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Evaluation the Effect of N Mineral Fertilization in Combination with N Bio-Fertilizer on Barley Yield and its Components in Sandy Soil

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ABSTRACT

The current work aimed to elucidate the effect of N mineral fertilization rates in combination with N bio-fertilizer source and its rate on barley yield *(Hordeum vulgare L.)* var. Giza 2000 and its components in sandy soil. Afield experiment was conducted at Kantra Shark, north Sinai Governorate during 2017/2018 winter season using randomized complete block design with split split plot arrangements replicated three times. The main plots assigned to four mineral - N rates (0.0, 50, 75 and 100 kg N fed^{-1}) as ammonium sulphate (205g N kg^{-1}). The sub plots occupied by two commercial bio-fertilizer sources, Cyrialine and Microbine. The sub-sub plots dedicated to three bio-fertilizer rates (0.0,400,600 and 800 g fed^{-1}). The results appeared that barley grain, straw and biological yields, harvest index(HI), grains protein content (%), N, P , K-uptake (kg fed^{-1}) by grains or straw , total uptake (grains + straw) , agronomical and recovery (P and K) use efficiencies increased significantly with increasing N-fertilizer rate up to 100 kg fed^{-1}.Agronomical, recovery nitrogen use efficiencies and physiological (N,P and K) use efficiencies decreased significantly with increasing N-fertilizer rate. Cyrialine was superior to Microbine in its beneficial effect on most abovementioned traits. All studded vegetative characters as well as chemical composition, nutrient uptake and nutrient use efficiency increased significantly with increasing bio-fertilizer rate. Generally, although the crop responsed to mineral N rates up to 100kg N fed^{-1} under the studied soil (sandy), the combination application with bio-fertilizers was the best for all studied parameters and can save approximately 25 % of mineral N fertilizer at least as well as help in reducing mineral fertilizer pollution in growth media.

Keywords: bio-fertilizer, nutrient uptake, biomass, nutrient use efficiencies.

INTRODUCTION

Barley (*Hordeum vulgare L.*) is considered one of the major and important cereal crops in Egypt as well as in many dry areas of the world and grown in environments ranging from the desert of the Middle East to the high elevation of Himalayas (Hayes *et al*., 2003). It is the major human food and animal fodder sources in many North African countries and can replace wheat as the dominant crop because of its tolerance to drought and salinity. Therefore, increasing barley productivity and cultivated area is greatly required, especially in desert soils for facing the progressive increasing of population.

It is known that sandy soils are poor in crop productivity due to its low natural fertility, nutrient status and water holding capacity, thus a good fertilizer and water management program must be applied for obtaining desired barley production. Nitrogen is commonly the most limiting nutrient for crop production in the major world's agricultural areas and therefore plays a very important role in crop productivity (Zapata & Cleenput, 1986; Ahmad, 1999; Miao *et al*., 2006; Oikeh *et al*., 2007; Worku *et al*., 2007). Efficient use of N is also important for minimizing environmental contamination (Scharf & Alley, 1988). Nitrogen is the key element in achieving consistently high yields in cereals. Nitrogen is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments. The rate of uptake and partition of N is largely determined by supply and demand during various stages of plant growth. Soil N supply must be sufficient for tillering, stem elongation, booting, heading and grain filling as well as accumulation of proteins in the grains. Nitrogen is considered one of the most important factors affecting crop morphology (Amanullah *et al*., 2008a), crop growth rate and grain yield (Amanullah *et al.*, 2008b). The amount of nitrogen that a barley crop needs to maximize yield and quality will depend on the seasonal conditions, soil type, and rotational history of the soil as well as the potential yield of the crop. It needed for early tiller development of barley to set up the crop for a high yield potential. Ayoub *et al*., (1994) reported that spilt N application had little effect on yield, but decreased lodging and spike population with increased grain weight. Singh and Uttam (1992) recorded increased grain yield with increase in nitrogen level. However, increasing N fertility beyond a certain limit induced lodging and ultimately decreased grain yield and its components.

The great interesting towards reducing environmental pollution and the high costs due to use mineral fertilizers led to strong believe for applying bio-fertilizers in combination with mineral fertilizers. Microorganisms have specific functions to improve plant growth and its productivity, through nitrogen fixation and releasing phosphorus and potassium from its non – soluble compounds in soil. Biological N_2-fixation is a major source of nitrogen for plants as part of environment friendly agricultural practices. The aim of using biotechnology is to provide soil rhizosphere with different strains of microorganisms for minimizing fertilizer application and maximizing plant growth as well as nutrition availability. Application of biofertilizers to the soil improves soil fertility and then increase crop productivity in all cultivated area. As a result of this technology, crop requires little of N fertilizer and makes little demand on soil N reserves. Antoun *et al.* (1998); Biswas *et al*. (2000) and Zahir (2004) reported that free-living bacteria as well as rhizobium strains can promote the growth of cereal plants by contributing to N-economy through their ability to fix N_2. The free nitrogen fixing bacteria are not only able to fix the atmospheric nitrogen, but also have multiple benefits such as its ablity to synthesize and secrete phytohormone substances like thiamin, riboflavin pyridoxine, indol acetic acid, gibberellins, cytokinines and abscisic acid (Mohamed and Sherif, 2011). So, the current work aimed to study the effect of different rates of inorganic N fertilizers N bio-fertilization and their combination on barley yield and its components in sandy soil.

MATERIALS AND METHODS

The present experiment laid out in a sandy soil at Kantra Shark, north Sinai Governorate during 2017/2018 winter season using randomized complete block design with split split plot arrangements replicated three times. The main plots assigned to four mineral - N rates (0.0, 50, 75 and 100 kg N fed^{-1}) as ammonium sulphate (205g N kg^{-1}). The sub plots were occupied by two commercial bio-fertilizer sources, the first is nitrogen fixing bacteria (*Bacillus polymxa* and *Azospirillum lipoferum*) termed by Cyrialine, while the second source is nitrogen fixing combined with phosphorus dissolving bacteria *(Bacillus polymxa* ,*Bacillus megatherium* and *Pseudomonas spp*) named by Microbine. The sub-sub plots dedicated to four bio-fertilizer rates (0.0, 400, 600 and 800 g fed^{-1}). The two biofertilizers obtained from Egyptian Ministry of Agriculture (Department of Soil Microbiology Research, Agricultural Research Center). Table 1 shows the main properties of the studied soils. Barley seeds grown broadcasting on a plot size of 2 m x 2 m. The recommended rates of phosphorus (13.5 kg P fed^{-1}) as Ca – superphosphate (68 g P kg^{-1}) and potassium (20 kg K fed^{-1}) as potassium sulphate (400 g K kg^{-1}) were added during soil preparation. Barley seeds (*Hordeum vulgare L.*) var. Giza 2000 wetted by Arabic gum solution and then mixed with biofertilizers directly before sowing on 15/11/2017. Nitrogen fertilizer applied in five equal splitting doses; the first was at planting; and the others doses added every 30 day from each. After harvest on 6/4/2018, all plants of each plot taken and separated into grains and straw. The biological yield (BY), grain yield (GY) and straw yield (SY) were recorded (ton fed^{-1}) as well as plant samples were taken and oven dried at 70 ^{o}C to a constant weight and conserved for analysis. The N, P and K contents of the plants were determined by wet digestion using the standard methods as reported by Westerman (1990).

