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Response of Some Rice Cultivars to Rhizobacteria (PGPR), Different Rates of Nitrogen Fertilizer and its Combinations under Flooding Condition

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ABSTRACT

To evaluate the role of growth promoting Rhizobacteria (PGPR) either added a single or combined with nitrogen fertilizer (urea) on yield and yield components of five Egyptian rice cultivars.i.e. Giza179, Sakha102, Sakha105, Sakha106 and Sakha103.Two field experiments were carried out at the farm of Sakha Agriculture Station during 2014 and 2015 growing seasons. Five fertilizer were application different combination between Rhizobacteria and nitrogen fertilizer; Recommended dose of N 165 Kg N/ha (T_1), Rhizo+1/4 recommended dose of nitrogen (T_2), Rhizobia only (T_3), Rhizo+1/2 recommended dose of nitrogen(T_4) and Rhizo+3/4 recommended dose of nitrogen(T_5).The Experiments were conducted using the Randomized Complete Block Design (RCBD) with splitplot arrangements. Split plot design was used with four replication. The main plots received the five rice cultivars while the fertilizer treatments were located in sub plots. The recorded data were chlorophyll content of flag leaf, plant height (cm) at harvest, number of tillers (m^{-2}), number of panicles (m^{-2}), panicle length (cm), panicle weight (g), number of filled grains/panicle, number of unfilled grains/panicle, 1000- grain weight (g), grain and straw yield (t/ha). Results indicated that the application of either Rhizo+3/4 dose of N (T_5) or recommended dose of N (urea) (T_1) gave nearly the highest value of growth characters, yield and yield components. While, Rhizobia application alone gave the lowest value of the previous studied characters. The results also clarified that the treatments of combined Rhizobacteria with 3/4 of recommended dose of urea produced nearly the same grain yield as recommended dose with very little difference between the tested cultivars. According to the results, it can save 1/4 of the recommended dose of nitrogen fertilizer (165 kg N/ha)without significant reduction in the yield beside minimized the economical and the pollution resulted from chemical fertilizers.

INTRODUCTION

Rice is one of the most important food crops in the world, and staple for more than half of the global population. Rice is one of the major cereals cultivated in Egypt. Nitrogen requirements of rice crop are met from both soil and fertilizers. Because of acute N deficiency in most rice soils, fertilizer N must be applied to meet the crop demand. Increased use of mineral fertilizers, especially nitrogen fertilizer rise in crop production costs and pollutes the soil and plant resulted in hazard effect for human and animal health. The inoculation of leguminous plants with rhizobia is one of the main methods of biotechnological use of microorganisms in order to obtain biological nitrogen fixation in agriculture. However, in recent years it has been attributed to these microorganisms the ability to produce phytohormones, mainly Indole acetic acid (lAA) and to promote the growth in plant (Marcos *et al*., 2011). Biofertilization with Rhizobium was found to partially substitute application of urea –N by promoting growth and root morphology of rice plant and production of plant growth promoting substances that can improve rice ability to assimilate more soil N (Yanni *et al*., 1997). The inoculation of leguminous plants with rhizobia is one of the main methods of biotechnological use of microorganisms in order to obtain biological nitrogen fixation in agriculture. However, in recent years it has been attributed to these microorganisms the ability to produce phytohormones, mainly Indole acetic acid (lAA), and to promote the growth in rice.

Rhizobia can fix nitrogen in legume association and colonize the rice plants in rotation. The production of phytohormones, mainly indole acetic acid (IAA) is possibly the main mechanism of growth promotion of rice by rhizobia (Benjamin *et al* 2014).

Yanni and Dazzo (2010)found that biofertilizer inoculants containing endophytic Rhizobium leguminosarumbv. trifolii strains enhanced rice production under Egypt field conditions. Inoculation with single strains or multi- strain consortia plus application of integrated agronomic practices used in 24 large-scale field experiments in the Nile delta significantly increased grain yield up to 47% with an average increase of 19.5% comparing with the yields gained by the farmers when they used their conventional field management practices.

Microbial inoculants have attained special significance in modern agriculture. Responses have been obtained in cereals, millets, pulses, legumes, oilseeds, sugarcane and cotton grown under different agro-climatic conditions. In general, increase in yield due to biofertilizer application was of the order of 15-20%. Biofertilizers containing rhizobia or cyanobacteria can supply 20 – 25 kg N/ha. Recently, complex biofertilizers were reported to be more effective in increasing nutrient supply and crop yield.

The objectives of this study were to know the best combination between fertilizer (urea) and Rhizobia that give the maximum yield and saving both the economical and pollution factors.

MATERIALS AND METHODS

Rhizobium leguminous bv. Trifolii as plant growth promoting rhizobacteria was obtained from microbiology department., (Prof. Dr. Y. G. Yanni), Sakha Agriculture Research Station, Kafrelsheikh, Egypt. It can be observed that Rhizobia isolated from Alfalfa increased and accelerate germination of rice seeds and stimulated the growth of rice seedling.

Field experiments:

Two field experiments were conducted on clay soil during two summer seasons 2014and 2015 at the farm of Sakha Agriculture Research Station, Kafrelsheikh, Egypt, to study the responsiveness of different rice cultivars namely; Giza179, Sakha102, Sakha105, Sakha106 and Sakha103that inoculated with Rhizobia (PGPR), either, added alone or combined with nitrogen (as form of urea). Five fertilizer treatments i.e., recommended dose of N (urea) (RRTC recommendation "165 kg/ha") (T1), Rhizobia+1/4 recommended dose of N (T2), Rhizobiaalone (T3), Rhizobia +1/2 recommended dose of

N (T4) and Rhizobia +3/4 recommended dose of N (T5). The experiments were laid out in a split plot design with four replications; the five cultivars were located in the main plots and fertilizer treatments were placed in the sub-plots. Pre-germinated seeds of the five rice cultivars at the rate of 120 Kg seeds/ha, were broadcasted manually in the prepared nursery on 10th of May in both 2014 and 2015 seasons.Nitrogen as form of urea was applied according to the experimental treatments. Phosphorus at the rate of 36 kg P/ha was applied during land preparation, while zinc as zinc sulphate at the rate of 23.8 kg/ha was applied in the nursery after wet leveling. The other cultural practices were applied according to therecommendation of Rice Research and Training Center (RRTC). The bacteria (Rhizobia) under study was applied 10 days after transplanting when the roots still young to give the chance of Rhizobia to penetrate the roots easily and also to avoid the harmful of the chemical of weed control which applied 4 -7 days after transplanting.

