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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 by decreasing the recommended 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, using biofertilizers plus 75% or 100% mineral NK reflected improvements in all measured parameters of flower head characters, i.e., weight, length and diameter as well as receptacle, i.e., weight, diameter and thickness as compared to the mineral fertilizing alone. Whereas, the highest values in all of these parameters were recorded due to the combination between 75% NK mineral dose and biofertilizers twice / season. In addition, the highest quality expressed as the highest values of inulin, total carbohydrates and lowest value of fiber percentage were 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 treatment for saving 25% of the recommended mineral NK with improving in survival of plants,* *vegetative growth parameters, early and total yield as well as its quality.*

Keywords: Globe artichoke, Nitrogen, Potassium, *Baccillus circulans,* cyanobacteria (bluegreen algae), yield, head quality.

INTRODUCTION

Globe artichoke *(Cynara scolymus* L.*)* is considered 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 combination 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 solubilizing 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 plants survival, 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 algae:- 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. They 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 Topsin fungicide (2g/L 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.

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

A complete randomized blocks design with three replicates was used, plot area was 25 m^2; it was 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 measure 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 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

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

Treatments	plants survival %		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

vegetative growth parameters. The superiority values of survival plants, plant height and number of leaves were detected with decreasing the mineral NK to 75% plus biofertilizers twice / season while the dose of 50% mineral NK plus the same rate of biofertilizers gave similar results of the recommended application (control). In contrast, plants received biofertilizers alone, either once or twice / 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 agrochemical use supporting ecofriendly crop production was detected (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).

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.

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 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 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. 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) who 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 (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	2014/1	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

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 %		Fibers %		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.

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 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 concluded 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 fertility as well as water pollutions in addition to the decrement of the input cost.

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تأثير مستويات التسميد النيتروجينى والبوتاسى الحيوى والمعدنى على المحصول والجودة للخرشوف

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

اجريت تجربه حقليه بمحطة البرامون للبحوث الزراعية بالمنصورة - محافظة الدقهليه خلال موسمى ٢٠١٣/٢٠١٤ ، ٢٠١٤/٢٠١٥ وذلك لدراسة تأثير مستويات التسميد النيتروجينى والبوتاسي الحيوى والكيماوى (المعدنى) على نمو النبات والانتاجية وجودة نورات الخرشوف صنف هيريوس. 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 لنسبة بقاء النباتات (نسبة النجاح) وارتفاع النبات وعدد الاوراق قد سجلت عند انخفاض مستوى التسميد النيتروجينى والبوتاسى المعدنى الى ٧٥ % من المعدل الموصى به مع اضافة السماد الحيوى مرتين/الموسم. كما سجلت نفس المعامله زيادة معنوية فى المحصول المبكر والكلى. وعلاوة على ذلك، فكان لإضافة ١٠٠% من السماد الكيماوى الموصى به مع إضافة السماد الحيوى تأثيا ايجابيا على المحصول الكلى عن معاملة المقارنة. كما أن استخدام الاسمدة الحيوية مع ٧٥ أو ١٠٠ % من المعدل الموصى به من السماد النيتروجنى والبوتاسى المعدنى عكس تحسنا على كل الصفات التى تم دراستها للرؤوس الزهرية (وزن وطول وقطر الرأس) وتحسنا مماثلا فى صفات التخت (الوزن والقطر والسمك) مقارنة بالتسميد المعدنى منفردا. وقد لوحظت أعلى القيم لهذه الصفات بالتفاعل بين مستوى التسميد النيتروجينى والبوتاسى المعدنى بمعدل ٧٥ % من الموصى به مع اضافة السمادى الحيوى مرتين /الموسم.

بالاضافة الى ذلك كانت أعلى صفات للجودة متمثلة فى أعلى القيم للأنيولين والكربوهيدرات الكليه والمحتوى من النيتروجين والبوتاسيوم واقل القيم لمحتوى الالياف قد سجلت مع معامله ٧٥ % من المعدل الموصى به من السماد النيتروجينى والبوتاسى المعدنى مع اضافة السماد الحيوى مرتين /الموسم.

التوصية : من خلال هذه الدراسة نستخلص ان استخدام التسميد الحيوى مرتين / الموسم قد يفيد فى توفير ٢٥ % من المعدل الموصى به من السماد النيتروجينى والبوتاسى المعدنى مع تحسنا فى نسبة النجاح بعد الزراعة (نسبة بقاء النباتات) وصفات النمو الخضرى والمحصول المبكر والكلى وكذلك صفات الجودة للنورات.