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IMPACT OF INTERACTION BETWEEN NANO PARTICLES AND BACTERIAL AND AMINO FERTILIZERS ON GROWTH AND YIELD OF WHEAT PLANT

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Abstract

The spilt-spilt plot experiment was conducted at field in loam soil to study the effect of Interaction Between Nano fertilizers, Amino and bacterial fertilizers on growth and yield of wheat variety buhooth-22 .This experiment was carried out in according to randomized complete block design(RCBD) at three replicates included four levels of nano particles fertilizer (0, 0.5, 1 and 2) gm.l^{-1} and three levels of amino fertilizer (0, 4 and 8)ml.l^{-1} and two levels of bacterial fertilizer (with and without *Azotobacter*). The results indicated that the treatment (nanofertilizer 2gm.l^{-1} + amino fertilizer 8 ml.l^{-1} + *Azotobacter*) outperformed all other treatments in all indicators of studies characteristics , its led to increased plant height(cm), dry weight (gm), number of spikes.m^{-2}, number of grain. Spike^{-1} , weight of 1000 grains (gm), grain yield (ton.ha^{1}), biological yield (ton.ha^{-1}) ,except for the harvest index (%), its highest value at treatment was (nanofertilizer 1 g.l^{-1} + amino fertilizer 8 ml.l^{-1} + *Azotobacter*).

Key words: plant; Amino Fertilizers; bacterial

Introduction

Wheat is considered one of the most important crops in the world and has a nutritional significance that affects the economy and politics of most countries of the world , about 35% of the world's population depends on this crop for their food (Yacoub and Youssef, 2011).Its importance is due to the nutritional value ,which is represented by a good balance in its grains of proteins and carbohydrates as well as fats, vitamins, some amino acids and some nutrients like Ca, Mg and P are necessary in human food (Al-Sahuki *et al*., 2009). Iraq is one of the original habitats for the emergence of wheat and one of the countries that have success factors for its cultivation, However, its productivity is still below the required level (Central Statistical Organization, 2018).

Nano fertilizers are an important tool in agriculture to improve yield growth and production quality while reducing fertilizer waste and increasing nutrient use efficiency, nano fertilizers provide a larger surface area for different metabolic reactions in plants , which in turn increases the rat of photosynthesis and produces more yield, dry matter, the use of various nano fertilizers plays a major role in improving crop production, reducing the cost of production and reducing the risk of pollution (Meena *et al*., 2017).

Amino acids are the building block of proteins and preform photosynthesis, metabolism and transport functions in plants (Xing *et al*., 2008). Plants can produce amino acids , but their synthesis consumes high energy therefore, its use to be ready for absorption allows the plant to save energy , increase its growth and repair its damage especially at critical stage of plant growth (Popko *et al*., 2014).many studies have shown positive role of amino acids in improving the quality of plant product, when sprayed at different stage of growth , especially critical ones such as flowering and branching ,they stimulate the biochemical and physiological processes, these acids are involved in the construction of carbohydrates and proteins and believed to be responsible for the production of some natural growth hormones such as GA_3 and cell division, thereby improving quality and increasing the yield (Faissal *et al*., 2014).

Azotobacter is one of species of bacteria that has good ability to stabilize atmospheric nitrogen and which is used as a biofertilizer with a large number of crops, in addition to its ability to secrete some enzymes, hormones, vitamins and growth regulators, these compounds play an important role in plant growth (Abd Al-Gawad, 2009). For its ease of use and its positive impact on the crop and

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its low cost, the use of biofertilizers is one of the best ways to sustain agriculture(Behrooz *et al*., 2015). Azotobacter is one of the alternatives available to improve soil fertility And has beneficial effects on the crop growth and yield, it helps in the creation of growth organization such as auxin, cytokinen and gibberellic acid. in addition, it stimulates rhizosphere organisms, protects the plant from pathophyte, improves nutrient absorption and increases nitrogen fixation (Arjun *et al.,* 2015). The aim of this study is to know the role of growth promoters represented by nano, amino and bacterial fertilizers in the growth and yield of wheat plant.

Table 1: Some of its chemical and physical properties.

