irrigation with $4L.h^{-1}$).

Fertilization addition was applicated for 60 and 90 days after cultivation date.

Table 2: Description of used fertilizers

Type	Form	Composition	Concentration
Biofertilizer	Powder	Bacillus genus	$(10 \times 2)^6$
Organic Fertilizer	Solution	Humic acid	18% V/V
Organic fertilizer	Solution	Amino acids	17% W/V

Experimental Design: Split Plot design was used with three replications. First factor (*Bacillus* fertilizer) occupied the main plots, while the second factor (Humic acid fertilizer) occupied the split plots, and the third factor (Amino acids fertilizer) occupied the split split plots.

Statistical analysis: it was performed at the L.S.D. 5% level using SPSS V.25 and Excel programs.

Studied traits

- Plant Wet Weight (PWW) (g/plant): Weight of 20 plants from the internal rows in each plot was measured and the averages were estimated.
- Plant Dry Weight (PDW) (g/plant): 20 plants from the internal rows in each plot were dried at shadow for a week, then Weight and averages were estimated.
- Crop Growth Rate (CGR) (gr/ m^2 /week): From the Equation: Crop Growth Rate = Dry weight of plant / (Soil Area occupied by plant × Time).
- First Pick Percentage (FPP) *(%)*: From the Equation: First Pick Percentage = (production of first pick / total production) x 100.
- Cotton Yield (CY) (g/plant): Production of Cotton of 20 plants from the internal raws in each plot was measured and the averages were estimated.

Results and Discussion

Effect of Orgaic and Bio Fertilizers on Plant Wet Weight (PWW): Results of table (3) showed that there was no significant difference for any single type of fertilizers compared to the control, whereas each two fertilizers interactions was superiority significant compared to the control, with increasing values of *Bacillus* plant irrigation, Humic acid plant irrigation (17.05g/plant), and *Bacillus* plant irrigation Amino acids leaf spraying (17.30g/plant), and Humic acid plant irrigation Amino acids leaf spraying (18.08g/plant), comparing to the control. and *Bacillus* plant irrigation, Humic acid, plant irrigation Amino acids leaf spraying was superiority significant compared to the control with (22.13g/plant) increasing value. Organic and bio-fertilizers help plant growth and development and the accumulation of nutrients in the tissues, which increases the plant wet weight.

Table 3: Effect Organic and Bio Fertilizers on Plant Wet Weight (PWW)

Bacillus Fertilizer treatments	Humic acid Fertilizer treatments	Amino acids Fertilizer treatments				Average of Humic acid Fertilizer treatments	Average of *Bacillus* treatments
		Without	Soaking seeds	Leaf spraying	Plant irrigation		
Without	Without	178.92	180.45	186.68	183.62	182.42	187.60
	Soaking seeds	181.29	185.82	190.81	188.45	186.59	
	leaf spraying	184.37	187.57	193.41	189.88	188.81	
	Plant irrigation	187.43	191.84	197.00	194.07	192.59	
leaf spraying	Without	184.26	189.43	195.66	192.6*0*	190.49	194.23
	Soaking seeds	189.27	193.80	197.79	195.43	194.07	
	leaf spraying	191.35	194.55	199.39	196.86	195.54	
	Plant irrigation	193.41	195.82	200.98	197.05	196.82	
Plant irrigation	Without	186.43	189.99	196.22	192.16	191.20	195.67
	Soaking seeds	190.83	194.36	199.35	197.99	195.63	
	leaf spraying	193.91	196.11	200.95	198.42	197.35	
	Plant irrigation	195.97	197.38	201.05	199.61	198.50	
Average of Amino acids Fertilizer treatments		188.12	191.43	196.61	193.85		
	Bacillus	H.acid	A.acids	*Ba*×H	*Ba*×A	H ×A	*Ba*×H×A
L.S.D.5%	NS	NS	NS	6.28	6.68	5.93	4.01

