J. Product. & Dev., 22(3): 697- 713 (2017)

YIELD AND QUALITY OF GLOBE ARTICHOKE *(Cynara scolymus* L.*)* AS AFFECTED BY BIO AND MINERAL NK FERTILIZER LEVELS

Nagwa A. Mohamed, Usama M. Saif El-deen, Abd El-Monuem M. Abd El-Hameid
Potato and Vegetatively Propagated Crops Dept., Hort. Res. Inst., A.R.C., Egypt.

ABSTRACT

A field experiment was carried out at Baramoon Research Station, Mansoura, Dakahlya Governorate, during the two seasons of 2013/2014 and 2014/2015, to study the effect of bio and mineral NK fertilizer levels and their combinations on plant growth, productivity and quality of globe artichoke cv. Hyrious. Algae extracts (Bluegreen), and potassium dissolving bacteria i.e., Baccillus circulans (potssioumag) were used as biofertilizer sources for N and K, respectively beside mineral NK levels.

Results showed that *the superiority values of plant survival, plant height and number of leaves were detected with decreasing the recomended NK mineral dose to 75% plus biofertilizers twice / season. The same combination treatment significantly produced the highest early and total yield, moreover, the mixture of full mineral dose (100%) and biofertilizers significantly proved superiority in total yield compared with the control. In addition, biofertilizers plus 75% or 100% mineral NK reflected improvements in all measured parameters of flower head, i.e., weight, length and diameter as well as receptacle, i.e., weight, length and thickness as compared to the mineral fertilizing alone. Whereas, the highest values in all of these parameters were recorded may be due to the combination between 75% NK mineral dose and biofertilizers twice a season. In addition, the highest quality expressed as the highest values of inulin, total carbohydrates and lowest value of fiber percentage was recorded by using 75% mineral NK and biofertilizers twice / season. Concerning NK receptacle content, the highest values were recorded as a result of fertilizing the plants by 75% mineral NK plus biofertilizers twice / season.*

Conclusively, *this study suggests that using biofertilizers twice / season could be useful for saving 25% of the recommended mineral*

NK with improving in survival plants, vegetative growth parameters, early and total yield as well as its quality.

Keywords: Globe artichoke, Nitrogen, Potassium, *Baccillus circulans,* cyanobacteria (bluegreen algae)

INTRODUCTION

Globe artichoke *(Cynara scolymus* L.*)* is consider one of the most important vegetable crops due to its high nutritive and medical values. Recently artichoke is ranked as a fourth of the top ten foods that provide the largest proportion of antioxidants in the ration per nutritional due to its high content of antioxidants (phenols) (Halvorsen *et. al.*, 2006). Egypt has appropriate environmental conditions for globe artichoke which encourage promoting its productivity to satisfy the increased demands for both local and foreign markets resulting in ranking Egypt the second world producer of this crop (F.A.O., 2013).

Nitrogen and potassium are considered of the most limiting factors for plant growth and productivity; the soil deficiency of them is met by fertilizers. Using chemical fertilizers for a long time has resulted not only in the deterioration of soil health but also has led to some major environmental problems, such as greenhouse effect, ozone layer depletion, soil and water pollution and other health related problems as well as increasing the input cost for crop production. Besides, only one to two percent of potassium, presented in soil or applied as mineral fertilizers, is available to plants while the rest is being bound with other minerals and becomes unavailable to plants (George and Michael, 2002).

Soil microorganisms, *i.e*. nitrogen fixing cyanobacteria (bluegreen algae) influence the availability of soil minerals, playing a central role in ion cycling and soil fertility leading to reduce the need to mineral fertilizers (Adam, 1999; De-Mule *et al.*, 1999; Sergeeva, 2002; Cocking, 2003 and Bin Lian *et al.*, 2010). Besides, cyanobacteria produce growth promoting hormones that increase root and shoot growth (Venkataraman, 1993 and Cocking, 2003). Moreover, foliar spraying of algae compounds improved vegetative growth parameters and mineral content of tomato seedlings (Al-Khiat, 2006). In addition, Osman *et al.*, (2010) concluded that cyanobacterial addition combined with the half of the recommended dose of the chemical fertilizer was more effective in stimulating growth parameters, crop yield, photosynthetic pigment fractions, carbohydrate and protein contents of pea seeds than either its combined with the full dose or the control treatment. They suggested that this positive effect was due to their