Unit	Value	Property
$Ds.m^{-1}$	3.1	Electrical conductivity
	7.4	PH
$g.kg^{-1}$	408	Sand
$g.kg^{-1}$	342	Silt
$g.kg^{-1}$	250	Clay
	Loam	Texture
$mg.kg^{-1}$	45	N
$mg.kg^{-1}$	20	P
$mg.kg^{-1}$	223	K
$mg.kg^{-1}$	400	Ca
$mg.kg^{-1}$	250	Mg
$mg.kg^{-1}$	431	Na
$mg.kg^{-1}$	14	Fe
%	25	$CaCO_3$
%	23	HCO_3

Materials and Methods

The spilt-spilt plot experiment was conducted at field of the College of Education for Pure Sciences Ibn Al-Haitham–University of Baghdad for the agricultural season of 2018/ 2019 in loam soil, some of its chemical and physical properties were measured table 1. To study the effect of Interaction Between Nano Particles, bacterial and Amino Fertilizers on Growth and Yield of Wheat variety buhooth-22. This experiment was carried out in according to randomized complete block design (RCBD) at three replicates. The nanofertilizer used contains micro elements (Fe 6%, Zn 6%, Mn 6%, Cu 0.5%, Mo 0.2%, B 0.2%), the nanofertilizer was sprayed with four concentration (0, 0.5, 1 and 2) $gm.l^{-1}$, the concentrations were sprayed on the vegetative parts of the plant until complete wetness, the first spray was 81 days after the cultivation, the second spray was 92 days after the

Table 2: Effect of Triple overlap between nano , amino and bacterial fertilizers on height (cm) of wheat plant.

Mean A×M	Nanofertilizer (N) $gm.l^{-1}$				Amino fertilizer (M)$ml.l^{-1}$	*Azoto-bacter* (A)
	2	1	0.5	0		
77.42	82.04	78.02	79.14	70.50	0	-A
77.99	82.64	79.72	76.28	73.34	4	
79.62	82.64	81.80	77.37	75.68	8	
79.61	83.34	81.37	81.41	72.34	0	+A
82.73	84.22	82.15	82.56	81.98	4	
83.52	85.32	83.60	81.79	83.38	8	
3.512	5.119				LSD 0.05	
N × A						
Mean A	**Nanofertilizer (N) $mg.l^{-1}$**				***Azotob-acter* (A)**	
	2	**1**	**0.5**	**0**		
78.35	82.77	79.85	77.60	73.17	-A	
81.95	84.29	82.37	81.92	79.23	+A	
1.477	3.297				LSD 0.05	
N×M						
Mean M	**Nanofertilizer (N) $gm.l^{-1}$**				**Amino fertilizer (M) $ml.l^{-1}$**	
	2	**1**	**0.5**	**0**		
78.52	82.69	79.69	80.27	71.42	0	
80.36	83.43	80.93	79.42	77.66	4	
81.57	84.48	82.70	79.58	79.53	8	
1.809	4.250				LSD 0.05	
	83.53	81.11	79.76	76.20	Mean N	
	2.089				LSD 0.05	

Table 3: Effect of Triple overlap between nano, amino and bacterial fertilizers on shoot dray weight (g) of wheat plant.

Mean A×M	Nanofertilizer (N) $gm.l^{-1}$				Amino fertilizer (M)$ml.l^{-1}$	*Azoto-bacter* (A)
	2	1	0.5	0		
05.96	6.56	6.14	5.79	5.35	0	-A
6.26	6.74	6.42	6.26	5.64	4	
6.59	7.35	6.75	6.41	5.84	8	
6.54	7.20	6.88	6.43	5.64	0	+A
6.77	7.52	66.92	6.64	6.00	4	
7.05	7.77	7.32	6.89	6.22	8	
0.505	0.699				LSD 0.05	
N × A						
Mean A	**Nanofertilizer (N) $mg.l^{-1}$**				***Azotob-acter* (A)**	
	2	**1**	**0.5**	**0**		
6.27	6.88	6.44	5.61	5.61	-A	
6.78	7.50	7.04	5.95	5.95	+A	
0.144	0.359				LSD 0.05	
N×M						
Mean M	**Nanofertilizer (N) $gm.l^{-1}$**				**Amino fertilizer (M) $ml.l^{-1}$**	
	2	**1**	**0.5**	**0**		
6.25	6.88	6.51	6.11	5.49	0	
6.52	7.13	6.67	6.45	5.82	4	
6.82	7.56	7.03	6.65	6.03	8	
0.176	0.462				LSD 0.05	
	7.19	6.73	6.40	5.78	Mean N	
	0.204				LSD 0.05	

