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Okra Plants Response to Farmyard Manure, Mineral and some Bio-Fertilizers

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ABSTRACT

Two field experiments were carried at the Experimental Station Farm, Faculty of Agriculture, Mansoura University, Egypt, during 2014 and 2015 seasons to evaluate impact of Farmyard manure (Without – FYM), mineral (100%, 75% and 50% NPK of recommended doses), bio-fertilizers (Without – Yeast - Seaweed - EM) and their interactions on chemical components, quality and yield of okra (*Abelmoschus esculentus* L.) cv. White velvet. Data obtained in this study cleared that, fertilizing okra plants with FYM (organic treatments) at rate of 20m^3/fed increased significantly all measured parameters, *i.e.* chlorophyll a, b and total, nitrogen, phosphorus and potassium percentages in leaves, crude protein %, total carbohydrates %, crude fibers %, vitamin C, beta carotene, nitrate concentration and total yield/fed compared with control treatment (without) except crude fiber in the second season. However, fertilizing okra plants with 75% NPK from recommended doses gave the highest values of all studied parameters in the first season except nitrate and yield. Meanwhile, the superiority of all parameters mentioned previously in the second season was obtained from 100% NPK treatment except chlorophylls content. Moreover, treated plants with bio-fertilizers increased significantly all studied characters compared with untreated plants, except nitrate content. The interaction treatment among FYM at the rate of 20 m^3/fed, 75% NPK from recommended doses and EM (2ml/l) addition gave the highest values of quality and yield with significant differences in both seasons of study. Therefore, this treatment could be recommended for improving okra production and decrease the amount of mineral fertilizer under similar circumstances of this study.

Keywords: Okra, FYM, Mineral NPK, Bio-fertilizer, Yeast, Seaweed, EM.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) belongs to the family Malvaceae. It is rich source of vitamins, *i.e.* A, C and B_2 as well as minerals, *i.e.* Ca and Fe. It is used as a medicine in the treatment of the peptic ulcer. Okra is recommended for consumption by World Health Organization due to its ability to fight diseases. The cultivated areas of okra in Egypt were 12079.2 fed producing 57721 tons with an average of 4.7 ton/fed (FAO, 2016).

Continuous use of chemical fertilizers usually led to the deterioration of soil chemical, physical and biological properties and in turn soil health. Continuous usage of mineral fertilizer has also contributed to environmental pollution in the long run. The negative effects of chemical fertilization united with escalating costs led to growing interests in the use of organic manure as sources of nutrients, soil amendment, decrease costs and environmental pollution.

Organic fertilizer is a slow releasing nutrient. Mineral fertilizers application at required rates gives a positive impact on yield while organic fertilizers improved quality and chemical constituents of okra (Akande *et al*., 2010). Farmyard manure (FYM) is one of the most essential organic fertilizers; it contains most elements that required for plants development. Characteristically, not all of the nutrients in manure are directly accessible after its addition to the soil. Organic types must be mineralized into plant-available forms for example, nitrate. The rate of mineralization is variable and depends on soil type, temperature, moisture, manure composition and microorganism's activities. Olaniyi *et al.* (2010) and Chattoo *et al.* (2011) on okra indicated that the highest yield obtained from plants treated with organic fertilizer. Also, Subrahmanvam *et al.* (2011) reported that the highest values of fruits number /plant, fruit diameter, and total yield were produced when okra plants were treated with organic and bio-fertilizers. In the same direction, Kibria *et al.* (2013) showed that the combined application of 50% chemical fertilizer plus50% organic fertilizer gave best performance in terms of okra (Ladies finger) yield. As well as, Uikey *et al.* (2015) reported that the highest values of pea plant *i.e.* height, leaves and pods number /plant, number of seeds /pod and yield of green seeds were received by using 10 t/ha FYM. Huosman *et al.* and Melese (2016) found that fertilizing garlic and lettuce plant with 10 and 15 t/ha FYM respectively improved significantly yield and its components. Doklega and Abd El-Hady (2017) on broccoli showed that organic fertilizers gave maximum values of plant growth, yield and quality parameters.