release of various biologically active, *i.e.* exopolysaccharide, gibberellins, auxin and cytokinins. Likwise, foliar spraying of algae compounds improved artichoke establishment (Jahanian *et al.*, 2012) beside vegetative growth, qualitative and quantitative of yield and its mineral content of globe artichoke (Negro *et al.*, 2016 and Allahdadi *et al.*, 2016), also, for lettuce (Mohsen *et al.*, 2016). On the other hand, application of potassium dissolving bacteria promoted the vegetative growth, increased early and total yield and improved artichoke head quality traits (Sorial *et al.*, 1998; Shams, 2014 and Mohamed and Ali, 2016) as well as for egg plant (Nayak, 2001; Ramarethinam and Krishan 2006). Moreover, its enhancing N, P and K uptake of eggplant, (Han and Lee, 2005) as well as pepper and cucumber plants (Han *et al.*, 2006). In the same concern, (Sheng *et al.*, 2008) suggested that the plant growth promotion was related to K solubilization plus the release of organic acids by the potassium solubilizing strains. Bakr *et al.* (2009) showed that fertilizing artichoke with potassiumag (*B. circulans*) improved the productivity and most physical characteristics of heads, as well as, total carbohydrates and inulin contents than potassium mineral fertilizer alone. In addition, vegetative growth, plant dry weight and K uptake of okra plants was positively affected with potassium solubolizing bacteria fertilization (Prajapati *et al.*, 2013).

Therefore, the present study was conducted to investigate the effect of two of biofertilizers types *i.e.* bluegreen algae and *B. circulans* under varying levels of mineral NK on survival plants, vegetative growth, head yield and quality characteristics of globe artichoke plants.

MATERIALS AND METHODS

A field experiment was conducted at the Baramoon Research Station, Mansoura, Dakahlia Governorate, Egypt (+ 7m altitude, 30^{o} 11^{-} latitude and 28^{o} 26^{-} longitude), during seasons of 2013/2014 and 2014/2015, to study the effect of interaction between biofertilizers; algae extracts (Bluegreen), and potassium dissolving bacteria (KSB) *i.e.*, *Baccillus circulans* (Potssioumag) with NK mineral fertilizer levels on productivity, and quality of globe artichoke cv. Hyrious.

Potssioumag:- It was mixed with wet soft dust at (1:10 ratio). It was applied to the root absorption zone of plants, just before irrigation, once at 15 or twice at 15 and 45 days after transplanting, at the rate of 3 kg/fed.

Bluegreen:- It was applied to plants as foliar spray once at 30 or twice at 30 and 60 days after transplanting, at the rate of 2ml /L.

Both (potssioumag + bluegreen) were tested by plant pathology Res. Institute., Agric. Res. Center at El-Giza.

The potssioumag + bluegreen are commercial name in Egypt were taken from General Organization for Agriculture Equalization fund (GOAEF), Ministry of Agriculture, Egypt.

The stumps were planted on 15th and 20th of August in the 1st and 2nd seasons, respectively and treated pre-planting with fungicides for 30 minutes and planted at 1 m apart between each two plants on the ridge and 1 m between the ridges.

Physical and chemical properties of the experimental soil at the depth of 0-30 cm were determined according to Page (1982) as shown in Table 1.

A complete randomized blocks design with three replicates was used, plot area was 25 m^2; consisted of 5 ridges; 5 m long and 1 m width. The experiment included 9 treatments, which were as follows:

1. Recommended full dose of mineral NK at the rate of 120 kg N fed^{-1} and 96 kg K_2O fed^{-1} (Control).
2. Potssioumag + bluegreen (Once / season)
3. Potssioumag + bluegreen (Twice / season)
4. 50% mineral NK + (potssioumag + bluegreen, once / season)
5. 50% mineral NK + (potssioumag + bluegreen, twice / season)
6. 75% mineral NK + (potssioumag + bluegreen, once / season)
7. 75% mineral NK + (potssioumag + bluegreen, twice /season)
8. 100% mineral NK + (potssioumag + bluegreen, once / season)
9. 100% mineral NK + (potssioumag + bluegreen, twice / season)

- Half of the mineral NK rates were added to the plants soil before planting and the other half at 30 days after planting, however, P_2O_5 and the other agricultural practices were conducted according to the recommendations of Ministry of Agriculture.

Recorded data:

The following data were recorded:

- A random, sample of three plants from each plot were randomly taken at 120 days after planting to measured vegetative growth parameters *i.e.*, plant survival (%), plant height (cm) and number of leaves per plant.
- Early yield/ plot: was calculated from the start of harvest until the end of February.
- Number of flower heads/plot.
- Total yield (kg)/plot.
- Number of flower heads/fed. and total yield/fed: they were calculated.

Table 1: Some physical and chemical properties of the experimental soil.

Some physical properties	Values		Some Chemical Properties	Values	
	2013/14	2014/15		2013/14	2014/15
Sand (%)	27.8	28.0	pH value	8.1	7.9
Silt (%)	31.6	31.9	EC dSm^{-1}	0.9	0.8
Clay (%)	40.6	40.1	Total N (%)	0.03	0.04
Texture class	**Clay-loam**	**Clay-loam**	Available N (ppm) NH_4-N NO_2-N NO_3-N	 23.37 0.162 13.21	 23.00 0.126 13.12
$CaCO_3$ (%)	3.1	3.2	Available P (ppm)	12.3	12.1
Organic matter (%)	1.4	1.6	Available K (ppm)	304	295

- based on their values per plot.
- Average weight, length and diameter of flower head.
- Average weight, length and thickness of receptacle.
- Some nutrients and chemical composition:

Samples of receptacles at 120 days after planting were dried in an electric oven at 70°C till constant weight then finely ground and wet digested for N, P and K determinations. N, P and K were determined according to (A.O.A.C., 1990). Total sugars were determined according to Forsec (1938). Inulin was determined according to Winton and Winton (1958). Fiber percentage was determined according to (A.O.A.C., 1990).

