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Response of Sweet Potato Plants to Mineral and Bio-Fertilization

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ABSTRACT

Two field experiments were carried out during the two successive summer seasons of 2016 and 2017 at a private farm near Kafr saad center, Damietta Governorate, Egypt to study the impact of NPK fertilization at (100%, 50% and 0% NPK of the recommended doses) and some bio-stimulants (without, effective microorganisms (EM) 2ml/L, microbial mixture 1L/20L, yeast extract 10g/L and seaweed extract 1g/L) as well as their interaction on yield and its components and quality parameters of sweet potato plants Abees cultiver. Obtained results showed that increasing NPK fertilization levels from 0% to 100% of the recommended doses gave significant increments in total yield/fed, dry matter and quality parameters *i.e.* crude protein (%), total carbohydrates (%), starch%, total sugar %, beta-carotene and vitamin-C (vit.c) in tuberous roots of sweet potato in the two seasons. All bio-stimulants treatments increased significantly of all the previous mentioned parameters and decreased nitrate and nitrite contents in tuberous roots compared with untreated plants, EM gave the best values of all studied parameters. Doses 100 % and 50 % NPK plus EM gave the best significant increases in the studied parameters in both seasons and the interaction between 0% NPK plus EM decreased significantly nitrate and nitrite contents in the both seasons.

Keywords: Sweet potato, NPK fertilizer, EM, microbial mix, yeast, seaweed extract (SWE), yield and its components and quality parameters.

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a perennial root crop. It belongs to Convolvulaceae family. It is considered as a 'poor man's rich food' and the seventh biggest food crop after wheat, rice, maize, irsh potato, barely and cassava and the third of the world root and tuber crops production after potato and cassava (FAO, 2013). Sweet potato has a vital role in human and animal nutrition, health, and industrial uses especially in developing countries (Wang *et al.*, 2011)

Nitrogen (N) is one of the most essential major macronutrients in plant; it is very important in growth and development of crops, formation of yield and improves the quality of vegetables, great importance as a constituent of numerous organic molecules in plant such as chlorophyll, amino acids, enzymes, protein and nucleic acids etc.

Phosphorus (P), also known as a major plant nutrient is essential for plant respiration, cell division, photosynthesis, energy formations, transfer and storage in plants, ion transport across cell membranes, protein and nucleic acid synthesis, helps early growth, early crop maturity, increasing starch synthesis and root developments. Potassium (K) is one of the major essential macronutrients required for plant growth and development and optimizing yield. It plays an important role in energy transport, water content and relations, photosynthesis, translocation of assimilates and increase protein content of plants. Adejobi and Odeniyi (2006) reveled that application of NPK fertilizers increased growth parameter, P, K and Ca contents in leaf and tuber root and total tuber root yield of sweet potato compared with poultry manure treatments. Yeng *et al.* (2012) and Brobbey (2015) showed that combination of fertilizer (15-15-15) NPK increased significantly plant height, fresh vine weight, dry matter and total yield of sweet potato. On sweet potato, Kumabeji (2017) studied two factors, three levels of N (0, 45 and 90 kg /ha^{-1}) and four levels of P (0, 25, 50 and 75 kg/ ha^{-1}) the results showed that application of N and P significantly affected vegetative growth parameters and total marketable tuber root yield, increasing the level of N from 0 to 90 kg / ha^{-1} increased total tuberous root yield. Pushpalatha *et al.* (2017) indicated that applied sweet potato with 125 kg N ha^{-1} along with 100 kg K_2O ha^{-1} recorded significantly the highest values of tuber root length, number of tuberous roots/plant, fresh tuber root weight, increasing total tuber root yield, tuber root dry matter and quality characters *i.e.* total sugar, TSS, carbohydrates and protein over the control. Singh *et al.* (2018) found that sweet potato vine length, number of branches/plant, fresh weight, leaf area, number of leaves/plant and number of tuberous roots were significantly improved by the application of recommended dose of FYM at rate of 10t/ha and 50:25:50 NPK. During the last decade, there is a great concerning on using natural safety products for soil, environment and human health and improving productivity and quality of plants. In this context, EM is a proprietary combination of actinomycetes and photosynthetic bacteria, lactic acid and yeast, helps for balancing nutrition by controlling N fertilizer to be more available for plants, plays important role in converting fixed phosphorus and potassium form to be ready soluble for plant nutrients uptake, this lead to better yield and quality; EM solution consists of useful micro-organisms for plants and soil. Gorski *et al*. (2017) demonstrated that EM influenced positively the content of nutrients in lettuce leaves *e.g.* N, P, K content and some micro elements such as Fe Mg, and Zn. Doklega (2018) indicated that EM treatment at 2ml/L gave the highest significant values on okra, *i.e.* chlorophyll a, b and total, nitrogen, phosphorus and potassium percentages in leaves, crude protein %, crude fibers %, beta carotene, vit-C, total carbohydrates % and total yield/ fed compared with control treatment.

