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Potential Use of Bio-Fertilizer and Stimulating Growth Compounds to Promote Rice Productivity

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ABSTRACT

Giza 179 Egyptian rice cultivar was grown at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, in 2014 and 2015 seasons; to study the influence of *Cyanobacteria* and *Azospirillum* as bio-fertilizer, foliar spraying with solution of simulative compounds (ascobein , humic acid and water) and three nitrogen levels (100%, 75% and 50% of the recommended chemical nitrogen fertilizer,69 kg N fed^{-1}) on growth, yield attributes, yield and grain quality. The results show a positive effect of chemical N rate, biofertilizer and simulative compounds on crop growth rate (CGR), panicle numbers m^{-2}, 1000-grain weight, chemical ccompositions into milled grain such as protein and nitrogen content as well as grain and straw yields . Combination of 75% of chemical nitrogen fertilizer along with any biofertilizer or stimulating compounds were statistically at par with any combination containing the recommended nitrogen fertilizer (100% N) in the most of previous characters. Thus, it concluded that the application *Cyanobacteria* or *Azospirillum* with ascobien with humic acid as stimulating compounds as well as 75% of the recommended nitrogen dose could be used successfully to achieve optimum grain yield of Giza 179 Egyptian rice cultivar with saving 25 % of N fertilizer.

Keywords: Rice, Cyanobacteria, Azospirillum, ascobien, humic acid, Chemical compositions.

INTRODUCTION

Rice (*Oryza sativa* L.) is important food crop in Egypt and in the world. Nitrogen is one of the most important elements necessary in agriculture in Egypt and the world. Urea is the most common nitrogen sources used in crop production particularly for rice production in Egypt. Biofertilizers play a really vital role for supplementing the essential plant nutrients for agriculture, economy and eco-friendly environment. Biofertilizers are getting progressively common in several countries and for several crops, they're outlined as product containing active or latent strains of soil microorganisms, either bacterium alone or together with alga or fungi that increase the plant handiness and uptake of mineral nutrients (Elekhtyar, 2016). Cyanobacteria (blue green algae) is O_2-evolving, photosynthesizing prokaryotes that has an extensive history of use food source and as biofertilizer in rice fields.*Cyanobacteria* increase the oxygen concentration and improve other physic-chemical parameters of environment. *Azosipirllum* has beneficial effects on both plant growth and yield of rice and is of great agronomic importance. *Azospirillum* can utilize atmospheric nitrogen and contribute to plant nitrogen nutrition (Elekhtyar, 2011)

Ascobien compound (13% citric acid+25% ascorbic acid + 62% organic materials), ascorbic acid has effects on many physiological processes such as the regulation of growth and metabolism of the plants. Noctor and Foyer (1998) and Smirnoff (2005) concluded that ascorbic acid is a small, water-soluble molecule, which acts as a primary substrate in the cyclical pathway for detoxification and neutralization of superoxide radicals and singlet oxygen. humic acid is one of the major components of humus. humates are natural organic substances, high in humic acid and containing most of know trace minerals essential to the growth of plant life humic substances are crucial soil parts thus they constitute a stable fraction of carbon and improve water holding capability, pH buffering and thermal insulation.

The main objectives of this study are Minimize the chemical fertilizer in rice field through save it from leaching and Minimize the cost of inputs and reduce environmental pollution.

MATERIALS AND METHODS

Giza 179 Egyptian rice cultivar was grown at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, in 2014 and 2015 seasons, to study the effect of bio-fertilizer, simulative compounds and chemical nitrogen fertilizer on growth, yield, yield attributes, grains quality and chemical compositions. Barley was the preceding crop in the two seasons. Soil samples were taken at the depth of 0-30 cm and analyzed according the methods of Black et al. (1965) as given in Table 1. The experiment was laid out in split-split plot design with four replications. Main plots were assigned to nitrogen levels, sub-plots to bio-fertilizer and the sub-sub-plots to stimulating growth compound.

Chemical nitrogen fertilizers:

Urea fertilizer [CO (NH2)2 - 46%N] as a chemical nitrogen source was used at the rate of 50, 75 and 100% of the recommended rate (69 kg N fed^{-1}) in two split dose was 2/3 as basal application incorporated in dry soil before transplanting, while the second dose was 1/3 as topdressing at 30 Days after sowing.