Statistical analysis:

The data of both experiments were subjected to proper statistical analysis of variance according to Snedecor and Cochran, (1982) and means were compared according LSD at 5 % level.

RESULTS AND DISCUSSION

Vegetative growth:

Presented data in Table 2, generally, clear that the combination between biofertilizers and NK mineral source significantly improved vegetative growth parameters. The superiority values of survival plants , plant height and number of leaves was detected with decreasing the mineral NK to 75% plus biofertilizers twice a season while the dose of 50% mineral NK plus the same rate of biofertilizers gave similar results of

Table 2: Effect of bio and mineral NK fertilizer levels on plant survival plants (%) and vegetative growth of globe artichoke during 2013/2014 and 2014/2015 seasons.

Treatments	Survival plants %		Plant height (cm)		No of leaves/plant	
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
100% mineral + 0 bio fert. (control)	89.6 bc	87.3cd	60.1 bc	67.6 bc	29.8 bc	29.1 d
Bio fert. Once/season	75.4 e	77.6e	37.8 e	42.8d	26.1 e	27.1 e
Bio fert. Twice/season	79.2 e	79.6 e	44.2 de	45.5d	27.1 de	27.1 e
50% mineral + Bio fert. Once/season	85.2 cd	83.4 d	48.1 de	60.2 c	28.4 cd	27.8 e
50% mineral + Bio fert. Twice/season	86.8 bc	84.5 d	50.5 cd	62.23 c	28.9 bc	28.2 de
75% mineral + Bio fert. Once/season	95.1 a	97.9a	79.8 a	80.0 a	31.7 a	32.6 b
75% mineral + Bio fert. Twice/season	97.8 a	98.9a	77.2 a	82.3 a	32.6 a	34.6 a
100% mineral + Bio fert. Once/season	88.7 bc	90.8bc	63.4 b	74.0ab	30.0 b	29.3 d
100% mineral + Bio fert. Twice/season	90.1 b	93.1b	65.7b	76.2ab	29.6bc	31.0 c

Means in each column, followed by similar letter(s) are not significantly different at 5% probability Level, using Duncan's Multiple Range Test

the recommended application (control). In contrast, plants received biofertilizers alone, either once or twice a season gave the lowest values. In this connection, plant growth-promoting bacteria have been reported to be a key for plant establishment. Similar effect of potassium solubilizing bacteria was detected by Han and Lee (2005) and (Prajapati *et al.*, 2013) on okra and for algae compounds by (Mohsen *et al*., 2016) on lettuce. In addition, the application of K solublizing bacteria with N fixing bacteria, similar to those of (Jahanian *et al.*, 2012), positively influenced seedling artichoke establishment and its vegetative growth parameters. Reduction in agro-chemical use supporting ecofriendly crop production was detected by (Ghoneim, 2005; Vernieri *et al.*, 2006 and Osman *et al.*, 2010).

Yield and number of flower heads:

Data in Table 3 reveal that the combined treatment 75% mineral NK with biofertilizers twice / season significantly recorded the highest early yield in comparison to the other tested treatments in the two seasons. Moreover, no significant difference was found between plants received 75% mineral NK plus biofertilizers for one time and the later for two times with the full NK dose, while, they proved superior comparing with the control treatment.

As for, the effect of combined biofertilizers with mineral NK on total yield and number of flowers, the same data in Table 3 exhibit that the application of 75% mineral NK plus biofertilizers twice / season gave the highest values in comparison to the other treatments followed by plants received biofertilizers once a season with the same NK dose. Moreover, the mixture of 100% mineral NK plus biofertilizers significantly proved superiority for them compared with the control during the two experimental seasons. Conversely, applying biofertilizers alone (once or twice/season) produced the lowest total yield expressed as weight and number of heads showing that the application of biofertilizers alone, at these rates and conditions, could not fulfill the nutritional requirements of artichoke plants.

The beneficial effects of blue-green algae (Adam,1999; De-Mule *et al.*, 1999; Sergeeva *et al.*, 2002 and Cocking, 2003) may be due to their excretion of many types of active substances such as growth regulators, vitamins, amino acids that improve plant growth and productivity, besides, polysaccharides that help in soil aggregation and water retention (Maqubela *et. al.*, 2009), moreover, cyanobacteria play a key role in sustained nitrogen management and soil fertility, which is known to be responsible for maintaining sustainable yield as explained by (Singh,1961) and exhibited a tendency to lower the pH (Jaiswal *et al.*, 2010). This effect of KSB is might be due to its ability to produce organic acids like oxalic acid and tartaric acids and also due to its secretion of capsular polysaccharides which helps in dissolution of minerals to release potassium (Malinovskaya *et. al.*, 1990, Friedrich *et. al.*, 1991; and Sheng and Huang 2002), in addition to produce amino acids, vitamins and growth promoting substances like indole-3-acetic acid (IAA) and gibberellic acid (GA_3) which help in better growth of the plants (Ponmurugan and Gopi, 2006).