Microbial mixture consists of (*Azotobacter Chroococcum* bacteria, which fix nitrogen; Arbuscular Mycorrhiza fungi which increase phosphorus availability and *Bacillus circulans* bacteria, which make potassium more available. Baddour (2014) indicated that treating potato tubers and onion seedlings with the mixture of multi strains inoculants (*Azotobacter chroccoccum*, *Bacillus circulans and Bacillus megatherium)* gave significantly the highest values of total carbohydrates, crude protein, starch (%) and vit-C (mg/$100g^{-1}$).

Charoonnart *et al.* (2016) showed that inoculation of lettuce with Arbuscular Mycorrhizal fungi increased number of leaves, fresh and dry weight of plant and the yield of butter head lettuce. On artichoke, Abdel Naby *et* *al*. (2017) found that treated soil with Mycorrhiza fungi at the rate of 1L/20 L water improved vegetative growth, yield and yield components and chemical composition.

Yeast is an effective extract to provide plants with minerals (macro and micro-elements), natural cytokinins, vitamins (B1, B2, B3, B5 and B6) and 18 amino acids, which play an important role in improving growth and controlling the incidence of fungi diseases. El-Tohamy *et al.* (2015) found that the application of yeast at 10 ml/L influenced positively some sweet potato plant characters such as plant height, number of branches, fresh weight, total chlorophyll content, relative water content (an indicator of plant water status) of leaves, total soluble solids of roots and total yield as well as root length and diameter. Abo EL-Fadl *et al.* (2017) reported that treating sweet potato (Abees cultivar) with yeast extract gave the highest values of plant length, number of branches/plant and fresh weight/plant as well as maximum values of sugars %, reducing sugars %, beta-carotene %, dry matter % and starch% contents of sweet potato tuberous roots.

Seaweed extract (SWE) contains macro (N, P and K) elements and micro elements (Mn, Co, Cu, Mo, Zn, Ni and Fe) which play an important role in the activation of many enzymes and metabolic processes, also important plant hormones like Auxins, Gibberellins and Cytokinin. Arafa *et al.* (2012) found that spraying application of SWE improved potato tuber quality characters such as total soluble solids and ascorbic acid content. Mohammed (2013) reported that spraying pepper plants with SWE gave positive significant differences in plant height, chlorophyll content %, TSS %, vit.C, total yield, fruit diameter, fruit length, fresh and dry weight of fruit as compared to untreated plants. Helaly *et al.* (2018) indicated that SWE affected vegetative growth characters of tomato plants such as plant height, number of branches/plant, fresh and dry weight of shoots; also chlorophyll content and total yield per plant and ascorbic acid concentration.

The aim of this investigation was to evaluate the response of sweet potato plants to some bio-stimulants as a try to minimize amounts of mineral fertilization to decrease environmental pollution and costs under Damietta conditions.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive summer seasons of 2016 and 2017 at a private farm near Kafr saad center, Damietta Governorate, Egypt to study the effect of NPK and bio stimulants as well as their interaction on yield and its components and quality parameter of sweet potato.

Sweet potato transplants cv (Abees) were cultivated in nursery in the presence of water on 4^{th} and10 th of April in both seasons respectively. The transplants length were about 20-25 cm and were cultivated on plot ridges, ridges length were 10 m, 0.7m width then the plot area was $7m^2$ and were transplanted 0.3m apart on the third top of ridges. All agricultural practices such as hilling weeds, pest and diseases control were permeated according to the Ministry of Agriculture and Land Reclamation recommendation during the growing seasons.