Biofertilizers:

The bio-fertilizer sources namely *Azospirillum brasilens* bacterial inoculation and *Cyanobacteria* (Blue green algae) wear used at the rate of 1000g fed^{-1} in the permanent field and at the of400g in the nursery. The bio-fertilizer, *e.g. Azospirillum* and *Cyanobacteria* were used as a powder inoculation for soil application. Bio-fertilizer was mixed with a sufficient quantity of sand and distributed regularly to inoculate the nursery soil after 7 days from seed broadcasting and in permanent field after 15 days from seedlings transplanting. The biofertilizers were produced by the General Organization for Agricultural Equalization Fund, Ministry of Agriculture and Land Reclamation, Egypt.

Stimulating growth compounds:

Stimulating growth compounds (ascobein and humic acid) and tap water (as a control) were used as a foliar application at three times 50, 60 and 70 days after sowing (DAS). Ascobein (13% citric acid + 25% ascorbic acid + 62% organic materials) was applied at the rate of 1.5 g liter^{-1} water, while humic acid (86% humate potassium) was used at the rate of 0.25g liter^{-1} water.

Table 1. Some physical and chemical properties of the experimental soil before planting in 2014 and 2015 seasons.

Soil properties	2014	2015
Mechanical:		
Clay %	55.9	56.0
Silt %	31.5	32.0
Sand %	12.6	12.0
Texture	Clayey	Clayey
Chemical:		
Organic Matter (O.M)%	1.45	1.50
pH(1:2.5 soil suspension)	8.35	8.44
Ec (ds.m^{-1})	2.21	2.34
Total N (ppm)	477.00	430.50
Available P (ppm)	14.00	12.00
Exchorosable K (ppm)	460	432
Available ammonium (ppm)	18.0	17.2
Nitrate concentration (ppm)	14.0	13.2
Soluble anions, meq.L^{-1} :		
$CO^{=}_3$	--	--
HCO^-_3	5.30	6.20
Cl^-	8.50	9.10
$SO^{=}_4$	17.40	18.00
Soluble Cations, meq.L^{-1} :		
Ca^{++}	11.70	10.70
Mg^{++}	3.50	5.00
Na^{++}	1.60	2.00
K^+	14.40	15.60
Availabe micronutrients (ppm)		
Fe^{++}	5.00	5.80
Mn^{++}	3.04	3.20
Zn^{++}	1.00	0.95

Seeds at the rate of 60 kg fed^{-1} were soaked in water for 24 hr then incubated for 48 hr to hasten early germination. Pre-germinated seeds were uniformly broadcasted in the nursery on 10th and 15th May in the first and second seasons respectively. Phosphorus fertilizer was applied in the form of single super phosphate (15.5% P2O5) in the permanent field before land preparation. The permanent field was prepared, through plowing twice followed by good wet leveling . Seedlings were carefully pulled from the nursery after 30 days from sowing and distributed among the plots. Seedlings were manually transplanted into 12 m^2 sub plots in 20×20 cm spacing at the rate of 2-3 seedlings hill^{-1}. All other agronomic practices were followed as recommended during the growing season.

Studied characters:

Crop growth rate (CGR) in g m^{-2} week^{-1}, and net assimilation rate (NAR) in g m^{-2} week^{-1} as following:

$$\mathbf{CGR = (W_2 - W_1) / T_2 - T_1}$$

$$\mathbf{NAR = (W_2 - W_1) (\log_e A_2 - \log_e A_1) / (A_2 - A_1) (T_2 - T_1)}$$

Where:

W_1, A_1 and W_2, A_2, respectively refer to dry weight and leaf area at time T_1 and T_2 in weeks.

Number of panicles m^{-2}, 1000-grain weight (g), hulling %, milling %), head rice %, nitrogen% and protein% in milled grain, grain yield (t fed^{-1}) and straw yield (t fed^{-1}) were recorded. Hulling%, milling% and head rice% were estimated according to the methods reported by Adair (1952). N% in milled grain was determined using orange–G dye method (Hafez and Mikkelson, 1981) and multiplied the percentage by factor 5.95 to obtain the percentage of protein in milled grain.

All collected data were statistically analyzed according to the technique of analysis of variance as a Split-Split Plot Design analysis for the two seasons. and The Duncan's Multiple Range Test (1955) was used to test the difference among the treatment means as published by Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique using "MSTAT-C" computer software package.