Nitrogen, phosphorus and potassium are the most important nutrients needed by the plant in relatively large quantities compared to other nutrients. Using organic and mineral fertilizers together on okra plants has a greater beneficial residual impact than can be derived from use of either organic manure or mineral fertilizers alone (Akande *et al.,* 2010). As well as, Swapana *et al.* (2012) reported that FYM or vermicompost application at 10 t/ha with 75% NPK significantly gave higher yield of pea over that in mineral NPK or FYM alone. Dawa *et al.* (2013) showed that increasing fertilization with NPK to 100% of recommended doses cause significant increases in pea plants growth, yield and its components compared to organic manure and bio-fertilizer treatments. Also, Ganesh and Kumar (2016) found that 75% NPK + compost improved plant growth and yield of onion and cassava. As well as, Khandaker *et al.* (2017) reported that addition of NPK at the rates of 190 kg/ha and 210 kg/ ha on okra plants gave the highest growth and yield followed by application of NPK at the rates of 170 kg/ ha and 150 kg/ha. Doklega and Abd El-Hady (2017) found that fertilized broccoli plants with 75% NPK of recommended doses gave the highest values of yield and quality.

Bio-fertilizer is a substance containing living micro-organisms such as fungi, bacteria and blue green algae. Bio-fertilizers are applied as foliar application on plant surface and soil, which colonize the root rhizosphere that promotes plant growth and development through biological activity. Bio-fertilizers may influence plant growth and productivity via one or more mechanisms as

improving nutrient uptake, nitrogen fixation, organic acids production, safeguard against plant pathogens and excretion growth regulators such as IAA and GA_3. Application of bio-fertilizers achieve the following aims: limiting plant requirements of N by 25%, increasing the availability of different nutrients for plant absorption, enhancing the resistance of plants to root diseases and decreasing the environmental pollution (Kannaiyan, 2002). In addition, Mal *et al*. (2013) showed that the highest yield of okra was obtained when treated with bio-fertilizer followed by mineral fertilizers. In the same direction, Barnali *et al.* (2014) concluded that application of bio-fertilizers plus recommended doses of NPK would be beneficial in terms of vegetative growth, fruit yield and economics of okra. Also, Sharma *et al.* (2014) and Wangchuk and Chhetri (2016) suggested that application of bio-fertilizers interacted with mineral fertilizers had influenced growth and yield attributes in okra.

Yeast as a bio-stimulator identified by its abundance in protein, sugars, lipids, nucleic and some minerals, *e.g.* Mg, K, P, Na, Fe, S, Zn, Mn as well as thiamin, pyridoxine, riboflavin, hormones and other growth regulating substances, such as biotin, folic acid and B12 (Nagodawithana, 1991). Mahmoud *et al.* (2013) found that foliar spraying with yeast extract at level of (2%) increased all growth parameters, yield and quality of pea. Also, Ibraheim (2014) found significant increments in total chlorophylls contents, N, P, Zn, protein, total sugars and TSS (%) as well as yield/fed compared to untreated treatment when pea plants were sprayed with yeast extract.

Seaweed extract are the new types of products currently used in plant production. The sources of seaweed are many species of marine algae, which seem to be valuable for plant growth and development. As well as, it is considered as bio-stimulants because of the presence of hormones in the plant. Main phytohormones in seaweed are auxins, gibberellins, abscisic acid, cytokinins and ethylene, which are responsible for plant growth, development and resistance to pathogens (Khan *et al*., 2009). Also, Arafa *et al*. (2012) and (2013) showed that foliar spraying potato plants with seaweed extract significantly increased carbohydrate content and yield. Also, Shalaby and El-Ramady (2014) reported that foliar with seaweed extract improved plant growth and yield of garlic plants.