The studied characters were: Chlorophyll content (SPAD) was determined at late booting using chlorophyll meter(model SPAD-502) Minolta camera Co. Ltd., Japan.At harvest the plant height/cm, number of both tillers and panicles were counted, panicle length (cm), panicle weight (g), number of filled grains/panicle, number of unfilled grains/panicle,1000-Grain weight (g), grain and straw yield(t/ha) were estimated according to IRRI STS 1996. Some chemical analyses of the experimental soil site were determined in soil past extract before experimentsaccording to Richards (1969), Table 1. The analysis of variance was carried out according to Gomez and Gomez (1984). Treatment means were compared by Duncan's Multiple Range Test (Duncan, 1955).

Mostly, the farmers applied more mineral fertilizers in rice fields to get a high rice growth. So, this study was conducted to minimize and save the use of chemical fertilizer using growth promoting Rhizobacteria with different levels of nitrogen fertilizer and to identify the best combination of both Rhizobacteria and urea-N as well as the minimizing of both the costs and the environmental pollution due to the use of high chemical fertilizer dose.

Table 1. Some chemical analyses of the experimental soil before planting and after harvesting in 2014 and 2015 summer seasons.

Soil chemical properties	Before planting	
	2014	2015
pH(1:2.5)	8.35	8.44
Ec (ds.m^{-1})	3.12	3.34
Total N (ppm)	477.00	430.50
Available P (ppm)	14.00	12.00
Available K (ppm)	189.60	170.00
Anions(meq.L^{-1})		
$CO3^{--}$	--	--
$HCO3^{-}$	5.30	6.10
Cl^{-}	8.50	9.30
$SO4^{--}$	17.40	18.00
Cations (meq.L^{-1})		
Ca^{++}	11.70	10.50
Mg^{++}	3.50	5.00
Na^{++}	1.60	2.00
K^{+}	14.40	15.60
Available micronutrients (ppm)		
Fe	5.00	5.80
Mn	3.04	3.20
Zn	1.00	0.95

RESULTS AND DISCUSSION

Chlorophyll content of flag leaf, plant height (cm), number of tillers/m^2 and number of panicle/m^2 of some rice cultivars as influenced by growth promoting Rhizobacteria (RGPR) with different nitrogen rates in 2014 and 2015 seasons are presented in Table (2).

Data revealed that there wasa significant difference among the tested rice cultivars in chlorophyll content. Giza179 cultivar gave the highest chlorophyll content followed by both Sakha 106 and 102 rice cultivars, while Sakha103 and Sakha105 rice cultivars produced the least in two studied seasons. It might be due to the genetic background in this character. As for the varietal differences in plant height. Data clarified that a significant difference were observed among the studied cultivars in their height. the tallest plants were found in Sakha102 followed by Sakha 106 cultivar, while Sakha105 gave the least.

Table 2. Chlorophyll content of flag leaf, plant height (cm), Number of tillers (m^2) and number of panicle (m^2) at harvest of some rice cultivars as affected by growth promoting Rhizobacteria (PGPR) and nitrogen fertilizers during 2014 and 2015 seasons

Treatments	Chlorophyll content (SPAD)		Plant height (cm)		Number of tiller (m^2)		Number of panicles (m^2)	
	2014	2015	2014	2015	2014	2015	2014	2015
Rice varieties (A)								
Giza179 (V_1)	42.87a	41.64a	100.23d	99.10d	494.56a	479.56a	481.90a	464.56a
Sakha102 (V_2)	41.58abc	40.35abc	105.58a	104.45a	444.57c	429.57c	431.84c	414.57c
Sakha105 (V_3)	40.36c	39.13c	98.97 e	97.84 e	412.10e	397.10e	399.24e	382.10e
Sakha106 (V_4)	42.06ab	40.83ab	103.40b	102.27b	474.14b	459.14b	461.48b	444.14b
Sakha103 (V_5)	41.20bc	39.97bc	101.75c	100.62c	429.95d	414.95d	417.36d	399.95d
F. Test	*	*	*	*	**	**	**	**
Treatments (B)								
Recommended dose of N(T_1)	43.80a	42.57a	107.10a	105.97a	512.06b	497.06b	499.40a	482.06a
Rhizobia+1/4 dose of N (T_2)	40.79b	39.56b	101.06b	99.93 b	437.08d	422.08d	424.22b	407.08b
Rhizobia(T_3)	37.95c	36.72c	92.25 c	91.12 c	335.82e	320.82e	323.16c	305.82c
Rhizobia+1/2 dose of N(T_4)	41.27b	40.04b	101.70b107	100.57b	447.45c	432.50c	434.84b	417.49b
Rhizobia+3/4 dose of N(T5)	44.27a	43.04a	.82a	106.69a	522.87a	507.87a	510.21a	492.87a
F. Test	**	**	**	**	**	**	**	**
Interaction AXB	**	**	*	**	**	**	**	**

The data in the same Table (2) show also, that application of either Rhizobacteria plus 3/4 dose of nitrogen or the recommended dose of nitrogen produced the greatest chlorophyll content and plant height of rice plant followed by the application of Rhizobacteria + 1/2 of recommended dose of nitrogenwithout significant difference with the combination between Rhizobacteria + 1/4 of recommended dose of nitrogen, while the inoculation of Rhizobacteria alone significantly reduced the chlorophyll content and plant height. it means that the application of nitrogen with Rhizobacteria is necessary to activate and increase the function of Rhizobacteria.The previous results were in harmony withYanni *et al*., (1997) and Zaki *et al* (2009).