RESULTS AND DISCUSSION

I. Growth analysis:

Data in Table 2 show that crop growth rate (CGR) at the two periods of 75–90 and 90-105 DAS in both seasons and net assimilation rate (NAR) in the second period in the first season was significantly increased by each increment of chemical nitrogen rate. NAR was decreased by increasing nitrogen in the first period in the second season. Such impact of nitrogen might be attributed specially to its position inside the stimulation of diverse physiological processes, which resulted in more tillers formation, leaf numbers and photosynthetic area (leaf area), in turn lead to extra photosynthetic production and consequently improved dry matter accumulation m^{-2} (CGR). The promoting effect of nitrogen on dry matter accumulation was reported by *Gharib et al.* (2011) and Sorour (2015).

Biofertilizer had a significant effect on CGR, except in the period of 90-105 DAS in the first season. Application of *Cyanobacteria* or *Azospirillum*, being insignificant, resulted in a substantial increase in CGR compared with uninoculated treatment. Such effect of *Cyanobacteria* and *Azospirillum* may be due to increase in leaf area, which resulted in more photosynthetic assimilation and consequently increased crop growth rate (Elekhtyar 2007). Also, these results agreed with the findings of Elekhtyar (2011), who found that biofertilization with *Cyanobacteria* inoculation stimulated the proliferation of C and N cycle microbes, which was accompanied by a significant increase in both organic matter and plant available nutrients. And also enhance the immobilization and storage of considerable amounts of P in the cells. *Cyanobacteria* improve the physico-chemical properties of the soil by enriching them with carbon, nitrogen and available P. Cyanobacteria isolates may help in ameliorating the land and making them suitable for obtaining higher yields as benefits, other than nitrogen fixation. On the other hand biofertilizers had no significant effect on NAR in the two seasons.

Foliar spraying with solutions of stimulating compounds significantly increased CGR compared with foliar spraying with water (control) at all growth periods in the two seasons (Table 2). Plants sprayed with scobien did not significantly differ than those sprayed with humic acid in CGR at all growth periods. The effect of foliar application with ascobien compound on these growth traits may be due to the combined action of both ascorbic and citric acid on cell elongation division and cell enlargement, which reflected positively, plant height and number of tillers (Taha, 2008). NAR was not affected by foliar spraying with stimulating compounds in the two growth periods.

The interaction of chemical N level X biofertilizer X stimulating compounds had no significant effect on CGR and NAR in both seasons. The interaction of chemical N level X biofertilizer, chemical N level X stimulating compounds and biofertilizer X stimulating compounds had significant effect on CGR in both seasons

(Table 3). Plants received 100 or 75% chemical N along with Cyanobacteria or Azospirillum and 100% chemical N alone produced higher CGR than those received 75% chemical N alone or any combination with 50% chemical N at the most period in both seasons. At 50% chemical N, inoculation of Cyanobacteria or Azospirillum resulted in an increase in CGR compared with uninoculated treatment, which recorded the lowest values of this trait. These results are agreed with those obtained by Elekhtyar, 2011. Such effect of chemical nitrogen alone or with other biofertilizers inoculation was possibility due to its immediate availability and quick absorption from root zone both of that are associated with better growth. At the same chemical N level, CGR was significantly increased by foliar spraying with ascobein compared with water (control) in all periods in both seasons. The combination of 100 or 75% N with ascobein produced the highest CGR, while 50% N with water produced the lowest one. These results agreed with those findings by Sorour *et al.* (2015).The interaction between biofertilizer and stimulating compounds had a significant effect on crop growth rate (Table 3). The highest CGR was obtained from plants received ascobien or humic with *Azospirillum* or *Cyanobacteria*. In this connection, Foyer (1993) and Smirnoff (2005) concluded that ascorbic acid has effects on many physiological processes including the regulation of growth and metabolism of plants.

Table 2. Crop growth rate (CGR) and net assimilation rate (NAR) of rice cv. Giza 179 as affected by nitrogen level, biofertilizer and stimulating growth compounds in 2014 and 2015 seasons