1. Experimental design and treatments:

The experiments were set out in split plot experiment in randomized complete block design with three replicates in both seasons. The experiment includes 15 treatments comprising, 3 levels of NPK fertilizers as soil application and 5 bio-stimulants as soil and foliar application treatments. The main plots were contained of three levels of mineral NPK fertilizers soil application as follow: 100%, 50% and 0% NPK fertilizers of the recommended doses according to the recommendation of the Ministry of Agric and Land Reclamation for sweet potato. Nitrogen fertilizer source is ammonium sulphate (20.5%N) at the rate of 100 Kg/fed, phosphorus fertilizer source is calcium superphosphate (15.5% P_2O_5) at the rate of 200 Kg/fed and potassium sulphate (48% K_2O) as a source of potassium fertilizer at the rate of 100 Kg /fed., N and K fertilizers were applied twice, the first addition was after one month from transplanting and the second one month later, the additions were before irrigation, while P fertilizer was added during soil preparation.

The sub plots were divided to five application treatments of bio-stimulants as follow:

1) Spraying with tap water (Control treatments).
2) Soil application with EM 2 ml/L.
3) Microbial mixture *i.e. Azotobacter chroococcum* bacteria, *Bacillus circulans* bacteria and Arbuscular Mycorrhiza fungi were added to the soil surface beside the plants at the rate of 1L /20L.
4) Yeast extract was sprayed on vegetative growth at concentration of 10g/L.
5) Seaweed extract was applied as foliar spraying at the rate of 1 g/L.

All bio-stimulants treatments were done three times; the first time after 40 days from transplanting and the second and third applications 10 days later respectively.

2. Experimental soil analysis

The soil samples were taken from experimental field area at a depth of (0 to 50 cm) to estimate the mechanical and chemical properties of the soil during 2016 / 2017 as shown in Table 1

Table 1. Some physical and chemical properties of the experimental soil profile during 2016 and 2017 seasons.

Soil properties		2016	2017
Physical characteristics	Fine sand%	10.86	10.72
	Silt%	43.07	42.02
	Clay%	46.07	45.6
	Texture grade	Silty Clay	Silty Clay
	Saturation%	64.30	64.1
	Field capacity%	26.92	26.4
	Egrscopic Humidity%	5.89	5.76
Chemical analysis	CaCo3 %	2.08	2.06
	PH	8.28	8
	EC (dSm^{-1})	2.96	2.74
	Organic matter%	4.23	3.75
Available macronutrients (mg/kg)	Nitrogen	152.05	150.03
	Phosphorus	27.06	27.02
	Potassium	175.86	173.68

According to Table 1, organic matter % is clearly high because of the experimental field was cultivated with legume crop (field beans) before sweet potato cultivation in addition the field was fertilized with 20 m^3 farmyard manure (FYM) during soil preparation.

Data records:

1-Yield and its components:

Harvesting started after 135 days from transplanting.10 samples were taken randomly from each treatment through two seasons to estimate the following parameters:

- Total tuberous roots yield (ton/fed): tuberous roots weight taken on plot bases (kg), then calculated as ton/fed.
- Relative yield %: It is counted from the following equation

$$\mathbf{RY\%} = \frac{\textbf{Total yield ton/fed of each treatment} \times \mathbf{100}}{\textbf{Total yield of the control}}$$

- Dry matter of tuberous roots %. The fresh tuberous roots samples were weighted and oven dried at 70°C until a constant weight was reached then, dry matter calculated in expression of dry matter%. (AOAC, 1975)

2-Tuberous roots quality:

- Total carbohydrates: It was estimated by Hedge and Hofreiter (1962) methods.
- Crude Protein: Crude protein of each sample was recorded by multiplying the total nitrogen by the factor 6.25 according to AOAC (2000).
- Ascorbic acid (vit-C): It was extracted from tuber's juice and titrated with 2.6-diclorophenoindophenol blue dye as described by AOAC (1975).
- Total soluble sugar: It was determined according to the method described by Sadasivam (1996).
- Beta-carotene content: It was estimated by using spectrophotometer according to the method described by Wettestein (1957).
- Nitrate and Nitrite content: It was extracted and determined to the method described by Singh (1988).