cultivation, the third spray was 108 days after the cultivation and the fourth spray was 122 days after the cultivation. The amino fertilizer used is amino Quelant-k at three concentration (0, 4 and 8) ml.l^{-1} the concentrations were sprayed on the vegetative parts of the plant until complete wetness. The first spray was 65 days after the cultivation, the second spray was 84 days after the cultivation, the third spray was 99 days after the cultivation and the fourth spray was 113 days after the cultivation. Seed was treated with bacteria *Azotobacter chroococcum*, sterile seed were treated with bacterial vaccine with the addition of Arabic gum. The seed were grown in 27/11/2018. after the plants reached full maturity harvested in 15 /5/ 2019. The following attribute indicators have been taken:

Plant height (cm) the main height of five plants of 1 m^2 per experimental unit was randomly measured, the height of plant was measured for the main branch from the base of plant to the spike except for the turtle. (Khan and Spilde, 1992).

Dry weight (g) the dry weight of the vegetative group of plants was measured by randomly calculating the average dry weight of five plants per experimental unit.

Number of spikes.m^{-2} the number of spikes was calculated in an area of 1 m^2 per experimental unit.

Number of grains.spike^{-1} he average number of grains for five spikes of experimental unit was calculated randomly.

Weight of 1000 grains (g) each experimental unit was calculated randomly (Briggs and Aytenfisu, 1980).

Grains yield (ton.ha^{-1}) it was calculated from the harvest of the experimental unit , which has an area of 1 m^2 and was converted on the basis of ton.h^{-1}.

Biological yield (ton.ha^{-1}) it was calculated from the weight of the harvested plants from an area of 1 m^2 and was converted on the basis of ton.ha^{-1}.

harvest index (%) calculated by dividing the grains yield by the biological yield × 100 (Donald, 1962).

The Statistical Analysis System (2012)-SAS statistical program was used in data analysis, significant differences were compared to the least significant difference(LSD) at $p \leq 0.05$.

Results

Table 2 shows increase in plant height from (76.20

Table 4: Effect of Triple overlap between nano , amino and bacterial fertilizers on number of spikes.m^{-2}.

Mean A×M	Nanofertilizer (N) gm.l^{-1}				Amino fertilizer (M)ml.l^{-1}	*Azoto-bacter* (A)
	2	1	0.5	0		
196.06	248.67	208.85	179.69	150.04	0	-A
220.54	259.97	235.52	222.23	164.47	4	
243.60	287.79	257.76	242.24	186.62	8	
209.31	255.63	218.34	199.94	163.34	0	+A
237.33	278.05	264.45	227.79	179.05	4	
269.19	321.46	306.68	253.35	195.26	8	
34.86	37.27				LSD 0.05	
N × A						
Mean A	Nanofertilizer (N) mg.l^{-1}				*Azotob-acter* (A)	
	2	1	0.5	0		
220.07	265.48	213.72	234.04	167.04	-A	
238.61	285.05	227.03	263.16	179.22	+A	
6.718	26.29				LSD 0.05	
N×M						
Mean M	Nanofertilizer (N) gm.l^{-1}				Amino fertili-zer (M) ml.l^{-1}	
	2	1	0.5	0		
202.68	252.15	213.59	188.31	156.69	0	
222.94	269.01	249.98	225.01	171.76	4	
256.39	304.62	282.22	247.79	190.94	8	
8.22	20.47				LSD 0.05	
	275.26	248.60	220.37	173.13	Mean N	
	9.50				LSD 0.05	

Table 5: Effect of Triple overlap between nano , amino and bacterial fertilizers on number of grains. spikes^{-1}.