Table 1. Some physical and chemical analyses for soil under study.

Soil fertility characteristic	Value
Mechanical analysis (%)	93.5 sand, 4.63 silt,1.87 clay
Soil texture class	Sand
Saturation percentage (SP) %	20.00
EC (Soil paste extract) dSm^{-1}	1.63
Soluble cations (mmole L^{-1})	Ca^{2+} = 3.18 ; Mg^{2+} = 2.73 Na^{+} = 3.81 ; K^{+} = 0.68
Soluble anions (mmole L^{-1})	CO_3^{2-} = 0.00 ; HCO_3^{-} = 1.93 SO_4^{2-} = 5.40 ; Cl^{-} = 3.58
Soil – pH (1:2.5)	8.02
$CaCO_3$ (g kg^{-1})	2.60
O.M (g kg^{-1})	5.60
Soil - CEC ($cmol_c$ kg^{-1})	13.81
Total N (g kg^{-1})	0.33
Available N, P and K (mg kg^{-1})	
N	95.00
P	15.00
K	60.00

Notes:1- Soil analyses were done using representative composite samples.

2- Extraction solution for available N (KCl), P (Na-bicarbonate), K (NH_4-acetate).

Crude protein (CP) content was calculated by multiplying N content × 5.75 according to Ronald *et al.*, (2005). Harvest index (HI) was calculated as a percent [(grain yield ÷ total biological yield) × 100]. Agronomical N, P and K-use efficiencies (AUE); Nitrogen, P and K-Recovery efficiencies (RE) as well as Physiological N, P and K- use efficiencies (PhUE) were calculated as the following equations according to Naeem *et.al.*,(2017).

$$\text{- AUE} = \frac{\text{grain yield of treated - grain yield of control (kg fed}^{-1})}{\text{Element applied (kg fed}^{-1})}$$

$$\text{- RE} = \frac{\text{Element uptake of treated - Element uptake of control (kg fed}^{-1})}{\text{Element applied (kg fed}^{-1})}$$

$$\text{- Ph. UE} = \frac{\text{grain yield of treated - grain yield of control (kg fed}^{-1})}{\text{Element uptake of treated - Element uptake of control (kg fed}^{-1})}$$

Soil samples taken before planting and after harvest from the surface layer (0-30 cm), air – dried, ground to pass through a 2- mm sieve and analyzed for some physical and chemical properties according to Sparks (1996).

RESULTS AND DISCUSSION

1- Vegetative characters and yield:

a) Effect of mineral - N rate:

Data in Table (2) show that increasing mineral nitrogen rate from zero up to 100 kg N fed^{-1} led to significant increases in barley grain, straw and biological yields. As an average, the increments of (418,576 & 635 %), (385, 482 & 552 %) and (399, 510 & 579 %) for grain, straw and biological yields due to application of 50, 75 and 100 kg N fed^{-1}, respectively compared to control treatment (0.0 N fertilizer rate). These findings may be due to that nitrogen enhanced the vegetative growth of barley plant, increased photosynthetic activity and metabolites required to produce the higher grain yield. These results are in harmony with those obtained by Mosaad *et al.* (2013); Tigre *et al.* (2014) and Ahmed *et al.* (2017). Concerning harvest index , the values of this character significantly increased with increasing N application rate and the maximum value of 24.74 was obtained at 75 N rate followed by the value of 24 .18 at 100 N rate. This finding attributed to the ratio of (increment value in grain yield / increment value in straw yield) at 75 N rate (1.20) was higher than that the same ratio at 100 N rate (1.15). Many researchers reported that the harvest index has a positive relation with N fertilization rates as compared with control treatment (Munir, 2002; Shafi *et al.* 2011 and Niguse and Kassaye, 2018).

b) Effect of bio- fertilizer source:

As shown in Table 2 continuous; using Cyrialine and Microbine as bio- fertilizers source had a significant positive effect on all abovementioned agronomic traits (GY,SY and BY). As an average, Cyrialine gave the best values of 0.94, 2.91 and 3.86 ton fed^{-1} with increments of 32.39, 11,49 and 16.27 % for grain yield, straw yield and biological yield, respectively as compared to control treatment. On the other hand, Cyrialine was superior to Microbine in relation to its effect on GY, SY and BY with increases of 6.82, 11.07 and 10.29 %, respectively. These significant increases were probably due to that Cyrialine contains nitrogen fixing bacteria (*Bacillus polymxa* and

Azospirillum lipoferum) besides its ability to produce growth promoting substances which positively affect on plant growth. Laxmlnarayana (2001), Canbolat *et al.*(2006) and Azimi *et al.*(2014) reported that *Polymyxa* exhibited highest nitrogenase activity compared with other strains, *Azopirillum* fixating atmospheric nitrogen and produce indole acetic acid, gibberellins and cytokinine which enhance the crop production and nutrients uptake. Also, Bhakher *et al.* (2000) stated that maximum grain yield of forage sorghum was recorded in the treatment in which the seed was inoculated with *Azotobacter* as well as *Azospirillum*. On the other hand, Microbine as phosphorus dissolving bacteria (*Pseudomonas spp*) gave the highest value of harvest index (26.57%). Similar result obtained by Walley and Germida (1997) who reported that inoculation of wheat with *Pseudomonas* has shown to significantly increase root dry weight, and harvest index.

Table 2. Effect of nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors on barley yield and its quality.