Such conditions may facilitate nutrient uptake resulting in a good nutritional balance leading to a balanced vegetative growth which reflected on early and total yield expressing as number of heads. In this concern, Emad El-Din *et al.*, (2004) demonstrated that biofertilizers could be

Table 3: Effect of bio and mineral NK fertilizer levels on early and total yield and number of flowers of globe artichoke during 2013/14 and 2014/15 seasons.

Treatments	Early yield ton\fed		Total yield ton\fed		Number of heads (1000 fed.-1)	
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
100% mineral + 0 bio fert. (control)	1.739 d	1.781 d	9.262 e	9.252 e	39.130e	39.782c
Bio fert. Once/season	1.004 f	1.031 f	6.068 i	6.121 h	24.141h	25.212e
Bio fert. Twice/season	1.046 f	1.092 f	6.372 h	6.400 g	27.401g	27.672e
50% mineral + Bio fert. Once/season	1.684 e	1.717 e	8.917 g	8.796 f	36.100f	36.171d
50% mineral + Bio fert. Twice/season	1.705 e	1.743 e	9.038 ef	9.035e	37.403f	36.012d
75% mineral + Bio fert. Once/season	1.830 b	1.917 b	9.800 b	10.214 b	42.141b	43.623 ab
75% mineral + Bio fert. Twice/season	1.882 a	1.969 a	10.103a	10.442 a	44.432a	45.973a
100% mineral + Bio fert. Once/season	1.787 c	1.848 c	9.470d	9.680 cd	40.722cd	41.612b
100% mineral + Bio fert. Twice/season	1.826 b	1.922 b	9.591c	9.895 c	41.242bc	42.753b

Means in each column, followed by similar letter(s) are not significantly different at 5% probability Level, using Duncan's Multiple Range Test.

efficient in reducing chemical fertilizers where no significant difference was detected between biofertilizers plus (½ NK) and control (recommended NK) regarding vegetative growth and barley yield attributes. The present results matched well with those obtained by (Sorial *et al.*; 1998), Sarli and Calabrese (2004), Ghoneim, (2005), Bakr *et al.* (2009), Shams (2014), Allahdadi *et al.* (2016), Negro *et al*. (2016) and Mohamed and Ali (2016) on artichoke, as well as, (Osman *et al.*, 2010) on pea.

Head quality characteristics:

As shown in Table 4 that, fertilizing plants with 75% or 100% mineral NK plus biofertilizers reflected positive improvements in all measured parameters

Table (4): Effect of bio and mineral NK fertilizer levels on flower and receptacle characters of globe artichoke during 2013/2014 and 2014/2015 seasons.

Treatments	Flowers						Receptacles					
	Weight (gm)		Length (cm)		Diameter(cm)		Weight (gm)		Diameter (cm)		Thickness (cm)	
	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
100% mineral + 0 bio fert. (control)	223.40 e	230.27 c	11.63 c	11.73 cd	8.53 c	9.14 c	46.05 d	50.69 c	4.87 bc	5.07 cd	2.15 de	2.28 de
Bio fert. Once/season	153.50 i	164.47 g	9.40 g	8.67 g	6.63 f	6.81 g	32.20 h	37.25 g	3.93 f	3.98 g	1.70 g	1.68 f
Bio fert. Twice/season	169.23 h	178.90 f	10.03 f	9.73 f	7.05 e	7.81 f	38.45 g	40.40 f	4.17 e	4.39 f	1.81 f	1.77 f
50% mineral + Bio fert. Once/season	202.20 g	201.30 e	10.77 e	10.80 e	8.20 d	8.00 e	40.66 f	44.71 e	4.53 d	4.78 e	2.05 e	2.14 e
50% mineral + Bio fert. Twice/season	215.27 f	212.57 d	11.00 de	11.37 d	8.45 c	8.16 d	43.06 e	47.08 d	4.72 c	4.95 de	2.12 e	2.15 e
75% mineral + Bio fert. Once/season	247.03 b	254.93 b	13.47 b	12.60 b	9.08 b	9.41 b	50.09 b	55.21 b	5.01 b	5.45 b	2.36 b	2.53 ab
75% mineral + Bio fert. Twice/season	258.93 a	269.67 a	14.40 a	13.10 a	9.58 a	9.68 a	52.81 a	60.22 a	5.37 a	5.81 a	2.48 a	2.64 a
100% mineral + Bio fert. Once/season	230.10 d	231.87 c	11.40 cd	12.17 bc	8.96 b	8.98 c	47.59 c	51.39 c	4.91 b	5.23 c	2.24 cd	2.31 cd
100% mineral + Bio fert. Twice/season	237.30 c	252.70 b	11.73 c	12.33 b	8.80 b	9.12 c	49.33 b	54.60 b	4.96 b	5.24 c	2.29 bc	2.43 bc