Effective microorganisms (EM) cause hastening and increasing growth of plants. It improves development of roots system, stimulate plants photosynthetic ability with the increase of chlorophyll and protein formation, rise of antioxidant ability of plants, amino acids formation which, important for the synthesis of protein, hormones, and different biologically active compounds, it affects chemical elements availability, as well as it has positive impact on the content of lipids, carbohydrates, and gluten content. Abdel Naby *et al*. (2013) on carrot plants showed that the interaction treatment compost, bio-fertilizer (EM) and 75% NPK gave significant superiority of yield and quality. Also, Dawa *et al.* (2013) found that fertilization with 50% NPK and foliar spraying pea plants with humic acid plus EM gave higher values without significant differences in plant growth and yield/fed as compared to 100% NPK alone. Similarly, Muyang *et al*. (2014) reported that potato plants treated with EM increased vegetative growth parameters and yield. Doklega and Abd El-Hady (2017) found that treated broccoli plants with EM (10ml/plant) recorded significant superiority on yield and quality parameters.

Therefore, this research aimed to evaluate the response of okra plants to usage of organic manure and bio-fertilization as a partial alternative to chemical fertilizers to increase yield, quality and reduce environmental pollution, costs and protection of human health.

MATERIALS AND METHODS

Experimental design and treatments: twenty-four treatments were organized in strip-split plot design which were the simple feasible combinations among two organic fertilizers (without - FYM 20 m^3/fed) in main plots, three mineral levels (100 – 75 and 50% NPK from recommended doses) in sub plots and four sources of bio-fertilizers (Yeast extract 5g/L, Seaweed 1g/L, EM 2ml/L, and 0) in sub sub plots with 3 replicates for each treatment.

Seeds of okra were sown in 15 and 20 April 2014 and 2015 respectively on rows, 4 m length, 0.6 m width and 0.3 m apart between plants and every plots included 3 rows. All other farming practices for okra plants were used as recommended by Ministry of Agriculture. The physical and chemical properties of the experimental soil are presented in Table1 during both seasons.

Table 1. Physical and chemical analysis of the experimental soil during 2014 and 2015 seasons:

seasons	Mechanical analysis (%)				Texture class	OM (%)	SP (%)	$CaCO_3$ (%)	EC $dS.m^{-1}$ 1:5	pH (1:2.5)	Available (ppm)		
	Clay Sand	Fine Sand	silt	clay							N	P	K
1st	3.6	24.5	39.2	32.7	Loamy	1.87	48.9	2.62	1.21	7.95	48.2	6.33	295
2nd	4.2	23.9	40.1	31.8	Loamy	1.94	50.4	2.42	1.32	8.12	50.3	6.67	302

SP: saturation percentage OM: Organic matter EC: Electrical conductivity

Farmyard manure fertilizer (20 ton/fed) was applied during soil preparation. The chemical analysis of FYM is presented in Table 2.

Mineral fertilization was done as follow: calcium super phosphate (15.5% P_2O_5) at the level of 150 P_2O_5/fed was added during soil preparation, while Ammonium sulphate (20.5 N%) at the level of 150 kg N/fed and potassium sulphate (48% K_2O) at the rate of 50 K_2O/fed (recommended by Egyptian Ministry of Agric.)were divided into three equal parts; the first one was added after one month from sowing, the second at the beginning of flowering and the third after one month later in both seasons.

Table 2. Chemical analysis of FYM.

seasons	%			C/N	%		ppm			pH	EC1:10
	OM	OC	N		P	K	Fe	Mn	Zn	1:5	$dS^{-1}m$
1st	45.25	20.18	1.15	17.6	0.51	0.71	62.35	27.56	19.44	6.36	3.78
2nd	42.59	21.06	1.33	15.8	0.62	0.73	63.11	27.91	20.03	6.42	3.83

OM: Organic matter OC: Organic carbon

Bio-fertilization treatments were done five times; the first was one month after sowing and the others were every 7 days. Yeast extract and seaweed extract were sprayed on plant surface while EM was soil addition.

Measurements:

Five plants were taken at random from every plot at 70 days after seeding to determine the following measurements during both seasons.

Chemical composition:-

- Chlorophyll content in okra leaves were estimated as the method described by Goodwine (1965).
- N, P and K percentage in leaves of okra were determined according to AOAC (2000) method.