Factor	CGR (g m^{-2} week^{-1})				NAR (g m^{-2} week^{-1})			
	2014		2015		2014		2015	
	Days after sowing							
	75 - 90	90-105	75 – 90	90 - 105	75 – 90	90 - 105	75 - 90	90 -105
Nitrogen level (N):	**	**	**	*	NS	**	*	NS
100%	255 a	179 a	210.9 a	194.4 a	76.4	37. 5 a	78.6 c	56.0
75%	240 b	146 b	200.4 b	177.2 b	82.0	34.2 b	88.7 b	62.4
50%	182 c	116 c	135.0 c	161.9 c	79.1	31.9 c	100 a	52.5
Biofertilizer (B):	**	NS	**	*	NS	NS	NS	NS
Cyanobacteria	228 a	148.0	181.4 a	186.3 a	79.0	34.0	91.7	57.4
Azospirillum	235 a	151.1	187.7 a	187.4 a	79.2	34.0	84.0	53.4
Uninoculation	213 b	142.0	164.4 b	172.6 b	80.1	35.1	91.6	60.0
Stimulating compound (S)	**	*	**	*	NS	NS	NS	NS
Ascobien	237 a	159 a	190.4 a	189.7 a	79.1	36.0	88.8	55.8
Humic acid	228 a	145 b	181 ab	185.1 a	79.3	33.4	87.6	55.7
Water	211 b	137 b	162.1 b	171.6 b	79.0	34.1	90.9	59.5
Interaction								
N × B	*	*	**	*	NS	NS	NS	NS
N × S	*	**	*	**	NS	NS	NS	NS
B × S	*	*	*	**	NS	NS	NS	NS
N × B × S	NS	NS	NS	NS	NS	NS	NS	NS

***, ** and NS indicate P< 0.05 , P< 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.**

Table 3. CGR (g week^{-1}) of rice cv. Giza 179 as affected by the interaction of nitrogen level x biofertilizer, nitrogen level x stimulating compound and biofertilizer x stimulating compound in 2014 and 2015 seasons.

N %	Bio.	Stim. Com.	2014 season		2015 season	
			Days after sowing			
			75 - 90	90 - 105	75 - 90	90 – 105
	Cyan.		255 a	180 a	195.6 ab	210.6 a
100	Azo.		256 a	181 a	202.6 a	215.9 a
	Un.		245 a	176 a	185 a-d	206.2 a
	Cyan.		246 a	147 a-d	180.9 a-d	207.8 a
75	Azo.		247 a	152 abc	187 abc	209.3 a
	Un.		226 b	138 b-e	163.7 de	184.2 b
	Cyan.		182 d	117 de	167.7 cd	140.4 c
50	Azo.		196 c	120 cde	173.5 bcd	137.1 c
	Un.		169 e	111 e	144.6 e	127.5 d
		Asc.	264 a	182 a	204.7 a	213.7 a
100		HA	253 ab	181 a	194.3 ab	212 ab
		water	247 b	173 a	184.1 bc	206.6 b
		Asc.	250 ab	175 a	192.1 ab	206.9 ab
75		HA	243 b	134 b	179.1 bc	208.9 ab
		water	226 c	128 bc	160.4 d	185.4 c
		Asc.	199 d	119 cd	174.3 cd	148.4 d
50		HA	187 d	119 cd	169.6 cd	133.9 e
		water	160 e	109 d	141.9 e	122.8 f
		Asc.	239 ab	159 a	193.1 ab	188.9 a
	Cyan.	HA	229 abc	149 abc	181.5 abc	188.2 abc
		water	215 cd	136 cd	169.5 c	181.7 bc
		Asc.	252 a	161 a	202.4 a	195.1 a
	Azo.	HA	233 abc	149 abc	187.1 ab	188.7 ab
		water	220 bc	142 bcd	173.5 bc	178.5 bc
		Asc.	221 bc	156 ab	175.5 bc	185.1 abc
	Un.	HA	221 bc	137 cd	174.3 bc	178.2 c
		water	197 d	132 d	143.3 d	154.6 d

Means of each interaction designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

II.Yield and its components:

Number of panicle m^{-2}, 1000-grain weight, grain and straw yield of rice cv. Giza 179 as affected by nitrogen level, biofertilizer and stimulating compound in 2014 and 2015 seasons are presented in Table 4. Number of panicle m^{-2}, grain and straw yield significantly increased by application of the recommended dose (100% N) compared with 50 % N. The inverse was true in 1000-grain weight. The reduction in 1000-grain weight may be due to the excessive content of nitrogen in the plant, may be resulted in a shortage of carbohydrate supplied per grain which is directly caused by excessive number of grains produced by high N fertilization. The high nitrogen rate increased grain yield through increasing number of panicle $hill^{-1}$, number of filled grains $panicle^{-1}$. However, the increase in straw yield by increasing nitrogen level was due to the increase in growth, *i.e.* the number of tillers per hill and dry weight per unit area (CGR).the similar conclusion was previously drawn by *Gharib et al. (2011),* Elekhtyar (2015 a and b), Sorour (2015) and *Elekhtyar et al. (2017).*

Table 4. Number of panicle m^{-2}, 1000- grains weight, Grain yield and Straw yield of rice cv. Giza 179 as affected by nitrogen level, biofertilizer and stimulating growth compound in 2014 and 2015 seasons.