All data were statistically analyzed according to technique of analysis of variance (ANOVA) for the split-plots design as published by Gomez and Gomez (1984) by means of "MSTAT-C" Computer software package. Averages were compared using least significant difference (LSD) method at 5% levels of probability according to the procedure outlined by Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of mineral fertilization:

Referring the effect of NPK fertilization levels, it is evident from Tables 2, 3, 4, 5 that fertilization of sweet potato plants with 100% NPK was superior for increasing total tuber root yield (t/fed), tuber root dry matter (%), crude protein (%), total carbohydrates (%), starch (%), total sugars (%),vit-C and beta-carotene also increasing nitrate and nitrite contents in tuber root followed by 50 % NPK treatment. While the lowest values were realized of control treatment (0% NPK). There were less differences between 100% and 50% NPK treatments and this differences were significant. These results may be due to the positive effects of NPK on vegetative growth which reflected on yield and its components and quality parameters of sweet potato. The aforementioned results of mineral fertilizer are in agreement with those stated by Pushpalatha *et al.,* (2017) and Singh *et al,* (2018) on sweet potato.

Table 2. Total tuber root yield and dry matter percentage of tuber root of sweet potato as affected by mineral fertilization levels and some bio stimulants as well as their interaction during 2016 and 2017 seasons.

Characters		Total tuber root yield(t/fed)		Tuber root dry matter (%)		Relative yield (%)		
Treatments		2016	2017	2016	2017	2016	2017	mean
A- Mineral fertilization levels (ratio of the recommended doses):								
100 %		27.43	27.04	16.51	17.76	115.6	115.3	115.4
50 %		26.49	25.84	15.97	17.56	111.7	110.2	110.9
Without		23.71	23.44	15.31	16.00	100	100	100
LSD at 5 %-		0.48	0.54	0.08	0.06			
B- Biostimulants:								
Without		21.83	21.54	15.39	16.36	100	100	100
EM		28.22	27.57	16.62	17.78	129.2	127.9	128.5
Microbial mix		27.71	27.47	16.29	17.44	126.9	127.5	127.2
Yeast		26.90	26.23	15.56	17.14	123.2	121.7	122.4
SWE		24.73	24.38	15.81	16.82	113.2	113.1	113.1
LSD at 5 %		0.53	0.61	0.09	0.08			
C- Interaction:								
	Without	24.47	23.06	15.89	16.84	126.59	111.24	118.9
	EM	29.56	29.13	17.21	18.59	152.92	140.52	146.7
100 %	Microbial mix	28.98	29.13	16.75	18.16	149.92	140.52	145.2
	Yeast	28.03	27.73	16.53	17.84	145.00	133.76	139.3
	SWE	26.13	26.16	16.21	17.40	135.17	126.19	130.6
	Without	21.70	20.83	15.76	16.63	112.26	100.48	106.3
	EM	29.03	28.53	17.03	18.38	150.18	137.62	144.0
50 %	Microbial mix	28.40	28.53	16.66	17.98	146.92	137.62	142.2
	Yeast	27.33	26.23	14.33	17.61	141.38	126.53	133.9
	SWE	26.00	25.06	16.05	17.22	134.50	120.88	127.6
	Without	19.33	20.73	15.02	15.61	100	100	100
	EM	26.06	25.06	15.61	16.38	134.81	120.88	127.8
Without	Microbial mix	25.76	24.76	15.45	16.19	133.26	119.44	126.3
	Yeast	25.33	24.73	15.31	15.98	131.03	119.29	125.1
	SWE	22.06	21.93	15.17	15.83	114.12	105.78	109.9
LSD at 5 %		0.78	0.83	0.21	0.15			

EM: Effective microorganisms. SWE: Seaweed extract.