Means in each column, followed by similar letter(s) are not significantly different at 5% probability Level, using Duncan's Multiple Range Test

of flower, *i.e.*, weight, length and diameter as well as receptacle, *i.e.*, weight, length and thickness as compared to the mineral fertilizing alone. In this connection, the highest values in all of these parameters were recorded due to combination between 75% mineral NK plus biofertilizers twice / season, in contrast, using biofertilizers alone gave the worst characteristics in case of both flowers and receptacles. Similar improvements in quality parameters were found by Lozano *et al*. (1999) who stated that the application of an extract from algae to soil or foliage increased protein and carbohydrate contents of potatoes. Moreover, obtained results are agree with those reported by Sorial *et. al.*, (1998); Ghoneim, (2005); Shams (2014) and Negro *et. al*., (2016).

The ability of biofertilizers in improving quality, in addition to increasing availability of elements in roots rhizosepher, could be due to changing the microflora in the rhizosphere and affecting the balance between harmful and beneficial organisms as well as enhancing soil microbial biomass carbon, nitrogen fixing potential and related soil microbiological parameters (Apte and Shende, 1981), besides, El-Hadad *et. al.* (2011) stated that inoculation of *B. circulans* as KSB had a biological control effect which resulted in a reduction in nematode population comparing with the un-inoculated nematode-infested tomato.

Chemical constituents of receptacle:

Data in Table 5 indicate that fertilization plants with mineral NK plus biofertilizers tended to increase the inulin and total sugars percentages in flower head edible part (receptacle). Conversely, it tended to decrease fiber percentage in both seasons. In this connection, the highest quality expressed as inulin, total carbohydrates and fiber percentages were recorded in case of using 75% mineral NK plus biofertilizers twice / season as compared with the other tested treatments. Moreover, the lowest value of fiber % in flower head edible part was scored by the biofertilizers alone in the two seasons. In this connection, such increment resulting in biofertilizers was detected by (Osman *et al.*, 2010) on pea and Mohamed and Ali (2016) on artichoke.

As for the effect of fertilization treatments on the mineral content of receptacles, the same data in Table 5 refer that both N and K were significantly affected by the combination treatments during the two seasons of study. In this respect, the highest values of N and K were recorded as a result of fertilizing the plants by 75% mineral NK combined with biofertilizers twice /season whereas, the lowest values were scored by the

Table (5): Effect of bio and mineral NK fertilizer levels on chemical composition of globe artichoke receptacles during 2013/2014 and 2014/2015 seasons.

Treatments	Total sugars%		Inulin%		Fiber%		N%		P%		K%	
	2013/14	2013/14	2013/14	2013/14	2013/14	2013/14	2014/15	2013/14	2014/15	2014/15	2014/15	2014/15
100% mineral + 0 bio fert. (control)	3.03 b	3.11b	1.67c	1.68 c	8.00 a	8.00a	2.93 c	3.20 c	0.294a	0.305a	2.89 c	2.94 c
Bio fert. Once/season	2.14 c	2.09 d	1.00 e	1.29 d	6.00de	6.05de	1.80 d	2.53 e	0.110b	0.120b	2.00 d	2.01 d
Bio fert. Twice/season	2.17 c	2.12 d	1.03 e	1.28 d	5.86 ef	6.00 e	2.00 d	2.65 e	0.113b	0.122b	2.07 d	2.01 d
50% mineral + Bio fert. Once/season	3.00 b	3.00 b	1.54 d	1.65 c	6.35 d	6.33d	2.70 c	2.90 d	0.273a	0.284a	2.80 c	3.07 c
50% mineral + Bio fert. Twice/season	3.14 b	3.13 c	1.58 d	1.68 c	6.00 de	6.00e	2.76 c	2.90 d	0.284a	0.294a	3.00 c	3.12 c
75% mineral + Bio fert. Once/season	3.57 a	3.50 a	1.82 a	1.87ab	6.80cd	6.80cd	3.24 a	3.80 a	0.316a	0.347a	3.65ab	3.67ab
75% mineral + Bio fert. Twice/season	3.57 a	3.57 a	1.87 a	1.90 a	6.00 f	6.00e	3.36a	3.87a	0.330 a	0.357a	3.75 a	3.78 a
100% mineral + Bio fert. Once/season	3.69 a	3.23ab	1.67bc	1.76 b	7.74ab	7.76ab	2.97bc	3.41b	0.294a	0.315a	3.48 b	3.53 b
100% mineral + Bio fert. Twice/season	3.54 a	3.54 a	1.73b	1.78 b	7.30bc	7.32bc	3.08ab	3.77a	0.302a	0.336a	3.50b	3.53 b

Means in each column, followed by similar letter(s) are not significantly different at 5% probability Level, using Duncan's Multiple Range Test

plants received only biofertilizers in the two experimental seasons. Regarding P content in the head edible part, although, combination between bio and mineral fertilizers tend to increase P content, but no significant differences were detected among the investigated treatments except for the plants received only biofertilizers where they recorded the lowest values. Biofertilizers effect could be due to its assistance in the plant uptake of several vital nutrients, such as N and K from soil as revealed by (Sheng *and Huang*, 2002). Whereas, such results are in a harmony with those of Han and Lee (2005), (Al-Khiat, 2006), Han *et. al.*, (2006) on eggplant, pepper and cucumber plants, respectively as well as on globe artichoke (Mohamed and Ali, 2016).