Factor	Panicles (no m^{-2})		1000- grain wt. (g)		Grain yield (t fed^{-1})		Straw yield (t fed^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015
Nitrogen level (N):	**	*	**	**	*	**	**	**
100%	499 a	468 a	24.96 c	26.04 b	4.119 a	4.160 a	6.086 a	5.173 a
75%	459 b	450 a	25.34 b	26.40 a	4.059 a	3.838 b	5.531 ab	4.603 b
50%	428 c	368 b	25.70 a	26.56 a	3.691 b	2.869 c	4.853 b	3.696 c
Biofertilizer (B):	**	**	**	**	**	*	*	*
Cyanobacteria	472 a	430 ab	25.34 ab	26.39 a	4.048 a	3.777 a	5.655 a	4.586 ab
Azospirillum	477 a	446 a	25.61 a	26.56 a	4.060 a	3.708 a	5.556 a	4.680 a
Uninoculation	437 b	410 b	25.05 b	26.05 b	3.761 b	3.382 b	5.260 b	4.205 b
Stimulating compound (S):	**	*	**	**	*	*	NS	*
Ascobien	480 a	438 a	25.75 a	26.71 a	4.053 a	3.749 a	5.568	4.813 a
Humic acid	467 b	432 a	25.27 b	26.21 b	4.005 a	3.645 a	5.481	4.470 b
Water	437 c	416 b	24.98 b	26.07 b	3.811 b	3.473 b	5.421	4.188 c
Interaction								
N × B	*	**	**	**	**	**	**	*
N × S	*	**	**	**	**	**	**	**
B × S	*	*	**	**	*	**	*	**
N × B × S	NS	NS	NS	NS	NS	NS	NS	NS

***, ** and NS indicate P< 0.05 , P< 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.**

Inoculation with *Cyanobacteria* or *Azospirillum* resulted in markedly increased in number of panicle m^{-2}, 1000-grain weight, grain and straw yield compared with uninoculated treatment in the two seasons. The increase in number of panicle m^{-2} and yield may be due to that plant growth promoting rhizobacteria (PGPR) as biofertilizers involve the synthesis of substances by the bacterium or facilitation of the uptake of nutrients from the environment (Elekhtyar, 2016).

Plants sprayed with ascobien solution significantly exceeded those sprayed with water in number of panicle m^{-2}, 1000-grain weight, grain yield and straw yield in both seasons. Application of humic acid and ascobien were statistically at par in grain yield in the two seasons. This may be due to increase in early growth which reflected in higher grain yield attributes and in turn increased grain yield. Taha (2008), *Gharib et al. (2011)*, Sorour (2015) and *Sorour et al. (2015)* found that foliar application of ascobien resulted in a significant increase in plant height, dry weight and number of tillers, number of panicle, 1000-grain weight, grain yield and straw yield compared with other stimulative compounds. In this connection, Foyer and Harbinson (1994) and Smirnoff (2005) reported that ascorbic and humic acid play important role in ascorbate-glutathione pathway and scavenges reactive oxygen species in the chloroplast.