Barley characteristics / Treatment			Grain yield	Straw yield	Biological yield	Harvest Index	Protein
N- fert. rate (kg Fed^{-1})	Bio Source	Bio. rate (g Fed^{-1})	Ton Fed.$^{-1}$			%	
Zero	Cyrialine	0	0.11	0.67	0.78	14.06	3.22
		400	0.14	0.71	0.85	16.43	5.79
		600	0.21	0.77	0.98	21.50	6.23
		800	0.25	0.84	1.09	22.90	6.65
		Mean	0.18	0.75	0.93	18.72	5.47
	Microbine	400	0.12	0.33	0.45	26.38	3.85
		600	0.18	0.37	0.55	32.73	5.64
		800	0.22	0.39	0.61	35.97	6.04
		Mean	0.16	0.44	0.60	27.28	4.69
Mean			0.17	0.60	0.76	23.00	5.08
50	Cyrialine	0	0.72	2.75	3.48	20.77	9.97
		400	0.87	2.93	3.79	23.00	10.59
		600	0.93	3.14	4.08	22.93	10.87
		800	1.09	3.23	4.32	25.22	11.02
		Mean	0.90	3.01	3.92	22.98	10.61
	Microbine	400	0.79	2.77	3.56	22.19	10.26
		600	0.89	2.85	3.74	23.80	10.48
		800	1.01	2.88	3.90	26.02	10.50
		Mean	0.85	2.81	3.67	23.19	10.30
Mean			0.88	2.91	3.79	23.09	10.46
75	Cyrialine	0	0.95	3.28	4.22	22.38	10.81
		400	1.15	3.43	4.58	25.12	11.07
		600	1.26	3.73	4.99	25.32	11.38
		800	1.34	3.86	5.20	25.82	11.42
		Mean	1.18	3.57	4.75	24.66	11.17
	Microbine	400	1.12	3.35	4.47	24.99	11.12
		600	1.19	3.43	4.62	25.78	11.17
		800	1.25	3.55	4.80	26.09	11.32
		Mean	1.13	3.40	4.53	24.81	11.11
Mean			1.15	3.49	4.64	24.74	11.14
100	Cyrialine	0	1.05	3.74	4.79	21.96	11.16
		400	1.31	3.96	5.27	24.86	11.25
		600	1.35	4.07	5.43	24.95	11.46
		800	1.42	4.28	5.70	24.83	11.56
		Mean	1.28	4.01	5.30	24.15	11.35
	Microbine	400	1.21	3.76	4.98	24.39	11.16
		600	1.28	3.85	5.13	24.88	11.39
		800	1.34	3.88	5.22	25.64	11.42
		Mean	1.22	3.81	5.03	24.22	11.28
Mean			1.25	3.91	5.16	24.18	11.32

c) Effect of bio- fertilizer rate:

Data also clearly demonstrated that grain, straw, biological yields and harvest index significantly increased gradually with increasing bio- fertilizer rate (Table 2 continuous). Application of 800 g fed^{-1} resulted in realizing maximum values of 0.99, 2.87, 3.86 ton fed^{-1} and 26.56 % with increments of 39.44, 9.96, 16.27 and 34.21 % for grain, straw, biological yields and harvest index as compared to non inoculated treatment, respectively. The obtained results may be attributed to improve environment of plant growth through exudates and metabolic activities of rihizospheric microorganisms which improve plant productivity. These results are in agreement with those obtained by (Kumar *et al*., 2013; Mosaad *et al*., 2013 and Azimi *et al*., 2014).

d)Interaction effect:

Results presented in Table 2 indicate that the interaction effect gave a positive response on the studded

agronomic traits. The best interaction treatment that achieved the highest values of 1.42, 4.28 and 5.70 ton fed^{-1} with increases of 468, 410 and 423 % for grain, straw and biological yields, respectively was (100 kg N fed^{-1} + 800 g fed^{-1} Cyrialine). On the other hand, data also showed that there is no significant effect between the interaction treatments of (75 Kg N fed^{-1} + Cyrialine at rate 800 g fed^{-1}) and (100 Kg N fed^{-1} + Microbine at rate 800 g fed^{-1}). Also, data appeared that the interaction treatments of (75 Kg N fed^{-1} + Cyrialine at rate 800 g fed^{-1}) and (75 Kg N fed^{-1} + Microbine at rate 800 g fed^{-1}) gave approximately the same grain yields of (1.34 and 1.25 ton fed^{-1}, respectively) as that obtained by application of 100 kg mineral-N fed^{-1} (1.25 ton fed^{-1}). This means that using of N-bio-fertilizers may save about 25 kg of mineral-N fed^{-1} at least. Concerns harvest index, all interaction treatments contained Microbine gave higher values than that contained with Cyrialine and the treatment of (0.0kg N rate + Microbine at rate 800 g fed^{-}1) realized the maximum harvest index value of 35.97 % which may be due to the great reduction in straw yield. These results are in agreement with those obtained by Ibrahim *et al.*(2009) ; Piccinin *et al.*(2013) and Ibrahim *et al.*(2015).

Table 2. continuous. Effect of nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors on barley yield and its quality.

Barley characteristics / Treatment			Grain yield	Straw yield	Biological yield	Harvest Index	Protein
N- fert. rate (kg Fed^{-1})		Bio. Rate (g Fed^{-1})		Ton Fed.$^{-1}$			%
0		0	0.11	0.67	0.78	14.06	3.22
		400	0.13	0.52	0.65	21.41	4.82
		600	0.20	0.57	0.76	27.11	5.93
		800	0.24	0.62	0.85	29.43	6.34
50		0	0.72	2.75	3.48	20.77	9.97
		400	0.83	2.85	3.67	22.60	10.42
		600	0.91	2.99	3.91	23.36	10.68
		800	1.05	3.06	4.11	25.62	10.76
75		0	0.95	3.28	4.22	22.38	10.81
		400	1.13	3.39	4.52	25.06	11.10
		600	1.23	3.58	4.81	25.55	11.28
		800	1.30	3.71	5.00	25.96	11.37
100		0	1.05	3.74	4.79	21.96	11.16
		400	1.26	3.86	5.13	24.62	11.20
		600	1.31	3.96	5.28	24.91	11.43
		800	1.38	4.08	5.46	25.23	11.49
Bio Source	Cyrialine	0	0.71	2.61	3.32	19.79	8.79
		400	0.87	2.76	3.62	22.35	9.67
		600	0.94	2.93	3.87	23.68	9.99
		800	1.02	3.06	4.08	24.69	10.16
		Mean	0.94	2.91	3.86	23.57	9.94
	Microbine	400	0.81	2.56	3.37	24.49	9.10
		600	0.88	2.62	3.51	26.80	9.67
		800	0.96	2.68	3.63	28.43	9.82
		Mean	0.88	2.62	3.50	26.57	9.53
Bio. rate		0	0.71	2.61	3.32	19.79	8.79
		400	0.84	2.66	3.49	23.42	9.38
		600	0.91	2.78	3.69	25.24	9.83
		800	0.99	2.87	3.86	26.56	9.99
$LSD_{5\%}$	a*b*c		0.021	0.029	0.019	0.754	0.156
$LSD_{5\%}$	a*b		0.008	0.01	0.007	0.266	0.055
$LSD_{5\%}$	a		0.006	0.008	0.007	0.24	0.03
$LSD_{5\%}$	a*c		0.015	0.02	0.013	0.533	0.11
$LSD_{5\%}$	b*c		0.011	0.014	0.009	0.377	0.078
$LSD_{5\%}$	b		0.004	0.006	0.005	0.16	0.02
$LSD_{5\%}$	c		0.008	0.01	0.007	0.266	0.055