Effect of Organic and Bio Fertilizers on Plant Dry Weight (PDW): Results of table (4) showed that there was no significant difference for any single type or two fertilizers interactions compared to the control, whereas *Bacillus* plant irrigation Humic acid plant irrigation Amino acids leaf spraying was superiority significant compared to the control with (5.77g/plant) increasing value. Plant Dry weight is associated with several factors affecting it, such as the kind of fertilizer, wet weight, drying method, drying period and rate of accumulation of dry matter and nutrients in tissues and cells. Thus, the interaction of studied fertilizer additives plays an important role in increasing it. In Pakistan, [13] found that using of Humic acid improved growth and productivity of wheat plant. Fertilization was either by spraying on the vegetation, or mixing with soil. The results showed that the addition of Humic acid had a significant effect on plant height (18%), root depth (29%), dry weight (76%), root (100%) and chlorophyll content (96%). In the United States, [14] evaluated the use of *Azotobacter* to reduce dependence on mineral nitrogen in cotton fertilization. Two strains of *Azotobacter chroococcum* (AC1 and AC10) were fertilized for their efficiency in stimulating germination and growth, In the glass house, Treatments with the twice strains with 50% of the required urea increased plant height by 13%, root depth 12%, plant dry weight 13% compared to the control, and enhanced the plant content of nitrogen. In Hungary, [15] reported that using of bio-fertilizers increased the germination rate of maize (*zea mays* L.) seeds and improved growth, using *Bacillus megaterium* (1×10^8 cells/cm^3) and *Azotobacter chroococcum* (18%) for 25 minutes, treatments were applied either through seed inoculation with a concentration (1, 3.5 ml/L) and distilled water. Directly or using blotting paper in Petri dishes. The results showed an increase in the rate of germination by 20%, dry weight of the vegetative branches and roots by 7% compared to the control.

Table 4: Effect of Organic and Bio Fertilizers on Plant Dry Weight (PDW)

Bacillus Fertilizer treatments	Humic acid Fertilizer treatments	Amino acids Fertilizer treatments				Average of Humic acid Fertilizer treatments	Average of *Bacillus* treatments
		Without	Soaking seeds	Leaf spraying	Plant irrigation		
Without	Without	70.76	71.58	74.2*0*	72.95	72.37	73.96
	Soaking seeds	71.59	73.37	76.43	74.80	74.05	
	leaf spraying	72.70	*74.00*	75.78	75.08	74.39	
	Plant irrigation	73.29	74.84	76.30	75.66	75.02	
leaf spraying	Without	71.20	72.55	74.79	73.54	73.02	74.68
	Soaking seeds	72.57	73.19	75.48	73.85	73.77	
	leaf spraying	73.67	74.59	77.52	76.05	75.46	
	Plant irrigation	75.03	75.82	78.43	76.63	76.48	
Plant irrigation	Without	72.47	74.05	77.06	75.42	74.75	76.34
	Soaking seeds	74.06	75.07	77.75	76.50	75.85	
	leaf spraying	75.55	76.85	78.63	77.93	77.24	
	Plant irrigation	76.53	76.93	78.91	77.74	77.53	
Average of Amino acids Fertilizer treatments		73.29	74.40	76.77	75.51		
	Bacillus	H.acid	A.acids	Ba×H	Ba×A	H ×A	Ba×H×A
L.S.D.5%	NS	NS	NS	NS	NS	NS	1.34

Effect of Organic and Bio Fertilizers on Crop Growth Rate (CGR): Results of table (5) showed that there was no significant difference for any single type or two fertilizers interactions compared to the control, whereas *Bacillus* plant irrigation Humic acid plant irrigation Amino acids leaf spraying was superiority significant compared to the control with (7.40gr/m^2 /week) increasing value. Humic substances addition enhances the vitality and activity of microorganisms in the soil by providing the carbon source needed for the growth and development of these organisms and their various functions [10], also Crop Growth Rate reflects the agricultural service processes and studied fertilizer additions and is closely related to the weather conditions in the cultivation region. [16] observed a research in Egypt to show the effect of

adding the Humic acid on the cotton plant. The results showed that the addition of Humic acid at a rate of 15 kg/h had a clear positive effect on growth, yield, fiber quality and plant water efficiency, so humic acids can be used to modify soil pH to overcome the negative effects of salinity.

Table 5: Effect of Organic and Bio Fertilizers on Crop Growth Rate (CGR)

***Bacillus* Fertilizer treatments**	**Humic acid Fertilizer treatments**	**Amino acids Fertilizer treatments**				**Average of Humic acid Fertilizer treatments**	**Average of *Bacillus* treatments**
		Without	**Soaking seeds**	**Leaf spraying**	**Plant irrigation**		
Without	Without	57.39	59.09	60.94	60.14	59.39	60.67
	Soaking seeds	58.18	59.54	62.69	61.32	60.43	
	leaf spraying	58.99	60.40	62.89	61.70	61.00	
	Plant irrigation	59.75	61.45	63.71	62.56	61.87	
leaf spraying	Without	58.20	59.50	62.40	60.70	60.20	61.60
	Soaking seeds	59.18	60.50	63.39	62.03	61.28	
	leaf spraying	59.54	64.22	64.19	62.56	62.63	
	Plant irrigation	60.31	61.41	64.42	63.11	62.31	
Plant irrigation	Without	58.82	60.02	63.22	61.66	60.93	62.07
	Soaking seeds	59.40	61.08	63.61	61.95	61.51	
	leaf spraying	60.66	61.63	64.41	63.23	62.48	
	Plant irrigation	61.43	63.12	64.79	64.08	63.36	
Average of Amino acids Fertilizer treatments		59.32	61.00	63.39	62.09		
	Bacillus	H.acid	A.acids	*Ba*×H	*Ba*×A	H ×A	*Ba*×H×A
L.S.D.5%	NS	NS	NS	NS	NS	NS	1.00