Microbial mix: ***Azotobacter chroococcum*** **bacteria,** ***Bacillus circulans*** **bacteria and Arbuscular Mycorrhiza fungi.**

Effect of bio-fertilization:

By highlighting the results shown in Tables 2, 3, 4, 5 it was found that all the applied bio-stimulants to sweet potato plants, *i.e*. (EM, microbial mixture, yeast extract and SWE) were significantly decreased the mean values of nitrate and nitrite in sweet potato tuber root and increasing significantly the reminders characters comparing with the untreated plants. EM (2ml /L) recorded the lowest values of nitrate and nitrite followed by microbial mixture during both seasons, also EM treatment increased significantly total tuber root yield (t/fed), tuber root dry matter (%), crude protein (%), total carbohydrates (%), starch (%), total sugars (%), beta carotene and vit-C contents of tuber root of sweet potato compared to untreated plants which gave the lowest values during the both seasons, these results may be due to that EM is a proprietary combination of actinomycetes, photosynthetic bacteria and useful micro-organisms which supply the plants with growth regulators and elicitors results are in accordance with those obtained by Gorski *et al*. (2017) on lettuce and Doklega (2018) on okra.

Table 3. Nitrate and nitrite concentration in fresh sweet potato tuber root as affected by mineral fertilization levels and some bio stimulants as well as their interaction during 2016 and 2017 seasons.

Characters		NO_3-N (ppm)		NO_2-N (ppm)	
Treatments		2016	2017	2016	2017
A- Mineral fertilization levels (ratio of the recommended doses):					
100 %		35.09	37.50	1.493	1.711
50 %		34.33	36.90	1.451	1.612
Without		28.67	32.07	0.782	0.934
LSD at 5 %		0.09	0.11	0.050	0.048
B- Biostimulants:					
Without		34.50	37.02	1.482	1.664
EM		30.07	33.20	0.946	1.103
Microbial mix		31.90	34.79	1.057	1.311
Yeast		32.73	35.46	1.263	1.407
SWE		34.29	36.99	1.463	1.609
LSD at 5 %		0.23	0.17	0.057	0.020
C- Interaction:					
100 %	Without	38.18	40.01	1.943	2.133
	EM	31.96	34.85	1.030	1.330
	Microbial mix	33.47	36.15	1.183	1.510
	Yeast	35.16	37.48	1.547	1.683
	SWE	36.68	39.03	1.763	1.897
50 %	Without	37.48	39.70	1.823	2.030
	EM	31.17	34.10	1.070	1.210
	Microbial mix	32.74	35.47	1.270	1.403
	Yeast	34.35	36.87	1.467	1.610
	SWE	35.93	38.38	1.627	1.807
Without	Without	27.85	31.36	0.680	0.830
	EM	27.07	30.65	0.583	0.770
	Microbial mix	29.50	32.74	0.870	1.020
	Yeast	28.68	32.03	0.777	0.927
	SWE	30.27	33.57	1.000	1.123
LSD at 5 %		0.24	0.30	0.072	0.057

EM: Effective microorganisms. SWE: Seaweed extract
Microbial mix: *Azotobacter chroococcum* bacteria, *Bacillus circulans* bacteria and Arbuscular Mycorrhiza fungi.

Effect of interaction:

Data presented in the same previous Tables show that the interaction between mineral and bio-stimulants fertilizers gave significant effects on all mentioned parameters except total carbohydrates in the second season and beta-carotene in the first season. The interaction between 0% NPK plus EM decreased nitrate and nitrite content in sweet potato tuber root, while the highest mean values of total tuber root yield (t/fed), tuber root dry matter (%), crude protein (%), total carbohydrates (%), starch %, total sugars, B- carotene and vit-C of sweet potato tuber root were recorded from plants treated with 100% NPK from the recommended doses plus EM followed by 50% NPK plus EM in the both seasons, except, total carbohydrate (%) and total sugars (%) recorded the highest values (second season) due to application of 50% NPK + EM. These results may be due to effective role played by interaction between mineral fertilization elements and the effective microorganisms together on plant growth which reflected on yield and its component and quality parameters of sweet potato. These results are in agreement with Khan and Pariari (2012) on cucumber; Arafa *et al*., (2013) on potato; Abdel-Razzak *et al.* (2013) on sweet potato plant and Doklega and Abd El-Hady (2017) on broccoli.

Table 4. Crude protein, total carbohydrates and starch percentages in sweet potato tuber root as affected by mineral fertilization levels and some bio stimulants as well as their interaction during 2016 and 2017 seasons.