Conclusively, this study conclude that replacing 25% of recommended mineral NK with biofertilizers positively affected plant growth, productivity and quality. Consequently, it could be useful for a reduction of deterioration of soil health as well as water pollutions in addition to the decrement of the input cost.

REFERENCES

Adam, M. S. (1999). The promotive effect of the cyanobacterium *Nostoc muscorum* on the growth of some crop plants. *Acta Microbiologica Polonica.* 48(2):163-171.

Al-Khiat, S. H. A. (2006). Effect of Cyanobacteria as a Soil Conditioner and Biofertilizer on Growth and Some Biochemical Characteristics of Tomato (*Lycopersicon esculentum* L.) Seedlings. (M.Sc.) Thesis, Botany and Microbiology Dept., Fac. Sci., King Saud University.

Allahdadi, M., Y. Raei, B. Bahreininejad, A. Taghizadeh and S. Narimani (2016). Effect of chemical and biological fertilizers on quantitative and qualitative yield of artichoke (*Cynara scolymus* L.). *Biological Forum – An International Journal* , 8(1): 500-508.

A.O.A.C. (1990). *Official Methods of Analysis.* 15th ed. A.O.A.C., Washington, Dc, USA.

Apte, R. and S.T. Shende. (1981). Studies on Azotobacter chroococcum IV. Seed bacterization with strains of *Azotobacter chroococcum* and their effect on crop yield. *Zbl. Part.*, 11(136): 837-640.

Bakr, A. A., R. A. Gawish, E. M. Abdeen and H. S. Hegazy. (2009). Utilization of cooperation between agricultural trails and technological evaluation of artichoke to prepare biscuits for diabetics. *J. Agric. Res*., 34 (3): 1087-1103.

Bin Lian , Bin Wang , Mu Pan , Congqiang Liu , H. Henry Teng.(2010). Microbial release of potassium from K-bearing mineralsby thermophilic fungus *Aspergillus fumigatus. Geochimica et Cosmochimica Acta* , 72(8): 87–98.

Cocking, E. C. (2003). Endophytic colonisation of plant roots by nitrogen-fixing bacteria. *Plant and Soil*, 252:169-175.

De-Mule, M.C.Z., de G.Z. Caire, de M.S. Cano, R.M. Palma and K. Colombo. (1999). Effect of cyanobacterial inoculation and fertilizers on rice seedlings and post harvest soil structure. *Comm. Soil Sci. Plant Anal.*, 30: 97-107.

El-Hadad M.E., M.I. Mustafa1, Sh.M. Selim1, T.S. El-Tayeb, A.E.A. Mahgoob and N. H. Abdel Aziz. (2011). The nematicidal effect of some bacterial biofertilizers on Meloidogyne incognita in sandy soil. *Brazilian J. Microbiology*, 42:105-113.

Emad El-Din, H. M.; Rashad, M. H. and Ismail, E. A. (2004). Efficiency of biofertilizers in improving drought stress tolerance in barley. *Egypt. J. Biotechnol.* , 18.

F.A.O. (2013). Production of globe artichoke. *FAO Quarterly Bulletin Of Statistics* , 12: 314.

Forsec, W. T. Jr. (1938). Determination of Sugar in Plant Materials by a Photochlorimetric method. *Induce. Eng. Chem. Anal*. 10th ed.411-418.

Friedrich, S.N.P., Platonova, G.I., Karavaiko, E., Stichel and Glombitza, F. (1991). Chemical and microbiological soluiblization of silicates. *Acta. Biotech*,11: 187-196.

George, R. and S.Michael (2002). Potassium for crop production. Communication and Educational Technology Services, University of Minnesota Extension. In: **Sangeeth, K. P., R. Suseela Bhai and V. Srinivasan. (2012)**. Paenibacillus glucanolyticus, a promising potassium solubilizing bacterium isolated from black pepper (*Piper nigrum* L.) rhizosphere. *Journal of Spices and Aromatic Crops*., 21 (2): 118–124.

Ghoneim, I. M. (2005). Effect of biofertilizer types under varying nitrogen levels on vegetative growth, heads yield and quality of globe artichoke (*Cynara scolymus*, L.). *J. Agric. & Env. Sci. Alex. Univ*., Egypt.4 (2):42-53.

Halvorsen, B.L., Carlsen, M.H., Phillips, K.M. ,Bøhn, S.K. Holte, K ., Jacobs Jr, D.R. and Blomhoff. R. (2006). Content of redox-active compounds (i.e. antioxidants) in foods consumed in the United States. *Am. J. Clin. Nutr*., 84:95-135.