The second order interaction (chemical N level X biofertilizer X stimulating compounds) had no significant effect on number of panicle m^{-2}, 1000-grain weight, grain and straw yield in both seasons (Table 4). However, the mentioned traits were significantly affected by all the first order interactions in the two seasons (Table 5). Application of 100 or 75% chemical N along with Cyanobacteria or Azospirillum and 100% chemical N alone resulted in significant increase in number of panicle m^{-2}, grain yield and straw yield compared with 50% chemical N without inoculation treatment, which recorded the lowest values of these traits in both seasons. The increase in yield and number of panicles m^{-2} may be due to PGPR as biofertilizers involve the synthesis of substances by the bacterium or facilitation of the uptake of nutrients from the environment (Elekhtyar, 2016). The results were agreement with those of Zidan and Elekhtyar (2015). Ashrafuzzaman et al. (2009) found that application of PGPR as biofertilizers exerted beneficial effects on plant growth and development. The relative ranking of the interaction among nitrogen level and biofertilizer for 1000-grain weight was inconsistent in both seasons. Combinations of 50% chemical N + Cyanobacteria or Azospirillum and 75% chemical N + Azospirillum having the highest 1000-grain weight compared with combinations of 100% chemical N without inoculation in both seasons. Application of 100% chemical N alone or along with foliar spray of ascobien or humic acid and 75% chemical N along with foliar spray of ascobien were among those combinations having high number of panicle m^{-2}, grain yield and straw yield compared with 50% chemical N and foliar spraying with water in both seasons. The ascorbic acid is synthesized in the higher plants and affects plant growth and development; it is product of D-glucose metabolism which affects some nutritional cycle's activity in higher plants and plays an important role in the electron transport system. Enhancement the growth rate in early growth stages will, reflect in higher grain yield attributes then increase the grain yield *(El-Kobisy et al. 2005)*. Foliar spraying with the solution of ascobien with application of 50 or 75 % N resulted in significant increase in 1000-grain weight compared with foliar spraying with water at 100% N in the two seasons. Inoculation with Cyanobacteria or Azospirillum combined with foliar spraying of ascobien or humic acid resulted in substantial increase in number of panicle m^{-2}, grain yield and straw yield compared with uninoculated treatment and foliar spraying with water in both seasons. Foliar spraying with the solution of ascobien with Inoculation with Cyanobacteria or Azospirillum recorded the highest values of 1000-grain weight, while foliar spraying with water along with uninoculated treatment recorded the lowest values in both seasons. The increase in number of panicles m^{-2}, 1000-grain weight and grain yield may be due to PGPR as biofertilizers involve the synthesis of substances by the bacterium or facilitation of the uptake of nutrients from the environment (Elekhtyar, 2016). The ascorbic acid is synthesized in the higher plants and affects plant growth and development; it is product of D-glucose metabolism which affects some nutritional cycle's activity in higher plants and plays an important role in the electron transport system. Enhancement the growth rate in early growth stages will reflect in higher grain yield attributes then increase the grain yield *(El-Kobisy et al. 2005)*.

III. Grains quality:

Means of hulling % , milling% and head rice % as affected by nitrogen levels, bio-fertilizer and stimulating compounds are presented in Table (6). Neither hulling nor milling percentage was affected by nitrogen levels, biofertilizers, stimulating compounds and their interactions in both seasons. However, the recommended N level (100% N) substantially improved head rice % than 50% N. There were no significant differences in this trait between 75 and 100% N. Head rice percentage was significantly affected by biofertilizers in both seasons. *Cyanobacteria* then *Azospirillum* as biofertilizers significantly increased head rice percentage compared with uninoculated treatment in both seasons. This may due to bacterial inoculation enhance germination, seedling vigor, nitrogen uptake, yield and its attributes. It has been found that promising not only in maintaining and sustaining high productivity but also in providing stability to rice crop of Giza179 (Elekhtyar 2015a). There were no significant differences in head rice percentage among stimulating compounds and the entire first and second order interactions in both seasons.

Table 5. Some yield components, grain yield and straw yield of rice cv. Giza 179 as affected by the first and second order interactions in 2014 and 2015 seasons.