Characters		Crude protein (%)		Total carbohydrates (%)		Starch (%)	
Treatments		2016	2017	2016	2017	2016	2017
A- Mineral fertilization levels (ratio of the recommended doses):							
100 %		6.21	7.33	27.18	28.33	9.56	10.32
50 %		5.98	7.06	26.96	28.22	9.40	10.12
Without		4.37	5.00	25.41	26.10	8.40	8.72
LSD at 5 %		0.19	0.21	0.07	0.11	0.07	0.08
B- Biostimulants:							
Without		4.71	5.55	25.81	26.64	8.65	9.06
EM		6.35	7.52	27.28	28.23	9.61	10.36
Microbial mix		5.96	6.95	26.88	28.13	9.38	10.06
Yeast		5.47	6.43	26.50	27.64	9.09	9.73
SWE		5.10	5.85	26.14	27.12	8.88	9.39
LSD at 5 %		0.17	0.13	0.12	0.15	0.12	0.09
C- Interaction:							
100 %	Without	5.17	6.30	26.36	27.36	8.98	9.54
	EM	7.26	8.53	28.08	28.65	10.14	11.07
	Microbial mix	6.80	7.91	27.63	29.12	9.87	10.72
	Yeast	6.13	7.32	27.13	28.57	9.57	10.34
	SWE	5.69	6.57	26.73	27.96	9.26	9.93
50 %	Without	5.06	5.90	26.11	27.05	8.86	9.33
	EM	7.03	8.37	27.86	29.30	10.01	10.88
	Microbial mix	6.50	7.65	27.37	28.85	9.71	10.53
	Yeast	5.90	7.00	26.97	28.26	9.30	10.15
	SWE	5.40	6.38	26.51	27.66	9.13	9.71
Without	Without	3.91	4.46	24.96	25.51	8.10	8.32
	EM	4.75	5.65	25.89	26.73	8.69	9.12
	Microbial mix	4.58	5.31	25.63	26.42	8.57	8.92
	Yeast	4.39	4.96	25.42	26.10	8.41	8.71
	SWE	4.21	4.62	25.17	25.76	8.25	8.52
LSD at 5 %		0.33	0.35	0.22	NS	0.14	0.13

EM: Effective microorganisms. SWE: Seaweed extract.
Microbial mix: *Azotobacter chroococcum* bacteria, *Bacillus circulans* bacteria and Arbuscular Mycorrhiza fungi.

Table 5. Total sugars, beta carotene and vitamin-C contents in fresh sweet potato tuber root as affected by mineral fertilization levels and some bio stimulants as well as their interaction during 2016 and 2017 seasons.

Characters		Total sugars (%)		B. carotene (mg/100 g FW)		Vitamin-C (mg/100gFW)	
Treatments		2016	2017	2016	2017	2016	2017
A- Mineral fertilization levels (ratio of the recommended doses):							
100 %		8.03	7.73	10.87	11.70	21.52	22.52
50 %		7.93	7.66	10.66	11.48	21.31	22.28
Without		7.27	6.93	8.80	10.04	19.85	20.55
LSD at 5 %		0.08	0.13	0.18	0.12	0.08	0.11
B- Biostimulants:							
Without		7.44	7.11	9.62	10.39	20.20	20.98
EM		8.06	7.84	10.96	11.75	21.61	22.58
Microbial mix		7.90	7.58	10.57	11.40	21.24	22.21
Yeast		7.75	7.42	10.21	11.08	20.90	21.79
SWE		7.58	7.24	9.19	10.75	20.53	21.38
LSD at 5 %		0.11	0.17	0.17	0.11	0.12	0.10
C- Interaction:							
100 %	Without	7.66	7.32	9.97	10.88	20.66	21.55
	EM	8.40	8.15	11.76	12.53	22.41	23.44
	Microbial mix	8.21	7.91	11.32	12.10	21.95	23.04
	Yeast	8.04	7.73	10.88	11.70	21.54	22.53
	SWE	7.85	7.52	10.42	11.30	21.07	22.02
50 %	Without	7.55	7.23	9.84	10.67	20.47	21.30
	EM	8.30	8.26	11.55	12.29	22.16	23.26
	Microbial mix	8.12	7.82	11.09	11.88	21.73	22.78
	Yeast	7.94	7.61	10.63	11.51	21.33	22.27
	SWE	7.74	7.39	10.21	11.08	20.87	21.80
Without	Without	7.10	6.78	9.07	9.64	19.46	20.08
	EM	7.47	7.11	9.58	10.45	20.26	21.03
	Microbial mix	7.39	7.02	9.30	10.24	20.06	20.80
	Yeast	7.27	6.94	9.11	10.04	19.84	20.56
	SWE	7.15	6.81	6.94	9.86	19.65	20.31
LSD at 5 %		0.17	0.20	NS	0.16	0.10	0.13