2- Chemical composition, nutrient uptake and nutrient use efficiency:

a) Effect of N fertilizer rate:

Grains protein content (%), N, P , K-uptake (kg fed^{-1}) by grains or straw , total uptake (grains + straw) and nutrient use efficiency (kg kg^{-1}) markedly affected by N-fertilizer rate (Tables from 2 To 5 continuous). As an average, there are significant increases of grain protein contents (%) of 106,119 and 123 % due to graded raising of N-fertilizer rates from 50, 75 to 100 kg fed^{-1}, respectively compared to control treatment (0.0 N fertilizer rate). Highest N-uptake (kg fed^{-1}) in respect of grains and straw (24.66 and 23.52) with increments of (1432 and 1478 %), respectively were recorded with applying 100 kg N fed^{-1}. This result may be attributed to the enhancement of soil nitrogen supply to the plant with increasing N-fertilizer rate. Diacono *et al.* (2013) recorded similar result. Regarding the nitrogen use efficiencies, data presented in Table 3 showed that agronomical N use efficiency (ANUE), nitrogen recovery efficiency (NRE) and physiological N use efficiency

(ph.NUE) decreased significantly with increasing N-fertilizer rate up to 100 kg fed^{-1}. The lowest values were 11.41, 0.463 and 24.70 (kg kg^{-1}) respectively with applying 100 kg N fed^{-1}. This depressed effect is nearly attributed to the reduction in the rates of increase of both grain yield as well as grains N-uptake versus the increase in N fertilization rates. These results are in agreement with those obtained by Vukovic *et al.*(2008) and Mosaad *et al.* (2013).

Also, data in Table 4 showed that P-uptake by grains or straw, total P-uptake, agronomical P use efficiency (APUE) and phosphorus recovery efficiency (PRE) were increased significantly with increasing N-fertilizer rate up to 100 kg fed^{-1}. The highest values of total P-uptake (6.35 kg fed^{-1}), APUE (84.30 kg kg^{-1}) and PRE (0.428 kg kg^{-1}) with increments of 656, 1389 and 1429 %, respectively were occurred with applying N at rate 100 kg fed^{-1}. These results mainly due to applying one dose of P fertilizer (13.5 kg P fed^{-1}).Many researchers reported that phosphorus use efficiency decreased with increasing phosphorus fertilizer rate (availability in soil) (Hussein, 2009;Chagas *et al.* 2015 and Pelá *et al*. 2017). In contrast, physiological P use efficiency (ph.PUE) reduced with increasing N-fertilizer rate up to 100 kg fed^{-1} with the decrease of 9.16, 12.60 and 14.11 % with applying 50, 75 and 100 kg N fed^{-1}, respectively compared to without N fertilization treatment. This result may be attributed to the increase of P-uptake rates by grains with increasing N fertilizer rates. K-uptake by grains and straw, total K-uptake, agronomical K use efficiency (AKUE), potassium recovery efficiency (KRE) and physiological K use efficiency (ph.KUE) took the same trend as for phosphorus with application of N fertilization rates (Table 5) .

Table 3. N-uptake and N- Use Efficiency by barley yield as affected by nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors .

Barley characteristics								
Treatment			N- Uptake kg Fed^{-1}			Nitrogen Use Efficiency kg kg^{-1}		
N- fert. Rate (kg Fed^{-1})	Bio Source	Bio. rate (g Fed^{-1})	Grain	Straw	Total	ANUE	NRE	Ph.NUE
Zero	Cyrialine	0	0.62	0.57	1.19	-	-	-
		400	1.49	1.40	2.89	-	-	17.64
		600	2.28	2.12	4.39	-	-	31.23
		800	2.89	2.75	5.64	-	-	31.47
		Mean	1.82	1.71	3.53	-	-	26.78
	Microbine	400	0.92	0.74	1.66	-	-	21.15
		600	1.76	1.56	3.32	-	-	32.82
		800	2.31	2.25	4.56	-	-	32.68
		Mean	1.40	1.28	2.68	-	-	28.88
Mean			1.61	1.49	3.10	-	-	27.83
50	Cyrialine	0	12.51	12.52	25.02	12.23	0.463	26.45
		400	16.04	14.69	30.72	14.96	0.577	26.40
		600	17.68	16.60	34.27	16.50	0.648	25.48
		800	20.89	19.93	40.82	19.60	0.779	25.18
		Mean	16.78	15.93	32.71	15.82	0.616	25.88
	Microbine	400	14.08	13.04	27.13	13.59	0.505	26.90
		600	16.20	14.82	31.01	15.58	0.582	26.75
		800	18.52	17.88	36.40	18.08	0.690	26.19
		Mean	15.33	14.56	29.89	14.87	0.559	26.57
Mean			16.05	15.25	31.30	15.35	0.588	26.23
75	Cyrialine	0	17.77	16.50	34.26	11.14	0.432	25.81
		400	22.14	20.25	42.39	13.86	0.539	25.68
		600	25.01	23.00	48.01	15.38	0.615	25.02
		800	26.70	25.19	51.89	16.45	0.667	24.68
		Mean	22.90	21.23	44.14	14.21	0.563	25.30
	Microbine	400	21.61	19.24	40.85	13.43	0.519	25.86
		600	23.14	20.66	43.80	14.41	0.559	25.80
		800	24.68	22.28	46.96	15.24	0.601	25.37
		Mean	21.80	19.67	41.47	13.56	0.528	25.71
Mean			22.35	20.45	42.80	13.88	0.545	25.50
100	Cyrialine	0	20.41	19.08	39.49	9.42	0.376	25.06
		400	25.64	24.87	50.51	12.01	0.486	24.71
		600	26.98	25.84	52.82	12.44	0.509	24.42
		800	28.45	28.09	56.53	13.05	0.546	23.89
		Mean	25.37	24.47	49.84	11.73	0.479	24.52
	Microbine	400	23.56	22.71	46.27	11.04	0.444	24.88
		600	25.27	23.63	48.90	11.66	0.470	24.80
		800	26.57	24.87	51.44	12.27	0.495	24.78
		Mean	23.95	22.57	46.52	11.10	0.446	24.88
Mean			24.66	23.52	48.18	11.41	0.463	24.70