Mean A×M	Nanofertilizer (N) gm.l^{-1}				Amino fertilizer (M)ml.l^{-1}	*Azoto-bacter* (A)
	2	1	0.5	0		
68.23	71.80	68.67	67.40	65.06	0	-A
70.36	73.83	71.40	69.63	66.57	4	
73.52	76.60	74.57	72.63	70.30	8	
71.57	74.30	73.57	70.07	68.33	0	+A
73.40	76.63	74.37	72.60	70.00	4	
75.65	78.70	76.53	74.75	72.63	8	
3.374	6.18				LSD 0.05	
N × A						
Mean A	Nanofertilizer (N) mg.l^{-1}				*Azotob-acter* (A)	
	2	1	0.5	0		
70.70	74.08	71.55	69.89	67.31	-A	
73.54	76.54	74.82	72.47	70.32	+A	
1.784	3.742				LSD 0.05	
N×M						
Mean M	Nanofertilizer (N) gm.l^{-1}				Amino fertili-zer (M) ml.l^{-1}	
	2	1	0.5	0		
69.90	73.05	71.12	68.73	66.69	0	
71.87	75.23	72.88	71.11	68.28	4	
74.59	77.65	75.55	73.69	71.46	8	
2.18	4.358				LSD 0.05	
	75.31	73.18	71.18	68.81	Mean N	
	2.523				LSD 0.05	

to 83.53 cm) when treating plant with nanofertilizer from (0 to 2 gm.l^{-1}) by an increase of 9.58% . plant height increase from (78.52 to 81.57 cm) under effect of spring amino fertilizer from (0 to 8 ml.l^{-1}) by an increase 3.88%. The use of bacteria *Azotobacter chroococcum* led to an increase in plant height (81.95 cm) compared to the control by an increase of 4.59%. The triple interaction between nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) with *A. chroococcum* increase plant height from (70.50 to 83.38 cm).

Table 3 indicates an increase in dry weight of vegetative group of wheat plant from (5.78 to 7.19 g) when treated with nanofertilizer from (0 to 2 gm.l^{-1}) by an increase of %24.39. Dry weight increase from (6.25 to 6.82 g) when treated with amino fertilizer from(0 to 8 ml.l^{-1}) an increase of 9.12%. The use of bacteria *Azotobacter chroococcum* led to an increase in plant height (6.78 g) compared to the control by an increase %8.13. The treatment of the plant with nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) with *A. chroococcum* increase dry weight from (5.35 to 7.77 g).

Table 4 indicates an increase in number of spikes.m^{-2} from (173.13 to 275.26 spikes.m^{-2}) under the effect of sprayed of nanofertilizer from (0 to 2 gm.l^{-1}) by an increase 58.99%. The number of spikes.m^{-2} increase from (202.68 to256.39 spikes.m^{-2}) when treated with amino fertilizer from (0 to 8 ml.l^{-2}) an increase 26.49%. The inoculation the plant with *A. chroococcum* led to an increase in the number of spikes.m^{-2} from (220.07 to 238.61 spikes.m^{-2}) by an increase 8.42%. The triple overlap between nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) and inoculation with *A. chroococcum* resulted in an increase in the number of spikes.m^{-2} from (150.04 to 321.46 spikes.m^{-2}).

The result of table 5 shows that the increase in the concentration of nanofertilizer from (0 to2 gm.l^{-1}) caused an increase in the number of grains in spike from (68.81 to 75.31 grain.spike^{-1}) by an increase 9.44%. The treatment of plant amino fertilizer (8ml.l^{-1}) caused an increase in the number of grains in spike (74.59 grain.spike^{-1}) compared to the control (69.90 grain.spike^{-1}) an increase 6.70%. The inoculation the plant with *A. chroococcum* led to an increase in the number of grains in spike (73.54 grain.spike^{-1}) compared to the control (70.70 grain.spike^{-1}) by an increase 4.01%. The triple overlap between nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) and inoculation with *A. chroococcum* led to an increase in the number of grains in spike from

Table 6: Effect of Triple overlap between nano , amino and bacterial fertilizers on 1000-seed weight (g).