Results in Table 3 indicate that the chlorophyll content was significantly affected by the interaction between some rice cultivars and growth promoting Rhizobacteria (PGPR) with nitrogen fertilizer during 2014 and 2015 seasons. The highest values of chlorophyll content were obtained from Giza179 by Rhizobia + 3/4 of recommended dose of nitrogen(T5) followed by therecommended dose of N treatment (T1) with the same cultivar and Sakha 106 cultivar under Rhizobia + 3/4 of recommended dose of nitrogen(T5), while the application of Rhizobia alone produced the lowest values in this aspect in all the tested cultivars. It can be easily observed that the tested cultivars had nearly the same chlorophyll content when applied 3/4 of recommended dose of nitrogen+ Rhizobacteria or there commended dose of nitrogen. The same trend results occurred in the both two studied seasons. These results agreed with the findings of Benjamin *et al.,* (2014) who found integrated use of Rhizobia and nitrogen fertilizer will augment the efficiency of both substantially to maintaining a high level of productivity and rice production.

Data in Table 4 show that there werea significant differences among the values of plant height under the interaction between rice cultivars and growth promoting Rhizobacteria (PGPR) with nitrogen fertilizer during 2014 and 2015 seasons. The highest plant height was obtained when Sakha 102 received Rhizobacteria +3/4 of recommended dose of nitrogen (T5) followed bythe recommended dose of nitrogen (T1) and both Sakha106 and Sakha103 under the same treatments (T1 or T5) in the two studied seasons.

Table 3. Chlorophyll content of flag leaf as affected by the interaction between variousrice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	44.71ab	43.97b	42.52cde	44.09b	43.69bcd
Rhizobia+1/4 dose of N (T_2)	42.17ef	40.80gh	39.75hi	40.91f-h	40.32h
Rhizobia (T_3)	39.64h	38.24j	35.29k	38.85ij	37.71j
Rhizobia+1/2 dose of N (T_4)	42.39de	40.84f-h	40.62h	42.05e-g	40.45h
Rhizobia+3/4 dose of N (T5)	45.46a	44.04b	43.60b-d	44.39ab	43.85bc
	2015 season				
Recommended dose of N(T_1)	43.48ab	42.74b	41.29c	42.86b	39.09def
Rhizobia+1/4 dose of N (T_2)	40.94c	39.57de	38.52efg	39.68d	36.48i
Rhizobia (T_3)	38.41fg	37.01hi	34.06j	37.62gh	39.22def
Rhizobia+1/2 dose of N (T_4)	41.16c	39.61de	39.39def	40.82c	42.46b
Rhizobia+3/4 dose of N (T5)	44.23a	42.81b	42.37b	43.16b	42.62b

Table 4. Plant height (cm) as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	105.92de	108.67b	105.50de	108.25bc	107.17b-d
Rhizobia+1/4 dose of N (T_2)	98.08i	105.83de	97.00i	103.08fg	101.33gh
Rhizobia (T_3)	90.83kl	96.58 i	89.33L	92.83 j	91.66 jk
Rhizobia+1/2 dose of N (T_4)	99.92h	105.33de	97.25I	104.58ef	101.41gh
Rhizobia+3/4 dose of N (T5)	106.42cde	111.50a	105.75de	108.25bc	107.17b-d
	2015season				
Recommended dose of N(T_1)	104.79de	107.54b	104.37de	107.12bc	106.04b-d
Rhizobia+1/4 dose of N (T_2)	96.95h	104.70de	95.87 h	101.95f	100.20g
Rhizobia (T_3)	89.70jk	95.45 h	88.20 k	91.70 i	90.53 ij
Rhizobia+1/2 dose of N (T_4)	98.79 g	104.20 de	96.12 h	103.45 ef	100.28g
Rhizobia+3/4 dose of N (T5)	105.29cde	110.37a	104.62de	107.12bc	106.04b-d

It can be observed that Rhizobia +1/2 of recommended dose of nitrogen (T4) came in the second rank after the application of recommended dose of nitrogen (T1) and Rhizobia + 3/4 of recommended dose of nitrogen(T5) in the plant height of most the tested rice cultivars, while Rhizobia + 1/4 of recommended dose of nitrogen or Rhizobia alone significantly reduced the plant height of all the tested cultivars. These results were hold true in the two seasons. Chi *et al*., (2005) observed that plant was increased by about 23.63 % when the rice plant was inoculated byRhizobacteriaas compared with the uninoculated one. It might be due to continuous supply the rice plant by Auxins (IAA) or hormones (Gibberellins) which cause the promotion in rice growth.The current findings are in good agreement with those reported by Yanni *et al*., (1997), Zaki *et al*., (2009), Marcos *et al*., (2011) and Benjamin *et al*., (2014).

Number of tiller /$m^2$and number of panicles /m^2 of some rice cultivars at harvest as affected by growth promoting Rhizobacteria (PGPR), nitrogen fertilizer and their interaction during 2014 and 2015 seasons are presented in Tables 2, 5 and 6.

There were a significant differences among the tested cultivars in both number of tillers and panicles/m^2 at harvest. Giza179 cultivar gave the greatest number of tillers and panicle followed by Sakha 106 while Sakha105 gave the lowest value of both number of tillers and panicles/m^2in both seasons of study. It could be attributed to the genetic background. These results were hold true in the two studied seasons. The previous results were in harmony with Marcos *et al*., (2011) and Benjamin *et al*., (2014).

Data in the same Table show that the highest mean values of number of tiller and panicle at harvest were found whenRhizobia +3/4 of recommended dose of nitrogen(T_5) followed bythe recommended dose of nitrogen (165 kg N/ha) was applied (T_1) in number of tillers at harvest, while there was any significance between

T_1 and T_5in number of paniclesat harvest. In contrast the application of Rhizobia alone gave the lowest value in both number of tillers and paniclescompared with other fertilizer treatments. The same results were found in the two studied seasons.

Data in Table 5 indicate that Giza179 under Rhizobia + 3/4 of recommended dose of nitrogenproduced the greatest number of tillers and came in the first rank, while the same cultivar came in the second rank when fertilizedby recommended dose of nitrogen in the two seasons followed by Sakha106 under Rhizobia + 3/4 of recommended dose of nitrogenand recommended dose of nitrogen and came in the third rank in the two seasons. It can be easily noticed that inoculated the tested cultivars by Rhizobia alone produced the lowest number of tillers as compared with the other fertilizer treatments.It means that combined Rhizobia with nitrogen is necessary toencourage the up-ground nodes to emerge more tillers of rice cultivars and cause promotion for rice roots by increasing the root depth and volume consequently increase the sufficient uptake of both water and nutrients to make continuous supply to up ground parts of rice plants.