Effect of Orgaic and Bio Fertilizers on First Pick Percentage (FPP): Results of table (6) showed that there was no significant difference for any single type of fertilizers compared to the control, whereas each of *Bacillus* plant irrigation Amino acids leaf spraying and *Bacillus* plant irrigation Humic acid plant irrigation Amino acids leaf spraying was superiority significant compared to the control with (6.82, 7.62%) increasing values, respectively. The percentage of cotton is increased as a result of fertilizer treatment, which improves the various physiological and productive characteristics studied. First Pick Percentage of cotton is increased as a result of fertilizer treatments and their interactions, due to their positive effects on pant cells and tissues, which improves the various physiological, growth and productivity traits.

Table 6: Effect of Organic and Bio Fertilizers on Crop Growth Rate (CGR)

***Bacillus* Fertilizer treatments**	**Humic acid Fertilizer treatments**	**Amino acids Fertilizer treatments**				**Average of Humic acid Fertilizer treatments**	**Average of *Bacillus* treatments**
		Without	**Soaking seeds**	**Leaf spraying**	**Plant irrigation**		
Without	Without	63.61	64.97	66.17	65.30	65.01	65.76
	Soaking seeds	63.17	65.62	66.89	65.71	65.35	
	leaf spraying	64.23	65.90	67.84	66.19	66.04	
	Plant irrigation	65.01	66.23	68.04	67.31	66.65	
leaf spraying	Without	65.17	66.89	68.15	67.85	67.02	67.48
	Soaking seeds	65.98	66.28	68.52	69.47	67.56	
	leaf spraying	66.59	67.19	66.14	68.94	67.22	
	Plant irrigation	66.78	67.70	69.15	68.91	68.14	
Plant irrigation	Without	67.82	68.19	70.43	69.42	68.97	69.56
	Soaking seeds	68.11	68.63	70.09	69.67	69.13	
	leaf spraying	68.50	70.18	70.58	71.16	70.11	
	Plant irrigation	69.12	69.74	71.23	70.14	70.06	
Average of Amino acids Fertilizer treatments		66.17	67.29	68.60	68.34		
	Bacillus	H.acid	A.acids	*Ba*×H	*Ba*×A	H ×A	*Ba*×H×A
L.S.D.5%	NS	NS	NS	1.12	1.93	NS	1.48

Effect of Organic and Bio Fertilizers on Cotton Yield (CY): Results of table (7) showed that there was no significant difference for any single type of fertilizers compared to the control, whereas Humic acid plant irrigation Amino acids leaf spraying was superiority significant compared to the control with (5.47g/plant) increasing value. These results are in agreement with [9] who noticed that both cotton (Giza 86) and (Giza 88) cultivars that sprayed on vegetative part with amino acids three times, which gave the highest values for the number of open bolls per plant and one boll weight (g).

Table 7: Effect of Organic and Bio Fertilizers on Cotton Yield (CY)

Bacillus Fertilizer treatments	Humic acid Fertilizer treatments	Amino acids Fertilizer treatments				Average of Humic acid Fertilizer treatments	Average of *Bacillus* treatments
		Without	Soaking seeds	Leaf spraying	Plant irrigation		
Without	Without	70.97	71.06	71.53	71.16	71.18	73.54
	Soaking seeds	71.00	72.43	73.86	72.95	72.56	
	leaf spraying	73.45	74.69	76.24	75.43	74.95	
	Plant irrigation	74.60	75.52	76.32	75.42	75.47	
leaf spraying	Without	70.98	72.04	72.30	72.09	71.85	72.99
	Soaking seeds	71.28	71.23	72.15	71.32	71.50	
	leaf spraying	71.50	72.70	74.18	73.41	72.95	
	Plant irrigation	74.80	75.74	76.48	75.64	75.67	
Plant irrigation	Without	71.10	71.87	72.55	72.71	72.06	73.29
	Soaking seeds	71.84	73.38	73.99	73.47	73.17	
	leaf spraying	71.34	72.52	73.99	73.23	72.77	
	Plant irrigation	73.14	74.85	76.53	76.11	75.16	
Average of Amino acids Fertilizer treatments		72.17	73.17	74.18	73.58		
	Bacillus	H.acid	A.acids	*Ba*×H	*Ba*×A	H ×A	*Ba*×H×A
L.S.D.5%	NS	NS	NS	NS	NS	1.42	NS

Conclusion

This study exposed illegal addition of benzoic acid into some children food products in local market especially cakes and juices which considered a violation of Syrian specification, and should be of concern to the government.

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