Mean A×M	Nanofertilizer (N) gm.l^{-1} 2	1	0.5	0	Amino fertilizer (M)ml.l^{-1}	*Azotobacter* (A)
41.51	43.86	42.34	40.51	39.32	0	-A
42.92	44.93	43.63	42.84	40.30	4	
43.84	45.69	44.03	43.17	42.49	8	
42.59	44.80	43.29	41.93	40.33	0	+A
43.89	45.59	44.83	43.20	41.96	4	
45.62	48.26	46.23	44.92	43.06	8	
2.125	3.571				LSD 0.05	
N × A						
Mean A	**Nanofertilizer (N) mg.l^{-1} 2**	**1**	**0.5**	**0**	***Azotobacter* (A)**	
42.76	44.83	43.33	42.17	40.70	-A	
44.03	46.22	44.78	43.35	41.78	+A	
1.031	2.289				LSD 0.05	
N×M						
Mean M	**Nanofertilizer (N) gm.l^{-1} 2**	**1**	**0.5**	**0**	**Amino fertilizer (M) ml.l^{-1}**	
42.04	44.33	42.81	41.22	39.82	0	
43.41	45.26	44.23	43.02	41.13	4	
44.73	46.97	45.13	44.04	42.77	8	
1.26	2.639				LSD 0.05	
	45.52	44.06	42.76	41.24	Mean N	
	1.458				LSD 0.05	

Table 7: Effect of Triple overlap between nano , amino and bacterial fertilizers on grains yield (ton.h^{-1}).

Mean A×M	Nanofertilizer (N) gm.l^{-1} 2	1	0.5	0	Amino fertilizer (M)ml.l^{-1}	*Azotobacter* (A)
3.99	4.79	4.15	3.66	3.15	0	-A
4.10	4.85	4.30	3.89	3.35	4	
4.53	5.10	4.65	4.36	4.03	8	
4.29	5.11	4.68	3.92	3.47	0	+A
4.83	6.12	5.18	4.23	3.79	4	
5.67	6.68	6.43	5.02	4.55	8	
0.643	0.673				LSD 0.05	
N × A						
Mean A	**Nanofertilizer (N) mg.l^{-1} 2**	**1**	**0.5**	**0**	***Azotobacter* (A)**	
4.19	4.91	4.37	3.97	3.51	-A	
4.93	5.97	5.43	4.39	3.94	+A	
0.165	0.542				LSD 0.05	
N×M						
Mean M	**Nanofertilizer (N) gm.l^{-1} 2**	**1**	**0.5**	**0**	**Amino fertilizer (M) ml.l^{-1}**	
4.11	4.95	4.41	3.79	3.31	0	
4.46	5.48	4.74	4.06	3.57	4	
5.10	5.89	5.54	4.69	4.29	8	
0.202	0.678				LSD 0.05	
	5.44	4.89	4.18	3.72	Mean N	
	0.234				LSD 0.05	

(150.04 to 321.46 spikes.m^{-2}).

Table 6 indicated that the addition of nanofertilizer in concentration from (0 to 2gm.l^{-1}) resulted in an increase in the weight of 1000 grains from (41.24 to 45.52 g) an increase 10.37%. An increase in amino fertilizer from (0 to 8 ml.l^{-1}) leads to an increase in the weight of 1000 grains from (42.04 to44.73 g) an increase 6.39%. The inoculation the plant with *A. chroococcum* led to an increase in the weight of 1000 grains (44.03 g) compared to the control (42.76 g) by an increase 2.97%. The triple overlap between nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) and inoculation with *A. chroococcum* led to an increase in the number of grains in spike from (39.32 to45.62 g).

Table 7 shows that the increase in nanofertilizer concentration from (0 to 2gm.l^{-1}) lead to an increase in the grains yield from (3.72 to 5.44 ton.ha^{-1}) an increase 46.24%. The grains yield increase from (4.11 to 5.10 ton.ha^{-1}) when treated with amino fertilizer from (0 to 8 ml.l^{-2}) by an increase 24.08%. The inoculation the plant with *A. chroococcum* led to an increase in the grains yield (4.93 ton.ha^{-1}) compared to the control (4.19 ton.ha^{-1}) an increase 17.66%. The treatment of nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) and inoculation with *A. chroococcum* give a significant increase in the grains yield (6.68 ton.ha^{-1}) compared with control.