Table 5. Number of tiller/m2 at harvest as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	556.20b	497.90f	477.10i	539.50d	489.60g
Rhizobia+1/4 dose of N (T_2)	468.70k	445.90o	402.10q	460.40m	408.30p
Rhizobia (T_3)	397.90r	316.70 t	300.02v	356.20s	308.30u
Rhizobia+1/2 dose of N (T_4)	475.00j	452.08n	402.10q	462.50l	445.80o
Rhizobia+3/4 dose of N (T5)	575.00a	510.27e	479.20h	552.10c	497.77f
	2015 season				
Recommended dose of N(T_1)	541.20ab	482.90cd	462.10def	524.50b	474.60de
Rhizobia+1/4 dose of N (T_2)	453.70fg	430.90h	387.10i	445.40fgh	393.30i
Rhizobia (T_3)	382.90i	301.70k	285.02k	341.20j	293.30k
Rhizobia+1/2 dose of N (T_4)	460.00ef	437.08gh	387.10i	447.50fgh	430.80h
Rhizobia+3/4 dose of N (T5)	560.00a	495.27c	464.20def	537.10b	482.77cd

Data in Table (6) indicate that there were a significant differences in the interaction between rice cultivars and the fertilizer treatments in number of panicle /m^2. The highest number of panicles/m^2 was obtained from both Giza179 and Skha106 cultivars when fertilized by either the combination of Rhizobia with 3/4 of recommended dose of nitrogen(T_5) orthe recommended dose of nitrogen (T_1)which gave nearly the same value in this respect. on the other side the lowest number of panicle were obtained when the all tested cultivars were inoculatedby Rhizobia alone as compared with the other fertilizer treatments.

The data also, clarified that both the recommended dose of nitrogen and Rhizobia + 3/4 of recommended dose of nitrogen with all the tested cultivars surpassed the other fertilizer treatments with the rice cultivars under study in number of panicles/m^2. It could be attributed to the increase in activity of Rhizobia when combine with 3/4 of recommended dose of nitrogenbecause of the continuous supply the urea to plants by adequate amount by the promoting substance at different stage of rice resulted increase in the physiological processes in rice plants beside the improve in the root and shoot morphology resulted an increase in the water and nutrient uptake and photosynthesis.These results are harmony with those obtained by Yanni *et al*., (1997) and Biswas *et al*., (1998).

Table 6. Number of panicles/m^2 at harvest as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	543.54ab	485.24de	464.44d-g	526.84bc	476.94def
Rhizobia+1/4 dose of N (T_2)	456.04efg	432.91g	388.44h	447.74e-g	395.97h
Rhizobia (T_3)	385.24h	304.04j	287.36j	343.54i	295.64j
Rhizobia+1/2 dose of N (T_4)	462.34d-g	439.42fg	389.44h	449.84e-g	433.14g
Rhizobia+3/4 dose of N (T5)	562.34a	497.61cd	466.54d-g	539.44ab	485.11de
	2015 season				
Recommended dose of N(T_1)	526.20a	467.90cd	447.10c-f	509.50ab	459.60cde
Rhizobia+1/4 dose of N (T_2)	438.70d-i	415.90f	372.10g	430.40d-f	378.30g
Rhizobia (T_3)	367.90g	286.70i	270.02i	326.20h	278.30i
Rhizobia+1/2 dose of N (T_4)	445.00c-f	422.08ef	372.10g	432.50d-f	415.80f
Rhizobia+3/4 dose of N (T5)	545.00a	480.27bc	449.20c-f	522.10a	467.77cd

Panicle length (cm), panicle weight (g), number of filled grains /panicle and number of unfilled grains /panicle of some rice cultivars as affected by growth promoting Rhizobacteria (PGPR), nitrogen fertilizers andtheir interaction are presented in Table 7, 8, 9 and 10 during 2014 and 2015 seasons

It is clear from the data in Table 7 that the highest value of panicle length was obtained from Giza179 without any significant difference with Sakha106 which gave nearly the same value in this respect followed by Sakha103 and Sakha102 which gave the same value of panicle length, while Sakha105 gave the lowest length of panicle in the two season under study. It could be attributed to the genetic differences among the tested rice cultivars. Also, Data showed thatthe highest panicle length was recorded when applied either Rhizobia +3/4 of recommended dose of nitrogen(T_5) orrecommended dose of nitrogen (165 kg N/ha) (T_1) which gave the same valuefollowed by

Rhizobia + 1/2 of recommended dose of nitrogen (T_4) and Rhizobia + 1/4 of recommended dose of nitrogen(T_2). While the application of Rhizobia alone gave the lowest value of panicle lengthas compared with the other fertilizer treatments. Similar finding, were reported byYanni *et al*., (1997), Zaki *et al* (2009), Hussain *et al*., (2009) and Benjamin *et al*., (2014).

Table 7. Panicle length (cm), panicle weight (g), number of filled grains/panicle and number of unfilled grains/panicle of some rice cultivars as affected by growth promoting Rhizobacteria (PGPR) and mineral fertilizers during 2014 and 2015 seasons