Han, H.S. and Lee K.D. (2005). Phosphate and potassium solubilizing bacteria effect on mineral uptake, soil availability and growth of eggplant. *Res. J. Agric. Biol. Sci.*, 1(2):176-180.

Han, H. S., Supanjani and K. D, Lee. (2006). Effect of co-inoculation with phosphate and potassium solubilizing bacteria on mineral uptake and growth of pepper and cucumber. *Plant Soil Environ*., 52 (3): 130–136.

Jahanian, A.; M. R. Chaichi; K. Rezaei; K. Rezayazdi and K. Khavazi. (2012). The effect of plant growth promoting rhizobacteria (PGPR) on germination and primary growth of artichoke (*Cynara scolymus* L.). *Intl J. Agric. Crop Sci.*, 4 (14): 923-929.

Jaiswal, P., A. K. Kashyap, R. Prasanna and P. K. Singh, (2010). Evaluating the potential of *N. calcicola* and its bicarbonate resistant mutant as bioameleorating agents for 'usar' soil. *Indian J. Microbiology*, 50 (1):12-18

Lozano, M. S., J. Star Verde, R. K. Maiti, C. A. Oranday, R. H. Gaona, H. E. Aranda and G. M. Rojas. (1999). Effect of an algal extract and several plant growth regulators on the nutritive value of potatoes (*Solanum tuberosum* L. *var. Gigant*). *Archives Latinoamericanos de Nutricion*, 49: 166-170.

Malinovskaya, I. M., L. V. Kosenko, S. K. Votselko, V. S. Podgorskii. (1990). Role of Bacillus mucilaginosus polysaccharide in degradation of silicate minerals. *Mikrobiologiya*, 59, 49–55.

Maqubela, M.P., P. N. S. Mnkeni, O. Malam Issa, M. T. Pardo, L. P. D'Acqui. (2009). Nostoc cyanobacterial inoculation in South African agricultural soils enhances soil structure, fertility, and maize growth. *Plant Soil*, 315: 79–92

Mohamed, M. H. and M. M. E. Ali. (2016). Effect of phosphorus fertilizer sources and foliar spray with some growth stimulants on vegetative growth, productivity and quality of globe artichoke. *Inter. J. Plant & Soil Sci*., 13 (1): 1-15.

Mohsen, A. A. M., A. S. A. Salama and F. M. A. El-Saadony. (2016). The effect of foliar spray with cyanobacterial extracts on growth, yield and quality of lettuce plants (*Lactuca sativa* L.). *Middle East J. Agric. Res.*, 5 (1):90-96.

Nayak, B. (2001). 'Uptake of potash by different plants with the use of potash mobilizing bacteria *Frateuria aurantia*.' Ph.D. Thesis submitted to Orissa University of Agric. Sci. Tech., Bhubaneswar, India.

Negro D., V. Montesano, G. Sonnante, P. Rubino, A. De Lisi and G. Sarli (2016). Fertilization strategies on cultivars of globe artichoke: Effects on yield and quality performance. *J. Plant Nutrition*, 39(2): 279 – 287.

Osman, M. E. H, M. M. El-Sheekh , A. H. El-Naggar, S. F. Gheda, (2010). Effect of two species of cyanobacteria as biofertilizers on some metabolic activities, growth, and yield of pea plant. *Bio. Fertil. Soils*, 46:861–875.

Page, A. L. (1982). *Methods of Soil Analysis*. 2nd Ed., Part 1, Soil Sci. Soc. Amer., Madison, Wisc., USA.

Ponmurugan, P. and C. Gopi. (2006). In vitro production of growth regulators and phosphatase activity by phosphate solubilizing bacteria. *Afr. J. Biotechnol*., 5 (4): 348-350.

Prajapati, K., M.C. Sharma and H.A. Modi. (2013). Growth promoting effect of potassium solubilizing microorganisms on okra (*Abelmoscus esculantus* L.). *Inter. J. Agric. Sci. Res*., 3 (1):181-188.

Ramarethinam, S. and C. Krishan. (2006). Studies on the effect of potash solubilizing/mobi- lizing bacteria Frateuria aurantia on brinjal (*Solanum melongena* L.) growth and yield. *Pestol*., 30: 35–39.

Sarli, G., and N. Calabrese. (2004). Influence of biostimulating products on irrigated artichoke crop in Southern Italy. *Acta Horticulturae*, 660: 173-179.

Sergeeva, E., Liaimer, A. Bergman, B. (2002). Evidence for production of the phytohormone indole-3-acetic acid by cyanobacteria. *Planta*, 215: 229-238.

Shams AS. (2014). Effect of silver nano-particles and mycorrhizae symbiosis on the development of artichoke. *Int. J. of Agric. Sci. and Res.*, 4(5):27-36.

Sheng, X. F. and Huang, W. Y. (2002). Mechanism of potassium release from feldspar affected by the strain NBT of silicate bacterium. *Acta Pedologica Sinica*, 39 (6):863–871 (in Chinese, with English abstract).