EM: Effective microorganisms. SWE: Seaweed extract.
Microbial mix: *Azotobacter chroococcum* bacteria, *Bacillus circulans* bacteria and Arbuscular Mycorrhiza fungi.

CONCLUSION

Under present work condition, it could be concluded with fertilization of sweet potato plant with 50% level of the recommended NPK fertilizer and Effective microorganisms (EM) 2 ml/L three times during the season. This treatment gave 44% yield increment relative to the control, save and reduce chemical fertilization by 50%, improve tuberous roots yield and quality parameters, decrease NO_2 and NO_3 content, reduce environment pollution and greatly maintain human health.

In case of seedling legume crops as well as adding farmyard manure (FYM) 20m^3/fed before cultivating sweet potato, it is possible to add EM (2ml/L) without any chemical fertilizers, thus the yield and quality are acceptable with minimizing the environmental pollution and costs under the environmental conditions of Damietta Governorate, Egypt.

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استجابة نباتات البطاطا للتسميد المعدنى والحيوى

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أجريت تجربتان حقليتان خلال موسمى الصيف 2016 ،2017 فى المزرعة الخاصة بالقرب من مركز كفر سعد ، محافظة دمياط ، وذلك لدراسة استجابة التسميد المعدنى من عناصر النيتروجين والفوسفور والبوتاسيوم عند (100%-50%- صفر% من الكميات الموصى بها) ، وبعض من المنشطات الحيوية (بدون اضافات ، مركب EM 2 مل / لتر ، مخلوط بكتريا 1 لتر/20لتر، مستخلص الخميرة 10 جرام / لتر ، مستخلص الطحالب البحرية 1 جرام/ لتر) وكذلك التفاعل بينهما على المحصول ومكوناته وصفات الجوده للنبات البطاطا صنف أبيس. وقد أظهرت النتائج المتحصل عليها أن زيادة مستويات التسميد المعدنى من صفر% إلى 100% من الكميات الموصى بها قد أظهرت تفوق ملحوظ على الإنتاج الكلى للمحصول ، المادة الجافة ، صفات الجودة مثل النسبة المئوية للبروتين والكربوهيدرات الكلية والنشا والسكريات الكلية ، البيتا كاروتين ، فيتامين C فى جذور البطاطا. وأظهرت جميع معاملات المنشطات الحيوية زيادة ملحوظة فى الصفات السابق ذكرها وعملت على خفض محتوى النترات والنيتريت فى جذور البطاطا مقارنة بالنباتات الغير معاملة وقد أعطى المركب EM أفضل النتائج لجميع الصفات المدروسة وأيضا أظهرالتفاعل 100% و50% من النيتروجين والفوسفور والبوتاسيوم مع مركب EM زيادة ملحوظة فى جميع الصفات المدروسة، والتفاعل بين صفر % مع EM خفض محتوى النترات والنيتريت فى كلا الموسمين لذا فيمكن التوصية باستخدام 50% من كمية السماد المعدنى الموصى بها مع الرش بمركب EM بمعدل (2 مل/ لتر) ثلاث مرات يؤدى الى زيادة فى المحصول وفى صفات الجوده لمحصول البطاطا الحلوة مع الاقلال من التلوث البيئى والتربة وخفض التكاليف. وفى حالة زراعة محصول بقولى وإضافة سماد بلدى بمعدل 20 متر^3 للفدان قبل زراعة البطاطا فإنه من الممكن إضافة EM بدون أى سماد معدنى والذى أعطى صفات محصولية وجودة على درجة مقبولة مع انخفاض التلوث البيئى والتكاليف تحت الظروف البيئية لمحافظة دمياط، مصر.