Table 3. continuous. N-uptake and Nitrogen Use Efficiency by barley yield as affected by nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors.

Barley characteristics / Treatment			N- Uptake kg Fed^{-1}			Nitrogen Use Efficiency kg kg^{-1}		
N- fert. rate (kg Fed^{-1})		Bio. rate (g Fed^{-1})	Grain	Straw	Total	ANUE	NRE	Ph.NUE
0		0	0.62	0.57	1.19	-	-	-
		400	1.21	1.07	2.28	-	-	19.39
		600	2.02	1.84	3.86	-	-	32.02
		800	2.60	2.50	5.10	-	-	32.07
50		0	12.51	12.52	25.02	12.23	0.462	26.45
		400	15.06	13.86	28.92	14.27	0.540	26.65
		600	16.94	15.71	32.64	16.04	0.615	26.12
		800	19.71	18.91	38.61	18.84	0.734	25.69
75		0	17.77	16.50	34.26	11.14	0.432	25.81
		400	21.87	19.75	41.62	13.65	0.530	25.77
		600	24.08	21.83	45.91	14.90	0.587	25.41
		800	25.69	23.74	49.43	15.85	0.634	25.03
100		0	20.41	19.08	39.49	9.42	0.376	25.06
		400	24.60	23.79	48.39	11.53	0.465	24.79
		600	26.13	24.74	50.86	12.05	0.490	24.61
		800	27.51	26.48	53.99	12.66	0.521	24.33
Bio Source	Cyrialine	0	12.83	12.17	24.99	10.93	0.423	19.33
		400	16.33	15.30	31.63	13.61	0.534	23.61
		600	17.99	16.89	34.87	14.77	0.590	26.54
		800	19.73	18.99	38.72	16.37	0.664	26.30
		Mean	18.01	17.06	35.07	14.92	0.596	25.48
	Microbine	400	15.04	13.93	28.98	12.69	0.489	24.70
		600	16.59	15.17	31.76	13.88	0.537	27.54
		800	18.02	16.82	34.84	15.20	0.595	27.25
		Mean	16.55	15.31	31.86	13.92	0.541	26.50
Bio. rate		0	12.83	12.17	24.99	10.93	0.423	19.33
		400	15.68	14.62	30.30	13.15	0.512	24.15
		600	17.29	16.03	33.32	14.33	0.564	27.04
		800	18.88	17.91	36.78	15.78	0.630	26.78
$LSD_{5\%}$ a*b*c			0.46	0.20	0.35	0.37	0.005	0.82
$LSD_{5\%}$ a*b			0.16	0.07	0.12	0.13	0.002	0.29
$LSD_{5\%}$ a			0.09	0.06	0.06	0.10	0.001	0.26
$LSD_{5\%}$ a*c			0.33	0.14	0.25	0.26	0.004	0.58
$LSD_{5\%}$ b*c			0.23	0.10	0.17	0.19	0.003	0.41
$LSD_{5\%}$ b			0.06	0.04	0.04	0.09	0.001	0.17
$LSD_{5\%}$ c			0.16	0.07	0.12	0.13	0.002	0.29

b) Effect of bio- fertilizer source:

Data in Tables 2, 3, 4 and 5 continuous reveal that bio-fertilizer sources had positive effects on grain protein content, N, P and K-uptake by grains or straw as well as the nutrient use efficiencies. As an average, Cyrialine was superior to Microbine in its beneficial effect on all previous characters except for P- uptake by grains or straw, total P-uptake PRE and Ph.NUE. Microbine achieved the highest values of 3.15, 1.75, 4.90 (kg fed^{-1}), 0.321 and 26.50 (kg kg^{-1}) with increases of 43.84, 65.09, 50.31 , 60.50 and 37.09 %, respectively compared to the values of 3.04, 1.34, 4.38 (kg fed^{-1}), 0.283 and 25.48 kg fed^{-1}(for Cyrialine) with increments of 38.81, 26.42, 34.36, 41.50 and 31.81 %, respectively compared to non-inoculated treatments . This result may be due to the improving effect of Microbine on increases P availability *via* increasing the solubility of unavailable forms in soil. On the other hand, the maximum average values obtained by using Cyrialine for protein %, total N uptake, total K-uptake (kg fed^{-1}), ANUE, NRE, APUE, ph.PUE, AKUE, KRE, and ph.KUE (kg kg^{-1}) were 9.94 %, 35.07, 10.30, 14.92, 0.596, 61.55, 242.52, 41.83, 0.453 and 100.96 with increases of 13.08, 40.34, 37.33, 36.51, 40.90, 39.54, 45.41, 39.53, 44.73 and 40.20 %, respectively over the control (without addition bio-fertilizer). This result could be explained on the basis that Cyrialine as nitrogen fixing bacteria increases N availability to plants which enhances the crop production and nutrient uptake. These results were confirmed with those obtained by Mosaad *et al*. (2013); Tigre *et al*. (2014) and Ahmed *et al.*(2017).

c) Effect of bio- fertilizer rate:

The data showed that using bio- fertilizers resulted in significant increases in all mean values of the above-mentioned studded parameters of barley with application of graded rates up to 800 g fed^{-1} accept for Ph.PUE and Ph.KUE which appeared diminished increases as compared with non bio-fertilizer treatments, (Tables 2, 3, 4 and 5 continuous). As an average, the treatment 800 g fed^{-1} gave the best treatment with increments of 13.65, 47.18, 44.37,48.93,38.54, 60.12,47.43, 72.50, 49.87, 47.43 and 60.06 % for grain protein content, total N -uptake, (ANUE), (NRE), (Ph.NUE), total P-uptake, (APUE), (PRE), total K-uptake, (AKUE) and (KRE),respectively increased with increasing of bio- fertilizer rates .While physiological P and K- use efficiencies showed diminishing increases as affected by bio- fertilizer rate.