N %	Bio.	Stim. Com.	Panicles (no m^{-2}) 2014	Panicles (no m^{-2}) 2015	1000-grain wt. (g) 2014	1000-grain wt. (g) 2015	Grain yield (t fed^{-1}) 2014	Grain yield (t fed^{-1}) 2015	Straw yield (t fed^{-1}) 2014	Straw yield (t fed^{-1}) 2015
	Cyan.		504 a	461 a	25.06 d	26.11 d	4.115 a	4.225 a	6.194 a	5.199 a
100	Azo.		512 a	483 a	25.34 bcd	26.26 bcd	4.132 a	4.211 a	6.144 a	5.276 a
	Un.		480 ab	458 a	24.48 e	25.75 e	4.109 a	4.044 ab	5.920 a	5.043 a
	Cyan.		477 ab	459 a	25.3 bcd	26.45 abc	4.137 a	4.016 ab	5.860 ab	4.569 ab
75	Azo.		471 abc	463 a	25.53 abc	26.6 abc	4.155 a	3.919 ab	5.660 a-c	4.759 ab
	Un.		428 de	427 b	25.18 cd	26.15 cd	3.885 b	3.579 bc	5.073 b-d	4.479 ab
	Cyan.		433 cde	368 d	25.67 ab	26.62 ab	3.890 b	3.090 cd	4.910 cd	3.990 b
50	Azo.		447 bcd	393 c	25.94 a	26.81 a	3.893 b	2.993 de	4.863 cd	4.004 b
	Un.		403 e	344 e	25.49 abc	26.24 bcd	3.290 c	2.523 e	4.786 d	3.094 c
		Asc.	515 a	472 a	25.4 bc	26.3 bcd	4.164 a	4.234 a	6.157 a	5.399 a
100		HA	502 ab	470 a	24.85 cd	25.97 cd	4.102 ab	4.207 a	6.085 a	5.206 ab
		water	480 abc	460 a	24.63 d	25.85 d	4.089 ab	4.040 ab	6.017 a	4.913 b
		Asc.	480 abc	462 a	25.71 ab	26.88 ab	4.184 a	3.986 ab	5.684 ab	5.089 ab
75		HA	468 bc	459 a	25.23 bc	26.25 cd	4.111 ab	3.858 ab	5.477 b	4.456 c
		water	428 de	429 b	25.07 cd	26.08 cd	3.883 bc	3.672 b	5.433 b	4.263 cd
		Asc.	446 cd	379 c	26.13 a	26.97 a	3.810 c	3.027 c	4.864 c	3.950 de
50		HA	432 de	367 c	25.74 ab	26.44 abc	3.803 c	2.873 c	4.882 c	3.748 ef
		water	405 e	359 d	25.23 bc	26.26 cd	3.460 d	2.707 c	4.813c	3.390 f
		Asc.	481 ab	434 ab	25.78 ab	26.76 ab	4.101 a	3.898 a	5.672 a	4.837 ab
	Cyan.	HA	473 ab	430 ab	25.3 bcd	26.27 bcd	4.062 a	3.76 ab	5.668 a	4.561 abc
		water	461 b	424 b	24.95 cd	26.15 cd	3.979 a	3.674 bc	5.624 a	4.361 bcd
		Asc.	495 a	456 a	26.18 a	26.98 a	4.104 a	3.776 ab	5.662 a	5.134 a
	Azo.	HA	476 ab	445 ab	25.43 bc	26.45 abc	4.050 a	3.716abc	5.561 a	4.708 abc
		Water	458 b	439 ab	25.21 bcd	26.25 bcd	4.026 a	3.631 bc	5.445 ab	4.197 cd
		Asc.	465 ab	424 b	25.29 bcd	26.41 abc	3.953 a	3.573 cd	5.371 ab	4.467 bcd
	Un.	HA	453 b	421 b	25.09 cd	25.95 cd	3.904 a	3.46 d	5.215 b	4.141 cd
		Water	393 c	385 c	24.77 d	25.79 d	3.427 b	3.114 e	5.194 b	4.007 d

Means of each interaction designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.

III. Chemical compositions:

Data in Table 6 show the effect of biofertilizers and stimulating compounds as foliar spray under nitrogen levels in 2014 and 2015 seasons on chemical compositions into milled grain of Giza 179 rice cultivar. Nitrogen and protein percentages were significantly increased by each increment of chemical nitrogen fertilizer in both seasons. This may be due to increase nitrogen uptake in the plant with increasing nitrogen level, which reflected on nitrogen and protein content in grain.

Inoculation of *Cyanobacteria* or *Azospirillum* as biofertilizers, being insignificant, resulted in a substantial increase in nitrogen and protein content in milled grain compared with uninoculated treatment in the two seasons. Elekhtyar (2015b) reported that biofertilizers with mineral NPK fertilizers significantly increased chemical compositions in rice grains.

There were no significant differences in nitrogen and protein content in milled grain among stimulating compounds in both seasons.

None of the interactions had significant effect on nitrogen and protein content in milled grain in the two seasons.

Table 6. Hulling %, milling% and head rice% as well as nitrogen% and protein% in milled grain of rice cv. Giza 179 as affected by nitrogen level, bio-fertilizer and stimulating growth compounds in 2014 and 2015 seasons.