Treatments	Panicle length (cm)		Panicle weight (g)		Number of filled grains /panicle		Number of unfilled grains /panicle	
	2014	2015	2014	2015	2014	2015	2014	2015
Rice varieties (A)								
Giza179 (V_1)	20.10a	19.40a	3.69a	3.36a	142.74a	133.94a	6.89a	9.13a
Sakha102 (V_2)	19.49bc	18.80bc	3.36c	3.02c	127.60c	118.80c	5.86bc	8.10bc
Sakha105 (V_3)	19.09c	18.43c	3.13d	2.80d	118.53e	109.73e	5.06d	7.30d
Sakha106 (V_4)	19.90ab	19.24ab	3.55b	3.22b	134.57b	125.77b	6.32ab	8.56ab
Sakha103 (V_5)	19.31bc	18.65bc	3.22d	2.89d	122.24d	113.44d	5.56cd	7.80cd
F. Test	**	**	*	*	**	**	**	**
Treatment (C)								
Recommended dose of N(T_1)	20.33a	19.67a	3.85ab	3.52ab	146.72b	137.92b	7.24a	9.48a
Rhizobia+1/4 dose of N (T_2)	19.32b	18.68b	3.26c	2.93c	121.58d	112.78d	5.37b	7.61b
Rhizobia (T_3)	18.39c	17.73c	2.54d	2.21d	103.99e	95.19e	3.66c	5.90c
Rhizobia+1/2 dose of N (T_4)	19.43b	18.77b	3.35bc	3.01bc	123.12c	114.32c	5.56b	7.80 b
Rhizobia+3/4 dose of N (T_5)	20.42a	19.76a	3.95a	3.62a	150.26a	141.46a	7.86a	10.10a
F. Test	**	**	*	*	**	**	**	**
Interaction: AXB	**	**	NS	NS	**	**	**	**

The interaction between rice cultivars and the fertilizer treatments had a significant influenced on panicle length. From the results presented in Table 8, it could be concluded that both Giza179 cultivar produced the highest values of panicle length under both Rhizobia+3/4 of recommended dose of nitrogen(T_5) and recommended dose of nitrogen (T_1) followed by Sakha106 cultivar in the two studied seasons. it can be easily noticed that Sakha102, Sakha103 and Sakha 105 cultivars gave nearly the same length of panicle under both recommended dose of nitrogen and Rhizobia + 3/4 of recommended dose of nitrogen.

Table 8. Panicle length (cm)as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
	2014 season				
Recommended dose of N(T_1)	21.06 a	20.13a-e	19.88a-e	20.63abc	19.93a-e
Rhizobia+1/4 dose of N (T_2)	19.75a-f	19.30c-g	18.85d-h	19.63b-f	19.07d-h
Rhizobia (T_3)	18.75e-h	18.45f-h	17.75h	18.75e-h	18.25gh
Rhizobia+1/2 dose of N (T_4)	19.83a-e	19.38c-g	19.07d-h	19.63b-f	19.25d-g
Rhizobia+3/4 dose of N (T_5)	21.10a	20.20a-d	19.90a-e	20.85ab	20.03a-e
	2015 season				
Recommended dose of N(T_1)	20.42ab	19.47a-e	19.22a-e	19.97a-d	19.27a-g
Rhizobia+1/4 dose of N (T_2)	19.09c-g	18.64e-i	18.19f-j	18.97e-i	18.41e-i
Rhizobia (T_3)	18.09g-j	17.79h-j	17.09j	18.09g-j	17.59ij
Rhizobia+1/2 dose of N (T_4)	19.17c-g	18.72e-i	18.41e-i	18.97d-h	18.59e-i
Rhizobia+3/4 dose of N (T_5)	20.44a	19.54a-e	19.24b-g	20.19abc	19.37a-f

As for panicle weight, the data in Table 7 reveal that the highest panicle weight was obtained from Giza179 followed by Sakha106 and Sakha102 cultivar which came in the third rank while the lowest value of panicle weight were observed in Sakha105 and Sakha103 cultivar without any significant difference between them.It could be attributed to the variation in genetic back ground among the studied cultivars. The data shown in Table 7 indicated that the application of either Rhizobia +3/4 of recommended dose of nitrogen(T_5) or recommended dose of nitrogen (165 kg N/ha) (T_1) produced the greatest weight of panicle, while inoculated rice by Rhizobia alone gave the lowest value in this respect. the other treatments came in between.These results are in good agreement with those reported by Yanni *et al*., (1997), Chi *et al*.,(2005), Zaki *et al*.,(2009) and Biswas *et al*., (2000).

The varietal differences in number of filled grains / panicle and their interaction is presented in Table (7). Data indicated that there were a significant differences among the tested cultivar in number of filled grains in two studied seasons. Giza179 cultivar produced the greatest number of filled grains/panicle in the two studied seasons followed by Sakha106, while Sakha105 cultivar gave the lowest value in this aspect. The other cultivars come in between differences among the tested rice cultivars in number o filled grain could be attributed to genetic background. Data in the same Table indicated that, the application of Rhizobia + ¾ of recommended dose of nitrogen(T_5)gave the highest number of filled grains (T_1) followed by the recommended dose of nitrogen, while the lowest value were recorded with Rhizobia alone (T_2) which reduced the number of filled grain. It means that the application of nitrogen with Rhizobacteria is necessary to activate and increase the function of Rhizobacteria.These genotypes differences in number of filled grains were also reported by Yanni *et al*., (1997),Nowak, (1998), Zaki *et al* (2009) and Benjamin *et al*., (2014)

Number of filled grains/panicle as influenced by the interaction between some rice cultivars and Rhizobacteria with different nitrogen ratesare presented in Table 9. Data demonstrated that the greatest number of filled grain/panicle were found with Giza 179 cultivar when rice plant fertilized by Rhizobia + ¾ of recommended dose of nitrogen followed by recommended dose of nitrogen, the same trend were observed with the other cultivars and the previous two fertilizer treatments. While the lowest value was observed when rice cultivars were inoculated by Rhizobia alone in the two studied seasons. It could be attributed to the variation in the response of the cultivar under study to the impact of Rhizobacteria with different nitrogen rates as the results to varietal differences in genetic back ground.