Table 8 showed an increase in biological yield from (6.59 to 8.25ton.ha^{-1}) when treating wheat plant with nanofertilizer from (0 to 2gm.l^{-1}) by an increase 25.18%. The treatment of amino fertilizer from (0to8ml.l^{-1}) also caused an increase in the biological yield from (6.99 to 7.93 ton.ha^{-1}) an increase 13.44%. The inoculation the plant with *A. chroococcum* led to an increase in the biological yield (7.72 ton.ha^{-1}) compared to the control (6.82 ton.ha^{-1}) an increase 13.19%. The treatment of nanofertilizer (2 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) and inoculation with *A. chroococcum* give a significant increase in the biological yield (9.53 ton.h^{-1}) compared with control.

Table 9 shows that the increase in the harvest index from (56.35%) when treated with nanofertilizer (1 gm.l^{-1}) compared to the control by an increase of 16.69%. The treatment plant with amino fertilizer (8ml.l^{-1}) give the highest increase in harvest index (63.87%) compared to the control an increase of 8.82%. The harvest index increase (63.24%) when inoculation the plant with *A.*

Table 8: Effect of Triple overlap between nano , amino and bacterial fertilizers on biological yield (ton.h^{-1}).

Mean A×M	**Nanofertilizer (N) gm.l^{-1}**				**Amino fertilizer (M)ml.l^{-1}**	***Azoto-bacter* (A)**
	2	**1**	**0.5**	**0**		
6.81	7.65	7.09	6.42	6.10	0	-A
6.97	7.67	7.20	6.69	6.32	4	
7.42	7.96	7.52	7.28	6.92	8	
7.18	8.00	7.49	6.93	6.31	0	+A
7.54	8.69	7.86	7.03	6.58	4	
8.45	9.53	8.89	8.10	7.30	8	
0.574	0.586				LSD 0.05	
N × A						
Mean A	**Nanofertilizer (N) mg.l^{-1}**				***Azotob-acter* (A)**	
	2	**1**	**0.5**	**0**		
6.82	7.76	7.27	6.80	6.45	-A	
7.72	8.74	8.08	7.35	6.73	+A	
0.091	0.466				LSD 0.05	
N×M						
Mean M	**Nanofertilizer (N) gm.l^{-1}**				**Amino fertili-zer (M) ml.l^{-1}**	
	2	**1**	**0.5**	**0**		
6.99	7.82	7.29	6.67	6.20	0	
7.25	8.18	7.53	6.86	6.45	4	
7.93	8.74	8.20	7.69	7.11	8	
0.112	0.542				LSD 0.05	
	8.25	7.67	7.07	6.59	Mean N	
	0.129				LSD 0.05	

Table 9: Effect of Triple overlap between nano, amino and bacterial fertilizers on yield index (%).

Mean A×M	**Nanofertilizer (N) gm.l^{-1}**				**Amino fertilizer (M)ml.l^{-1}**	***Azoto-bacter* (A)**
	2	**1**	**0.5**	**0**		
57.62	62.78	58.60	57.49	51.63	0	-A
58.55	63.26	59.67	58.24	53.02	4	
60.97	64.08	61.74	59.89	58.19	8	
59.76	63.92	62.72	57.36	55.03	0	+A
63.53	70.42	65.86	60.15	57.71	4	
66.77	70.10	72.48	61.98	62.54	8	
4.893	8.333				LSD 0.05	
N × A						
Mean A	**Nanofertilizer (N) mg.l^{-1}**				***Azotob-acter* (A)**	
	2	**1**	**0.5**	**0**		
59.05	63.37	60.00	58.54	54.28	-A	
63.24	68.15	67.02	59.83	58.43	+A	
2.405	4.832				LSD 0.05	
N×M						
Mean M	**Nanofertilizer (N) gm.l^{-1}**				**Amino fertili-zer (M) ml.l^{-1}**	
	2	**1**	**0.5**	**0**		
58.69	63.35	60.66	57.42	53.33	0	
61.04	66.84	62.76	59.19	55.36	4	
63.87	67.09	67.11	60.93	60.36	8	
2.94	6.187				LSD 0.05	
	65.76	63.51	59.18	56.35	Mean N	
	3.402				LSD 0.05	

chroococcum compared to the control by an increase of 7.09%. The triple overlap between nanofertilizer (1 gm.l^{-1}) and amino fertilizer (8 ml.l^{-1}) and inoculation with *A. chroococcum* led to an increase in the harvest index (72.48%) compared to the control.