Factor	Milled character (%)						Chemical content in milled grain (%)			
	Hulling		Milling		Head rice		Nitrogen		Protein	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Nitrogen fertilizer level (N)	NS	Ns	NS	NS	*	*	**	**	**	*
100%	79.66	80.1	67.44	67.4	60.68 a	60.0 a	1.04 a	1.00 a	6.18 a	5.95 a
75%	79.22	79.5	66.90	66.9	61.73 a	60.4 a	0.94 b	0.96 b	5.59 b	5.71 a
50%	79.12	79.2	66.37	66.4	59.10 b	57.9 b	0.82 c	0.87 c	4.88 c	5.17 b
Biofertilizers (B)	NS	NS	NS	NS	*	*	*	*	*	*
Cyanobacteria	80.00	79.6	67.00	67.2	62.03 a	58.89 ab	0.94 a	0.95 a	5.60 a	5.64 a
Azospirillum	79.13	79.5	66.05	66.4	60.24 b	60.58 a	0.95 a	0.96 a	5.63 a	5.74 a
Uninoculation	79.10	79.7	67.01	67.1	59.24 c	58.76 b	0.90 b	0.91 b	5.39 b	5.45 b
Stimulating compounds (S)	NS	NS	NS	NS	NS	NS	*	*	*	*
Ascobien	79.72	79.4	67.16	67.2	61.00	58.38	0.97 a	0.96 a	5.75 a	5.72 a
Humic acid	79.47	79.6	67.24	67.2	60.02	59.96	0.92 ab	0.95 a	5.49 ab	5.67 a
Without foliar spray	78.81	79.8	66.90	66.3	61.00	59.89	0.90 b	0.91 b	5.39 b	5.45 b
Interaction										
N × B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
N × S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
N × B × S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

***, ** and NS indicate P< 0.05 , P< 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test.**

CONCLUSION

The results from this study support that the application of biofertilizers and stimulating growth compounds as foliar spray with nitrogen levels were able to improve Giza 179 Egyptian rice cultivar productivity. application of 75 % N resulted a significant increase in yield and yield attributes compared with foliar spraying with water at 100% N in the two seasons so that the application of *Cyanobacteria* or *Azospirillum* as well as ascobien and humic acid can save 25% from chemical nitrogen fertilizer without any reduce in yield and yield attributes.

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إمكانية إستخدام الأسمدة الحيوية والمركبات المحفزة للنمو فى تعزيز إنتاجية الأرز

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أجريت تجربة حقلية بالمزرعة البحثية لمركز البحوث والتدريب في الأرز بمحافظة كفرالشيخ – جمهورية مصر العربية خلال موسمي زراعة الارز المتتالين ٢٠١٤ و ٢٠١٥ وذلك لتقييم تأثير كل من السيانوبكتريا والازوسبيريلم كأسمدة حيوية والاسكوبين وحامض الهيوميك كمركبات منشطة للنمو مضافة رشاً ورقياً فى ثلاث مواعيد وهى ٢٠ و ٣٠ و٤٠ يوم بعد الشتل فى وجود مستويات مختلفة من السماد النيتروجينى وهى ١٠٠% و ٧٥% و ٥٠% وتأثيره على النمو والمحصول ومكوناته والتركيب الكيميائي فى الحبه وكذلك صفات الجوده لصنف الارز جيزه ١٧٩. وكان التصميم الاحصائي المستخدم هو تصميم القطاعات المنشقة مرتين باربعة مكررات، واوضحت النتائج وجود تأثير ايجابى من تطبيق الاسمده الحيويه والمركبات المنظمه للنمو مع مستويات من السماد النيتروجينى الكيميائى حيث أثرت إيجابيا على معدل النمو، ومعدل الكفاءة التمثيلية عند فترتين ٧٥-٩٠ و ٩٠-١٠٥ يوم بعد الزراعة وعدد السنابل فى المتر المربع ووزن الالف ومحصول الحبوب والقش والتركيب الكيميائي فى الارز الابيض. كما ان التفاعل بين الأسمدة الحيوية والمركبات المنظمه للنمو او التفاعل بين مستويات السماد النيتروجينى والأسمدة الحيوية او التفاعل بين السماد النيتروجينى والمركبات المنظمة للنمو كان له تأثيراً معنوياً على معظم الصفات المدروسه. ادى استخدام ٧٥%من السماد النيتروجينى مع الأسمدة الحيوية والمركبات المحفزة للحصول على انتاجية تعادل ١٠٠%من السماد النيتروجينى ,أى أن التلقيح بالسيانوبكتريا او الازوسبيريلم أو الرش بالاسكوبين أو حامض الهيوميك الى تخفيض معدل استخدام الاسمدة الكيماوية بنسبة ٢٥% من المعدل الموصى به من السماد النيتروجينى دون اى انخفاض فى انتاجية صنف ارز جيزه ١٧٩.