d. Interaction effect:

Data presented in Tables 2, 3, 4 and 5 indicate that the interaction effect gave positive response on the studded chemical characters and nutrient use efficiencies. On an average, the best interaction treatments that achieved the higher values of protein %, total N- uptake, total P- uptake, total K- uptake, APUE, PRE, AKUE and KRE were (100 kg N fed^{-1} + 800 g Cyrialine fed^{-1}) and (100 kg N fed^{-1} + 800 g Microbine fed^{-1}) with increments of 3.58, 43.15, 44.72, 42.95, 38.57, 50.15,38.55 and 48.30 %, respectively for the first interaction treatment and 2.33,30.26, 56.30, 41.52, 30.30, 63.16, 30.3 and 46.69 %, respectively for the second ones, compared to 100 kg mineral N . The effect of Cyrialine was better than Microbine except for protein content; there was no significant effect between them, while Micrrobine was superior to Cyrialine as concerns of PRE and total P- uptake. The mean values of NRE,ANUE, Ph.PUE and Ph.KUE showed diminished increases with interaction treatments which can ranged in the following descending order: (50 kg N fed^{-1} + 800 g Cyrialine fed^{-1}) > (75 kg N fed^{-1} + 800 g Cyrialine fed^{-1}) > (100 kg N fed^{-1}800 g Cyrialine fed^{-1}) > control. Cyrialine gave higher values than that for Microbine while the reverse happened in case of Ph.NUE.

Table 4. P-uptake and P- Use Efficiency by barley yield as affected by nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors.

Barley characteristics / Treatment			P- Uptake kg Fed^{-1}			Phosphorus Use Efficiency kg kg^{-1}		
N- fert. rate (kg Fed^{-1})	Bio Source	Bio. rate (g Fed^{-1})	Grain	Straw	Total	APUE	PRE	Ph.PUE
Zero	Cyrialine	0	0.34	0.21	0.55	-	-	-
		400	0.40	0.22	0.62	2.22	0.005	432.05
		600	0.61	0.33	0.94	7.39	0.028	259.29
		800	0.73	0.37	1.10	10.34	0.041	255.34
		Mean	0.52	0.28	0.80	6.65	0.025	315.56
	Microbine	400	0.41	0.22	0.62	0.74	0.005	151.46
		600	0.67	0.35	1.02	5.17	0.034	151.41
		800	0.84	0.47	1.31	8.12	0.056	146.71
		Mean	0.56	0.31	0.87	4.68	0.032	149.86
Mean			0.54	0.30	0.84	5.66	0.028	232.71
50	Cyrialine	0	2.07	1.11	3.18	45.17	0.194	232.98
		400	2.57	1.24	3.81	55.23	0.240	229.91
		600	2.93	1.34	4.27	60.93	0.275	221.90
		800	3.56	1.48	5.03	72.38	0.331	218.79
		Mean	2.78	1.29	4.07	58.43	0.260	225.89
	Microbine	400	2.47	1.67	4.14	50.17	0.265	188.96
		600	2.97	1.74	4.71	57.54	0.307	187.26
		800	3.67	1.95	5.62	66.77	0.374	178.38
		Mean	2.80	1.62	4.41	54.91	0.285	196.90
Mean			2.79	1.45	4.24	56.67	0.273	211.40
75	Cyrialine	0	3.01	1.36	4.37	61.68	0.282	218.49
		400	3.65	1.47	5.12	76.79	0.337	227.70
		600	4.09	1.68	5.76	85.20	0.385	221.35
		800	4.57	2.15	6.72	91.13	0.456	199.91
		Mean	3.83	1.67	5.50	78.70	0.365	216.86
	Microbine	400	3.84	2.13	5.97	74.39	0.400	185.92
		600	4.20	2.26	6.46	79.83	0.437	182.88
		800	4.73	2.46	7.18	84.44	0.490	172.39
		Mean	3.94	2.05	6.00	75.08	0.402	189.92
Mean			3.89	1.86	5.75	76.89	0.384	203.39
100	Cyrialine	0	3.35	1.57	4.92	69.57	0.323	215.65
		400	4.15	1.69	5.84	88.69	0.390	227.25
		600	4.43	1.82	6.25	91.86	0.421	218.20
		800	4.77	2.35	7.12	96.40	0.485	198.62
		Mean	4.18	1.86	6.03	86.63	0.405	214.93
	Microbine	400	4.35	2.38	6.73	81.56	0.456	178.75
		600	4.69	2.61	7.30	86.09	0.498	172.82
		800	4.98	2.71	7.69	90.65	0.527	171.98
		Mean	4.34	2.32	6.66	81.97	0.451	184.80
Mean			4.26	2.09	6.35	84.30	0.428	199.87

Table 4. continuous. P-uptake and Phosphorus Use Efficiency by barley yield as affected by nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors.