Table 9. Number of filled grains/panicle as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	168.30b	146.70e	130.00h	152.90d	135.700g
Rhizobia+1/4 dose of N (T_2)	128.90hi	120.80l	115.70n	124.90j	117.60m
Rhizobia (T_3)	114.10o	100.90q	95.23s	112.03p	97.70 r
Rhizobia+1/2 dose of N (T_4)	129.20hi	122.10k	116.00n	128.30i	120.00l
Rhizobia+3/4 dose of N (T_5)	173.20a	147.50e	135.70g	154.70c	140.20f
	2015 season				
Recommended dose of N(T_1)	159.50b	137.90e	121.20h	144.10d	126.90g
Rhizobia+1/4 dose of N (T_2)	120.10hi	112.00kl	106.90n	116.10 j	108.80m
Rhizobia (T_3)	105.30o	92.10 q	86.43s	103.23p	88.90 r
Rhizobia+1/2 dose of N (T_4)	120.40 hi	113.30 k	107.20n	119.50i	111.20l
Rhizobia+3/4 dose of N (T_5)	164.40a	138.70e	126.90g	145.90c	131.40f

As fornumber of unfilled grains /panicle, the data in Table 7 reveal that Giza179 and Sakha106 cultivars recorded the highest value of number of unfilled grains /panicle while, Sakha105 recorded the lowest value of number of unfilled grains/panicle in the two studied seasons. Regarding to the effect of growth promoting Rhizobacteria with nitrogen treatments on number of unfilled grains/panicle,data showed that application of either Rhizobia +3/4 dose of nitrogen or recommended dose of nitrogen gave the same greatest value of number of unfilled grain followed by Rhizobia +1/2 of recommended dose of nitrogenand Rhizobia +1/4 of recommended dose of nitrogenwhich gave nearly the same value of unfilled grains. While the Rhizobia alone gave the lowest value in this respect.These results are in good agreement with those reported by Yanni *et al*., (1997), Chi *et al*., (2005), Zaki *et al* (2009) and Biswas *et al*., (2000).

Regarding to the interaction between rice cultivars and effect of growth promoting Rhizobacteria with nitrogen treatments on number of unfilled grains/panicle, data in Table 10 showed that Giza 179 gave the highest value in number of unfilled grains/panicle when plant fertilized by Rhizobia +3/4 dose of nitrogen followed by Sakha106 under the same fertilizer treatment while in 2015 season either recommended dose of nitrogen or Rhizobia +3/4 of recommended dose of nitrogenproduced the greatest number of unfilled grains/panicle in Giza179 cultivar followed by Sakha106 cultivar under the same fertilizer treatments. Data also, revealed that the same trend was observed with all the tested cultivars under the same fertilizer treatments.It can be also noticed that inoculated all the tested cultivar by Rhizobia alone gave the minimize value of number of unfilled grains.

Table 10. Number of unfilled grains/panicle as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	8.00bc	7.40b-d	6.30c-h	7.65b-d	6.85b-f
Rhizobia+1/4 dose of N (T_2)	6.05d-i	5.45e-j	4.50h-l	5.55e-j	5.30f-j
Rhizobia (T_3)	4.40i-l	3.54kl	3.05l	4.15j-l	3.15kl
Rhizobia+1/2 dose of N (T_4)	6.20c-i	5.50e-j	4.87g-k	5.90d-j	5.35e-j
Rhizobia+3/4 dose of N (T_5)	9.80a	7.40b-d	6.60b-g	8.35ab	7.15b-e
	2015 season				
Recommended dose of N(T_1)	10.24a	9.64b-e	8.54d-h	9.89b-d	9.09b-g
Rhizobia+1/4 dose of N (T_2)	8.29d-i	7.69g-j	6.74i-l	7.79f-j	7.54g-j
Rhizobia (T_3)	6.64i-l	5.78kl	5.29l	6.39j-l	5.39l
Rhizobia+1/2 dose of N (T_4)	8.44 d-h	7.74f-j	7.11h-k	8.14e-i	7.59g-j
Rhizobia+3/4 dose of N (T_5)	12.04a	9.64b-e	8.84c-g	10.59b	9.39b-f

Weight of 1000-grain, grain and straw yield as affected by Rhizobacteria with different nitrogen rates in 2014 and 2015 seasons are presented in Table 11.

Data revealed that there were a significant differences among the tested rice cultivars in the weight of 1000-grains. Sakha103 and Sakha105 cultivars in 2014 and 2015 produced the greatest weight of 1000-grains without any significant differences among them, while Giza179 cultivar gave the least in this respect in 2014 and 2015 seasons. The other cultivars came in between. It could be attributed to the differences in genetic structure or back ground.

Data in the same Table also indicate that the difference among the treatment of Rhizobacteria with different nitrogen rates reached to the significant. The greatest weight of 1000-grains was recorded with Rhizobacteria alone in the two studied seasons followed by the application of Rhizobacteria + ¼ of recommended dose of nitrogen, while the application of either recommended dose of nitrogen or Rhizobacteria + ¾ of recommended dose of nitrogengave the lowest value in this aspect. It might be due to the less number of spikelet's / panicle under inoculation with Rhizobacteria only with adequate amount of photosynthetic products consequently increase filling percentage resulted in higher weight of grains.These results are in harmony with those reported by Kannaiyan *et al*., (1997), Peng *et al*., (2002), Marcos *et al*., (2011).

Weight of 1000-grain weight as influenced by the interaction between Rhizobacteria with different nitrogen rates and some rice cultivars in 2014 and 2015 seasons are presented in Table 12.

Data demonstrated that inoculated rice plants by Rhizobacteria alone gave the maximum value in 1000-grain weight of all the tested rice cultivars followed by Rhizobacteria + ¼ of recommended dose of nitrogenin the two studied seasons. It could be attributed to production of less number of spikelet's / panicle under inoculation with Rhizobacteria only with adequate amount of photosynthetic products consequently increase filling percentage resulted in higher weight of grains. Most similar results were reported by Yanni *et al*., (1997), Cong *et al*., (2009), Zaki *et al* (2009) and Baset and Shamsuddin(2010).