Sheng X.F.;F. Zhao; l.H. He; G.Qiu, and L.Chen (2008). Isolation and characterization of silicate mineral solubilizing *Bacillus globisporus* Q12 from the surface of weathered feldspar. *Canadian J. Microbiology*, 54: 1064-1068.

Snedecore, G. W. and W. G. Cochran (1982). *Statical Methods*. 7th ed., Iowa State Univ. Press, Ames., Iowa, USA.

Sorial, M.E.; M.A. Abd El-Fattah and I.M. Ghoneim. (1998). Some attempts to changes the production pattern of globe artichoke to meet export requirements. II. Physiological changes in plant growth, biochemical composition, earliness and productivity of globe artichoke plants (*Cynara scolymus,* L.) following biofertilizer application and the influence of their interaction on the production pattern of heads. *Annals Agric. Sc., Moshtohor*, 36(2): 879-899.

Singh, R.N. (1961). Role of blue-green algae in nitrogen economy of Indian agriculture. *Indian Council Agric. Res.,* New Delhi.

Venkataraman, G. S.,(1993). Blue-green algae (cyanobacteria). pp. 45-76 In: S. N. Tata, A. M. Wadhwani & M. S. Mehdi (Eds.), Biological Nitrogen Fixation. *Indian Council Agric. Res*., New Delhi.

Vernieri, P., E. Borghesi, F. Tognoni, A. Ferrante, G. Serra, and A. Piaggesi. (2006). Use of biofertilizer for reducing nutrient solution concentration in floating system. *Acta Horticulturae*, 718: 477- 484.

Winton, A. L. and K. B. Winton (1958). *The Analysis of Food*. Johan Wiley and Sons, Inc. London.857.

تأثير مستويات التسميد النيتروجينى والبوتاسى الحيوى والمعدنى على المحصول والجودة للخرشوف

نجوى عبدالنبى محمد ، اسامه محمد سيف الدين ، عبد المنعم محمد عبد الحميد
قسم بحوث البطاطس والخضر خضرية التكاثر – معهد بحوث البساتين- مركز البحوث الزراعية- مصر.

اجريت تجر به حقليه بمحطة البرامون للبحوث الزراعية ، الم نصورة محافظة الدقهليه خلال موسمى 2014/2013 ، 2015/2014 وذلك لدراسة تأثير مستويات التسميد النيتروجين والبوتاسيوم الحيوى والكيماوى على نمو النبات والانتاجية وجودة نورات الخرشوف صنف هيرس. وكان مستخلص الطحالب الخضراء المزرقة والبكتريا المذيبة للبوتاسيوم باسلس سركيولنس (البوتاسيوماج) هما مصدرى السماد النيتروجينى والبوتاسى الحيوى على التوالى بجانب مستويات السماد النيتروجينى والبوتاسى المعدنى.

وقد اوضحت النتائج ان أعلى القيم للنباتات المتبق يةِ ، ارتفاع النبات ، عدد الاوراق قد سجلت مع تناقص مستوى التسميد النتيروجنى البوتاسى المعدنى بمعدل 75 % من الموصى به مع اضافة السمادى الحيوى مرتين /الموسم. كما

سجلت نفس المعامله زيادة معنوية فى المحصول المبكر والكلى ، وفوق ذلك فكان لاضافة 100% من السماد الكيماوى الموصى به مع اضافة السماد الحيوى تأثيرا مشجعا على المحصول الكلى مقارنة بمعاملة المقارنة. بالاضافة الى ذلك فكان لاضافة الاسمدة الحيوية مع 75 أو 100 % من السماد النتيروجنى والبوتاسى المعدنى الموصى تاثيرا مشجعا على كل الصفات التى تم دراستها مثل صفات رؤوس الخرشوف (وزن وطول وقطر الرأس، وكذلك التخت (الوزن والطول والسمك) مع التسميد المعدنى فقط، وقد لوحظت أعلى القيم لهذه الصفات بمعاملة التفاعل بين مستوى التسميد النتيروجنى البوتاسى المعدنى بمعدل 75 % من الموصى به مع اضافة السمادى الحيوى مرتين /الموسم.

بالاضافة الى ذلك كانت أعلى صفات للجودة متمثلة فى أعلى القيم للأنيولين ، الكربوهيدرات الكليه ، المحتوى من النيتروجين والبوتاسيوم واقل القيم لمحتوى الالياف قد سجلت مع معامله 75 % من الموصى من السماد النتيروجنى البوتاسى المعدنى مع اضافة السمادى الحيوى مرتين /الموسم.

التوصية : من خلال هذه الدراسة نستخلص ان استخدام التسميد الحيوى مرتين / الموسم يمكن ان تقو م بتوفير 25 % من السماد النتيروجنى والبوتاسى المعدنى مع الحصول على نسبة أعلى للنباتات المتبقيه ، صفات النمو الخضرى ، المحصول المبكر والكلى وكذلك صفات الجودة.