Barley characteristics / Treatment			P- Uptake kg Fed^{-1}			Efficiency Phosphorus Use kg kg^{-1}		
N- fert. rate (kg Fed^{-1})		Bio. rate (g Fed^{-1})	Grain	Straw	Total	APUE	PRE	Ph.PUE
0		0	0.34	0.21	0.55	-	-	-
		400	0.40	0.22	0.62	1.48	0.005	291.75
		600	0.64	0.34	0.98	6.28	0.031	205.35
		800	0.78	0.42	1.21	9.23	0.048	201.03
50		0	2.07	1.11	3.18	45.17	0.194	232.98
		400	2.52	1.46	3.97	52.70	0.253	209.44
		600	2.95	1.54	4.49	59.23	0.291	204.58
		800	3.61	1.71	5.33	69.57	0.353	198.59
75		0	3.01	1.36	4.37	61.68	0.282	218.49
		400	3.74	1.80	5.54	75.59	0.369	206.81
		600	4.14	1.97	6.11	82.52	0.411	202.12
		800	4.65	2.30	6.95	87.78	0.473	186.15
100		0	3.35	1.57	4.92	69.57	0.323	215.65
		400	4.25	2.03	6.28	85.13	0.423	203.00
		600	4.56	2.22	6.77	88.97	0.460	195.51
		800	4.87	2.53	7.41	93.52	0.506	185.30
Bio Source	Cyrialine	0	2.19	1.06	3.26	44.11	0.200	166.78
		400	2.69	1.15	3.85	55.73	0.243	279.22
		600	3.01	1.29	4.31	61.34	0.277	230.18
		800	3.41	1.59	5.00	67.56	0.328	218.16
		Mean	3.04	1.34	4.38	61.55	0.283	242.52
	Microbine	400	2.77	1.60	4.37	51.71	0.282	176.27
		600	3.13	1.74	4.87	57.16	0.319	173.59
		800	3.55	1.90	5.45	62.49	0.362	167.36
		Mean	3.15	1.75	4.90	57.12	0.321	172.41
Bio. rate		0	2.19	1.06	3.26	44.11	0.200	166.78
		400	2.73	1.38	4.11	53.72	0.262	227.75
		600	3.07	1.52	4.59	59.25	0.298	201.89
		800	3.48	1.74	5.22	65.03	0.345	192.76
$LSD_{5\%}$	a*b*c		0.06	0.03	0.08	1.59	0.006	12.71
$LSD_{5\%}$	a*b		0.02	0.01	0.03	0.57	0.002	4.49
$LSD_{5\%}$	a		0.02	0.02	0.02	0.46	0.001	6.95
$LSD_{5\%}$	a*c		0.04	0.02	0.05	1.13	0.004	8.99
$LSD_{5\%}$	b*c		0.03	0.02	0.04	0.80	0.003	6.35
$LSD_{5\%}$	b		0.01	0.01	0.01	0.30	0.001	4.63
$LSD_{5\%}$	c		0.02	0.01	0.03	0.57	0.002	4.49

Table 5. K-uptake and P- Use Efficiency by barley yield as affected by nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors .

Barley characteristics / Treatment			K- Uptake kg Fed^{-1}			Potassium Use fficiency kg kg^{-1}		
N- fert. rate (kg Fed^{-1})	Bio Source	Bio. rate (g Fed^{-1})	Grain	Straw	Total	AKUE	KRE	Ph.KUE
Zero	Cyrialine	0	0.50	0.76	1.26	-	-	-
		400	0.59	0.86	1.45	1.51	0.009	170.94
		600	0.89	1.32	2.21	5.02	0.047	106.40
		800	1.14	1.49	2.64	7.03	0.069	102.20
		Mean	0.78	1.11	1.89	4.52	0.042	126.52
	Microbine	400	0.58	0.76	1.35	0.50	0.004	128.74
		600	0.77	1.29	2.05	3.51	0.040	89.39
		800	1.07	1.46	2.54	5.52	0.064	86.95
		Mean	0.73	1.07	1.80	3.18	0.036	101.69
Mean			0.76	1.09	1.85	3.85	0.039	114.10
50	Cyrialine	0	1.81	5.69	7.50	30.71	0.313	98.12
		400	1.91	6.99	8.90	37.54	0.383	97.92
		600	2.74	7.12	9.87	41.41	0.432	95.90
		800	3.91	7.84	11.75	49.20	0.526	93.49
		Mean	2.60	6.91	9.50	39.71	0.414	96.36
	Microbine	400	1.89	6.52	8.41	34.10	0.358	95.14
		600	2.63	6.92	9.56	39.11	0.416	93.97
		800	3.86	7.64	11.49	45.38	0.514	88.37
		Mean	2.55	6.69	9.24	37.32	0.400	93.90
Mean			2.57	6.80	9.37	38.52	0.407	95.13
75	Cyrialine	0	3.14	6.90	10.04	41.92	0.441	95.13
		400	3.19	9.44	12.63	52.20	0.571	91.48
		600	4.12	9.90	14.01	57.91	0.640	90.50
		800	4.46	10.60	15.06	61.94	0.692	89.50
		Mean	3.73	9.21	12.94	53.50	0.586	91.65
	Microbine	400	3.16	9.46	12.62	50.56	0.570	88.73
		600	4.04	9.57	13.61	54.26	0.620	87.58
		800	4.38	10.20	14.58	57.39	0.668	85.86
		Mean	3.68	9.03	12.71	51.04	0.575	89.33
Mean			3.70	9.12	12.82	52.27	0.580	90.49
100	Cyrialine	0	3.78	7.42	11.20	47.29	0.499	94.79
		400	3.85	10.30	14.15	60.29	0.647	93.23
		600	4.42	10.47	14.89	62.44	0.684	91.31
		800	4.99	11.02	16.01	65.52	0.740	88.60
		Mean	4.26	9.80	14.06	58.88	0.643	91.98
	Microbine	400	3.81	9.95	13.76	55.44	0.627	88.39
		600	4.39	10.49	14.88	58.52	0.684	85.60
		800	4.95	10.90	15.85	61.62	0.732	84.17
		Mean	4.23	9.69	13.92	55.72	0.635	88.24
Mean			4.25	9.75	13.99	57.30	0.639	90.11

Table 5. continuous. K-uptake and Potassium Use Efficiency by barley yield as affected by nitrogen mineral fertilizer rate, bio-fertilizer source and rate as well as the interaction effect of these factors .