Table 11.Thousand grain weight (g), grain yield and straw yield t/ha of some rice cultivars as affected by growth promoting Rhizobacteria (PGPR) and mineral fertilizers during 2014 and 2015 seasons

Treatments	Thousand grain weight/g		Grain yield (T/ha)		Straw yield (T/ha)	
	2014	2015	2014	2015	2014	2015
Rice varieties (A)						
Giza179 (V_1)	20.010d	19.690d	9.325a	9.070a	11.055a	10.830a
Sakha102 (V_2)	25.582c	25.262c	8.912b	8.657b	10.229ab	10.004ab
Sakha105 (V_3)	27.454a	27.134a	6.471d	6.216d	7.821c	7.596c
Sakha106 (V_4)	26.470b	26.150b	9.215ab	8.960ab	10.442ab	10.217ab
Sakha103 (V_5)	27.672a	27.352a	8.022c	7.767c	9.490b	9.265b
F. Test	*	**	**	**	**	**
Treatment (C)						
Recommended dose of N(T_1)	24.472d	24.152d	9.976b	9.721b	10.730a	10.505a
Rhizobia+1/4 dose of N (T_2)	26.049b	25.729b	7.154d	6.899d	9.181c	8.956c
Rhizobia (T_3)	26.783a	26.463a	5.870e	5.615e	7.720d	7.495d
Rhizobia+1/2 dose of N(T_4)	25.326c	25.006c	8.592c	8.337c	10.310b	10.085b
Rhizobia+3/4 dose of N(T_5)	24.558d	24.238d	10.353a	10.098a	11.096a	10.871a
F. Test	**	**	**	**	**	**
Interaction:						
AXB	**	**	*	**	**	**

Table 12. Thousand grain weight/g as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	19.370k	23.030h	26.600e-g	26.100fg	27.262cde
Rhizobia+1/4 dose of N (T_2)	20.480ij	26.900c-f	28.000a-c	26.950c-f	27.917a-d
Rhizobia (T_3)	21.000i	27.950a-d	28.662a	27.870a-d	28.432ab
Rhizobia+1/2 dose of N (T_4)	19.570jk	26.780d-f	27.380b-e	25.900fg	27.000c-f
Rhizobia+3/4 dose of N (T_5)	19.630jk	23.250h	26.630e-g	25.530g	27.750a-e
	2015 season				
Recommended dose of N(T_1)	19.050k	22.710h	26.280e-g	25.780fg	26.942cde
Rhizobia+1/4 dose of N (T_2)	20.160ij	26.580c-f	27.680a-c	26.630c-f	27.597a-d
Rhizobia (T_3)	20.680i	27.630a-d	28.342a	27.550a-d	28.112ab
Rhizobia+1/2 dose of N (T_4)	19.250jk	26.460d-f	27.060b-e	25.580fg	26.680c-f
Rhizobia+3/4 dose of N (T_5)	19.310jk	22.930h	26.310e-g	25.210g	27.430a-e

Data in Table 11 show that Giza179 cultivar produced the greatest grain yield. On contrasted the lowest grains was obtained from Sakha105 cultivar in the two studied seasons. The other tested cultivars came in between. It can be easily observed that Sakha106 and Sakha102 gave nearly the same values of grain yield and came in the second rank after Giza179 in the both seasons of study. It could be attributed to the varietal differences in their genetic structure or back ground.

As for fertilizer treatment, data in the same Table revealed that the application of Rhizobacteria + ¾ of recommended dose of nitrogengave the greatest grain yield followed by application of recommended dose of nitrogenin the two studied seasons, while the application of Rhizobacteria only gave the lowest grain yield. These genotypes differences in grain yield were also reported by Yanni *et al*., (1997),Nowak, (1998), Zaki *et al* (2009) and Benjamin *et al*., (2014)

Table 13 present the effect of the interaction between Rhizobia with different nitrogen rates and some rice cultivars in grain yield during 2014 and 2015 seasons. Data revealed that grain yield reached to the maximum value when Giza179,Sakha106, Sakha 102 and Sakha103 cultivars fertilized by the Rhizobacteria + ¾ of recommended dose nitrogen (T_5)in the two studied seasons came in the first rank followed by recommended dose of nitrogen came in the second rank after Rhizobia + 3/4 of recommended dose of nitrogen(T_5). These data are hold in two studied seasons. It can be easily observed that combined 3/4of recommended dose of nitrogen perform the same trend as the recommended dose of nitrogen with the same cultivars. On contrasted inoculated all the studied cultivars with Rhizobia alone caused a significant reduction in the grain yield as compared with other fertilizer treatments specially Sakha105 rice cultivar which produced the lowest grain yield when received Rhizobia alone. It means that inculcated rice plant by Rhizobacteria saved about one fourth of nitrogen fertilizer. It could be attributed to the advantage of Rhizobacteria for supplying the plants by some growth promoting substances that increase the root depth and volume resulted in increased both water and nutrient uptake beside the improve the plant canopy consequently increase photosynthetic process and its products thatimprove filling percentage which led to increase the weight of grains. So, according to the previous results combine growth promoting Rhizobacteria with 3/4 of recommended dose of nitrogen with all the tested cultivars led to save nitrogen fertilizer (as form of urea) by about 1/4 of recommended dose of nitrogen (165 kg N/ha) beside minimizing the pollution of the chemical fertilizer in rice field.

Table 13. Grain yield (t/ha) as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	10.908a	10.450a	7.688f	10.523a	10.310a
Rhizobia+1/4 dose of N (T_2)	8.345e	7.638f	5.063h	8.493de	6.230g
Rhizobia (T_3)	6.685g	6.610g	4.978h	6.790g	4.288i
Rhizobia+1/2 dose of N (T_4)	9.643b	9.130b-d	6.198g	9.295bc	8.695cde
Rhizobia+3/4 dose of N (T5)	11.043a	10.730a	8.430de	10.973a	10.588a
	2015 season				
Recommended dose of N(T_1)	10.653a	10.195a	7.433g	10.268a	10.055ab
Rhizobia+1/4 dose of N (T_2)	8.090fg	7.383g	4.808i	8.238ef	5.975h
Rhizobia (T_3)	6.430h	6.355h	4.723i	6.535h	4.033j
Rhizobia+1/2 dose of N (T_4)	9.388bc	8.875cde	5.943h	9.040cd	8.440d-f
Rhizobia+3/4 dose of N (T5)	10.788a	10.475a	8.175ef	10.718a	10.333a

Regarding to straw yield, data in Table 11 indicate that there were a significant differences among the tested cultivars in straw yield. Giza179 produced the greatest straw yield followed by Sakha106 and Sakha102 which gave nearly the same straw yield, while Sakha105 gave the lowest straw yield. It might be due to the genetic background. Also, data in the same Table demonstrated that the application of either Rhizobia + 3/4 of recommended dose of nitrogen(T_5) or recommended dose of nitrogen (T_1)gave the maximum straw yield, while incubated rice plant by Rhizobacteria alone gave the least in both study seasons. Similar finding, were reported by Yanni *et al*., (1997),Zaki *et al* (2009), Hussain *et al*., (2009) and Benjamin *et al*., (2014)

Straw yield as affected by the interaction between some rice cultivars and Rhizobia with different rates of nitrogen are present in Table 14.