Discussion

The increase in plant height table 2 is due to the content of nanofertilizer from zinc, which has an important role in the formation of tryptophan ,from which Indole acetic acid (IAA) is derived which is important in cell elongation, leading to increase plant height (Mansour, 2007), this is agreed with results of Muhammad *et al.*, (2019) on the wheat plant. The increase in the dry weight table 3 of the vegetative group of plants may be due to the provision of nanofertilizers more surface area for different metabolic reactions in the plant and thus lead to an increase in the rate of photosynthesis, which increases the demand for mineral elements and thus produces more dry matter (Meena *et al*., 2017). The increase in number of spikes.m^{-2} table 4 may be due to the adding the nanofertilizer that contains the micro nutrition in the critical stages of emergence and development of branches and spikes as a result, constant availability of nutrients improves growth by increasing the chlorophyll content in the leaves and its role in improving the efficiency of photosynthesis and increasing its products and this reduces the competition on nutrients within the plant (Marten and Westemen, 1997) the refore increase the number of spikes. Increasing the number of grains in spike table 5 may be due to the importance of zinc in increased pollen grains that increases the chances of fertilization and formation of grains, which leads to an increase in the number of grains.$spike^{-1}$ (Geith *et al*., 1989). The increase in weight of 1000 grain, grains yield and harvest index table (6, 7, 9) may be due to the content of nanofertilizer from iron, zinc and manganese that has important role in many vital and physiological processes such as photosynthesis, respiration, energy production, the formation of chlorophyll and building nucleic acids, which increase the products of photosynthesis(Marten and Westemen, 1997), the products of photosynthesis are transferred from the leaves (source) to the grains (downstream) (Al-Sulaymani *et al.,* 2011; Salih, 2010) which leads to increase of weight of 1000 grain and grains yield, this is reflected positively on harvest index. The increase of biological yield table 8 may be due to the content of nanofertilizer from iron, zinc and manganese that has role in in increasing the number of branches although it is genetic characteristic that is affected by nutrition of plant, providing plant micronutrients enhances photosynthesis efficiency which stimulates branch growth (Hammadi and Al-Khfajy, 1999) which reflected positively on the biological yield.

The positive impact of amino acids on plant growth and yield may be due to that amino acids are involved in the formation of chloroplasts in addition, nitrogen released from the amino acids involved in building chlorophyll, which increasing the chlorophyll content in the leaves thus enhancing photosynthetic efficiency, (Gutierrez-Micelli *et al*., 2007) thus, the products of photosynthesis increase, such as carbohydrates and proteins (Amujoyegbe *et al*., 2007). In addition to the role of amino acids in increasing the production of some plant hormones, such as auxin (IAA) and gibberellic acid that stimulate cell division and elongation (Walter and Nawacki, 1978). This reflects positively on plant height, shoot dry weight, number of spikes.m^{-2} and biological yield table (2, 3, 4, 8). The increase of products of photosynthesis and its transferred from the leaves (sours) to the drains (downstream) this reflects positively on yield and its compounds table (5, 6, 7, 9). This results are in line with those obtained by El-Naggar and El-Ghamry (2007) and this result are in agreement with those reported by Yousef (2011).

The positive effect of Azotobacter on plant growth table (2, 3, 4) and yield and its compounds table (5, 6, 7, 8, 9) may be due to that Azotobacter can fix atmospheric nitrogen by the process of biological nitrogen fixation, thereby providing nitrogen to the plan, which is essential in amino acids synthesis that are involved in synthesis of enzymes and hormones important in building protoplasm, stimulation growth and increasing the size and number of cell (Idris and Dirhab, 2007), this is in line with those reported by (Al-Eany, 2018). Also, chlorophyll is directly related to the plant's nitrogen content because it is involved in the synthesis of chlorophyll (Gutierrez- Micelli *et al*., 2007), which leads to enhancing the efficiency of photosynthesis ultimately increase its products and transfer of these products from the leaf (sours) to the grains (downstream), this reflects positively on growth and yield and its compounds . Or may be due to ability of Azotobacter to stimulating plant growth by producing chelating compounds for some nutrients such as P, Fe, Zn and Mn, which leads to an increases its readiness in the soil ultimately increase it in plant (Toledo *et al.*, 2000). These results are in line with those obtained by (Kader et al., 2002).

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