Barley characteristics / Treatment			K- Uptake kg Fed^{-1}			Potassium Use Efficiency kg kg^{-1}		
N- fert. rate (kg Fed^{-1})		Bio. rate (g Fed^{-1})	Grain	Straw	Total	AKUE	KRE	Ph.KUE
0		0	0.50	0.76	1.26			
		400	0.59	0.81	1.40	1.00	0.007	149.84
		600	0.83	1.30	2.13	4.27	0.043	97.90
		800	1.11	1.48	2.59	6.28	0.066	94.58
50		0	1.81	5.69	7.50	30.71	0.313	98.12
		400	1.90	6.75	8.65	35.82	0.371	96.53
		600	2.69	7.02	9.71	40.26	0.424	94.93
		800	3.88	7.74	11.62	47.29	0.520	90.93
75		0	3.14	6.90	10.04	41.92	0.441	95.13
		400	3.18	9.45	12.62	51.38	0.570	90.10
		600	4.08	9.73	13.81	56.09	0.630	89.04
		800	4.42	10.40	14.82	59.67	0.680	87.68
100		0	3.78	7.42	11.20	47.29	0.499	94.79
		400	3.83	10.13	13.95	57.86	0.637	90.81
		600	4.41	10.48	14.89	60.48	0.684	88.46
		800	4.97	10.96	15.93	63.57	0.736	86.39
Bio Source	Cyrialine	0	2.31	5.19	7.50	29.98	0.313	72.01
		400	2.39	6.90	9.28	37.88	0.403	113.39
		600	3.04	7.20	10.24	41.70	0.451	96.03
		800	3.63	7.73	11.36	45.92	0.507	93.45
		Mean	3.02	7.28	10.30	41.83	0.453	100.96
	Microbine	400	2.36	6.67	9.03	35.15	0.390	100.25
		600	2.96	7.07	10.02	38.85	0.440	89.14
		800	3.56	7.55	11.11	42.48	0.494	86.34
		Mean	2.96	7.10	10.06	38.83	0.441	91.91
Bio. rate		0	2.31	5.19	7.50	29.98	0.313	72.01
		400	2.37	6.78	9.16	36.52	0.396	106.82
		600	3.00	7.13	10.13	40.27	0.445	92.58
		800	3.60	7.64	11.24	44.20	0.501	89.89
$LSD_{5\%}$ a*b*c			0.020	0.13	0.14	1.09	0.005	4.16
$LSD_{5\%}$ a*b			NS	0.05	NS	0.38	0.002	1.47
$LSD_{5\%}$ a			0.006	0.03	0.02	0.31	0.002	1.10
$LSD_{5\%}$ a*c			0.020	0.09	0.10	0.77	0.004	2.94
$LSD_{5\%}$ b*c			0.010	0.07	0.07	0.54	0.003	2.08
$LSD_{5\%}$ b			0.004	0.02	0.02	0.21	0.001	0.73
$LSD_{5\%}$ c			0.010	0.05	0.05	0.35	0.002	1.47

CONCLUSION

This current research aimed to clarify the possible use of mineral N fertilization in combination with bio-fertilizers to improve yield and its components, chemical composition as well as nutrient use efficiencies of barley (*Hordeum vulgare L.*) var. Giza 2000 grown on sandy soil.

The results showed that:

1- Treating barley with 75 kg mineral N fed^{-1} with 800 g fed^{-1} bio-fertilizer gave grain yields of (1.34 and 1.25 ton fed^{-1}) for Cyrialine (*Bacillus polymxa* and *Azospirillum lipoferum*) and Microbine *(Bacillus polymxa* ,*Bacillus megatherium* and *Pseudomonas spp*), respectively which have the same values or more than that obtained when 100 kg N rate applied (1.25 ton fed^{-1}). This verifies the potentiality in saving about 25 % of mineral N fertilizer and reducing the growth media pollution.

2- The interaction treatments that realized the best values for the studded agronomic traits, chemical composition, nutrient uptake and nutrient use efficiencies were (100 kg N fed^{-1} + 800 g Cyrialine fed^{-1}) and (100 kg N fed^{-1} + 800 g Microbine fed^{-1}) compared to 100 kg fed^{-1} mineral N rate.

3- In view of sandy soils are poor in fertility and physical, chemical as well as biological properties, it is necessary to use organic and bio fertilization system with limited amounts of chemical fertilizers as a supplemental doses to overcome these problems for realizing the desired crop productivity and quality in such soils (this is the so called, organic and bio agriculture).

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تقييم تأثير التسميد النيتروجين المعدني بالإضافة إلي التسميد النيتروجيني الحيوي على محصول الشعير ومكوناته في التربة الرملية

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يهدف هذا العمل الحالي إلى توضيح تأثير معدلات التسميد النيتروجيني المعدني بالإضافة إلي مصدر الأسمدة النيتروجينية الحيوية ومعدلاتها على محصول الشعير ومكوناته (*Hordeum vulgare L.*) صنف جيزة ٢٠٠٠ في التربة الرملية. تم إجراء تجربة ميدانية في القنطرة شرق ، محافظة شمال سيناء خلال الموسم الشتوي ٢٠١٨/٢٠١٧ باستخدام تصميم القطاعات كاملة العشوائية في نظام القطع المنشقة مرتين وكررت كل معاملة ثلاث مرات. اشتملت القطع الرئيسية علي أربع معدلات للسماد النيتروجيني المعدني (صفر و ٥٠ و ٧٥ و ١٠٠ كجم ن ف$^{-1}$) علي صورة كبريتات الأمونيوم (٢٠٥جم ن كجم $^{-1}$). القطع التحت رئيسية تم شغلها بمصدرين من الأسمدة الحيوية التجارية (السريالين و الميكروبين) . خصصت القطع التحت تحت رئيسية لأربع معدلات للأسمدة الحيوية (صفر و ٤٠٠ و ٦٠٠ و ٨٠٠ جم ف$^{-1}$). أوضحت النتائج أن محصول حبوب الشعير و القش والمحصول البيولوجي ، و دليل الحصاد و النسبة المئوية للبروتين في الحبوب و ن و فو و بو الممتص بواسطة الحبوب و القش (كجم ف $^{-1}$) والكمية الكلية الممتصة (الحبوب + القش) و كفاءة الاستخدام الزراعية للفوسفور و البوتاسيوم و كذلك الفوسفور و البوتاسيوم المسترجع زادت معنويا مع زيادة معدل الأسمدة النيتروجينية إلى ١٠٠ كجم ن ف$^{-1}$. كفاءة الاستخدام الزراعية للنيتروجين وكفاءة الاسترداد للنيتروجين وكفاءات الاستخدام الفسيولوجية للنيتروجين و الفوسفور و البوتاسيوم انخفضت معنويا مع زيادة معدل الأسمدة النيتروجينية .تفوق السيريالين على الميكروبين في تأثيره المفيد على معظم الصفات المذكورة أعلاه. زادت جميع الصفات الخضرية المدروسة وبالمثل التركيب الكيميائي وامتصاص المغذيات وكفاءات استخدامها معنويا مع زيادة معدل الأسمدة الحيوية .بشكل عام على الرغم من استجابة المحصول لمعدلات التسميد المعدني النيتروجيني إلى ١٠٠ كجم ن ف$^{-1}$ تحت التربة المدروسة (الرملية) ، كانت الإضافات المتضمنة علي الأسمدة الحيوية هي الأفضل لجميع القياسات المدروسة ويمكن توفير حوالي ٢٥ ٪ من الأسمدة النيتروجينية المعدنية علي الأقل وبالتالي المساعدة في الحد من تلوث وسط النمو بالأسمدة المعدنية.