Data demonstrated that the application of Rhizobia + 3/4 of recommended dose of nitrogen(T_5)or recommended dose of nitrogen (T_1)cause an increase in straw yield of Giza179 cultivar and reached to the highest value in the two seasons without any significant difference with straw yield of Sakha106 cultivar underRhizobia + 3/4 of recommended dose of nitrogen(T_5) followed by the tested cultivars Sakha103 and Sakha102 when Rhizobia + 3/4 of recommended dose of nitrogen(T_5)or received recommended dose of nitrogen (T_1). It can alsoobserve that there was no any significant difference between Rhizobia + 1/2of recommended dose of nitrogen(T_4) or Rhizobia + 3/4 of recommended dose of nitrogen(T_5) in straw yield of Sakha106 and Sakha102 rice cultivars in both season of study. On the other side inoculated the tested cultivars with Rhizobia alone significantly reduced the straw yield and gave the lowest value specially with Sakha105 cultivar.Most similar results were reported by Yanni *et al*., (1997), Cong *et al*.,(2009), Zaki *et al* (2009) and Basetand Shamsuddin(2010).

Table 14. Straw yield (t/ha) as affected by the interaction between different rice cultivars and growth promoting Rhizobacteria (PGPR) with different nitrogen rates during 2014 and 2015 seasons.

Treatments / Rice Cultivars	Rice cultivars				
	2014 season				
	Giza 179 (V_1)	Sakha 102 (V_2)	Sakha 105 (V_3)	Sakha 106 (V_4)	Sakha 103 (V_5)
Recommended dose of N(T_1)	11.658a	11.200ab	8.438ef	11.273ab	11.083ab
Rhizobia+1/4 dose of N (T_2)	11.095ab	9.388de	7.813f	9.630cd	7.980f
Rhizobia (T_3)	9.335de	8.360ef	5.728g	8.540ef	6.638g
Rhizobia+1/2 dose of N (T_4)	11.393ab	10.718ab	7.948f	11.045ab	10.445bc
Rhizobia+3/4 dose of N (T5)	11.793a	11.480ab	9.180de	11.723a	11.303ab
	2015				
Recommended dose of N(T_1)	11.433a	10.975ab	8.213ef	11.048ab	10.858ab
Rhizobia+1/4 dose of N (T_2)	10.870ab	9.163de	7.588f	9.405cd	7.755f
Rhizobia (T_3)	9.110de	8.135ef	5.503g	8.315ef	6.413g
Rhizobia+1/2 dose of N (T_4)	11.168ab	10.493ab	7.723f	10.820ab	10.220bc
Rhizobia+3/4 dose of N (T5)	11.568a	11.255ab	8.955de	11.498a	11.078ab

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إستجابة بعض أصناف الأرز إلى الريزوبكتيريا ومستويات مختلفة من التسميد النيتروجينى تحت ظروف الغمر

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أجريت تجربتان زراعيتان بالمزرعة البحثية لمحطة بحوث سخا – كفرالشيخ خلال موسمى زراعة الأرز 2014 & 2015، وذلك لتقييم دورمنظمات النمو الريزوبكتيريا (PGRs)، والتى تضاف منفردة أو مختلطة مع الأسمدة النيتروجينية (اليوريا)على محصول الأرز ومكوناتة وذلك لخمسة أصناف من الأرز وهى: جيزة 179، سخا102، سخا 105، سخا 106، سخا103. وذلك مع خمسة توليفات مختلفة من الأسمدة النيتروجينية والريزوبكتيريا كالأتى: (T_1): إضافة الجرعة الموصي بها من سماد اليوريا (165كجم نيتروجين/هكتار)، (T_2): إضافة الريزوبكتيريا + 4/1 كمية السماد النيتروجينى الموصي به، (T_3): إضافة الريزوبكتيريا منفردة، (T_4): إضافة الريزوبكتيريا + 2/1 كمية السماد النيتروجينى الموصى به، (T_5): إضافة الريزوبكتيريا + 4/3 كمية السمادالنيتروجينى الموصى به.وقد أجريت التجربة باستخدام تصميم القطاعات العشوائية الكاملة المنشقة مرة واحدة فى أربع مكررات. وتم وضع الأصناف فى القطع الرئيسية ومعاملات السماد فى القطع الفرعية. تم أخذ بعض القياسات وهى طول النبات (سم)عند الحصاد، محتوى كلورفيل بورقة العلم،عدد الفروع وعدد السنابل /م2عند الحصاد، طول السنبلة (سم)، وزن السنبلة (جم)، عدد الحبوب الممتلئة والفارغة /سنبلة، وزن الألف حبة، ومحصول الحبوب والقش طن/ هكتار. وأشارت النتائج إلى إضافة الريزوبكتيريا +4/3 كمية السماد الموصى بة (T_5) أو إضافة إضافة الجرعة الموصي بها من سماد اليوريا (165كجم نيتروجين/هكتار) (T_1) قد اعطت أعلى النتائج بالنسبة لمعظم الصفات تحت الدراسة والمحصول ومكوناتة، بينما إضافة إضافة الريزوبكتيريا منفردة(T_3) قد أعطت أقل القيم لكل الصفات تحت الدراسة. أوضحت هذة الدراسة أيضا أن إضافة الريزوبكتيريا + 4/3 كمية السماد الموصى بة قد أعطت قيم متقاربة من محصول الحبوب مثل إضافة الجرعة الموصي بها من سماد اليوريا مع بعض الأختلافات القليلة وذلك بين الأصناف. ووفقا للنتائج، يمكن القول بأنة يمكن حفظ كمية من الأسمدة النيتروجينية حوالي4/1الكمية من الجرعة الموصى بها من الأسمدة النيتروجينة (165 كجم N / هكتار) دون نقص في المحصول بجانب التقليل في التكاليف الأقتصادية تلوث الأسمدة الكيماوية.