Quality parameters:

- Crude protein percentage in okra fruits was calculated by multiplying the total nitrogen by the factor 6.25.
- Total carbohydrates percentage was estimated in okra fruits according to the method described by Hedge and Hofreiter (1962).
- Crude fiber percentage and Vitamin C (mg/100g) in okra fruits were determined according to the method described in AOAC, (2000).
- Beta carotene (mg/100g) was estimated in okra fruits according to the method according to Aremu and Nweze (2017).
- Nitrate content (NO_3-N ppm) was determined according to the method described by Singh (1988).

Yield of okra:

After 75 days from sowing, okra fruits were harvested from each plot every 3 days and total yield of fruits was calculated as ton/fed.

Statistical analysis:

Data were statistically analyzed according to the technique of ANOVA for strip split plot design according to Gomez and Gomez (1984). While, least significant difference (LSD) method at 5% levels of probability used to compare the means as mentioned by Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of organic fertilizer (FYM):

FYM fertilizer gave significant superiority of all measurements *i.e.* chlorophyll a, b and total, nitrogen, phosphorus and potassium percentages in leaves, crude protein %, carbohydrates %, crude fibers %, vitamin C, beta carotene, nitrate contents in fruits and total yield/fed compared to untreated treatment (control) except crude fiber in the second season as shown in Tables 3,5,6 and 8.

These results may be due to that FYM content of organic matter, nitrogen % and appropriate C/N ratio made nutrients more easily available to plant as shown in Table 2. It supplies all major nutrients (N, P, K, Ca, Mg and S) which, important for plant growth, and micronutrients. Hence, it improves soil physical, chemical, biological properties, soil water holding capacity and improves root development. Our results are in harmony with those obtained by Kibria *et al.* (2013), Subrahmanvam *et al.* (2011) on okra and Huosman *et al.* (2016) on garlic.

Effect of mineral fertilizer:

Concerning the effect of mineral fertilization with 100 %, 75% and 50% from recommended doses, data presented in the same Tables show that 75% NPK from recommended dose gave the highest significant values in chlorophyll content in both seasons of the study, meanwhile the same rate gave only the highest significant values in the first season of N, P and K percentage in the leaves, crude protein %, total carbohydrates %, crude fibers %, vitamin C and beta carotene concentration however, 100% NPK from recommended dose gave significant superiority of the previous measurements in the second seasons, moreover the increment of NO_3-N and yield in both seasons of the experiment. Both 100% and 75% NPK from recommended doses gave the superiority of all aforementioned parameters. These results may be attributed to the roles played by N, P and K on improvement of plant growth, chlorophyll formation and chemical constituents which reflected on okra yield and quality. These results are harmony with those reported by Khandaker *et al.* (2017) on okra and Doklega and Abd El-Hady (2017) on broccoli.

Effect of bio-fertilizer:

Tables 3, 5, 6 and 8 show significant superiority when plants treated with all bio-fertilizers (yeast, seaweed and EM) comparing with control treatment in all aforementioned parameters except, NO_3-N concentration, this indicate that, the application of bio- fertilizer treatments prevent the accumulation of NO_3 in okra fruits. Moreover, the results showed that EM treatment at the rate of 2ml/L gave the highest significant values followed by yeast extract treatment at the rate of 5g/L in both seasons.

Regarding the effect of bio-fertilizers, results may be attributed to that some bio-fertilizers (EM) are substances containing living micro-organisms such as fungi, bacteria and blue green algae. Bio-fertilizers are applied as foliar application on plant surface (yeast and seaweed extract) and soil addition (EM), which colonize the root rhizosphere that promotes plant growth and development through biological activities thus, yeast and seaweed contains amino acids, protein, hormones, macro and microelements, lipids, carbohydrates and gluten. A side from that, EM was the pest treatment due to it causes acceleration of plant development and increased growth measurements because of its components mention previously. The principal factors determining these processes are as follow: improvement of root system formation, stimulation of photosynthetic ability and rise of antioxidant ability of plants. These results are harmony with those showed by Muyang *et al*. (2014) on potato, Wangchuk and Chhetri (2016) on okra and Doklega and Abd El-Hady (2017) on broccoli.

Effect of interactions:

Concerning the effect of interaction treatments (organic treatment, mineral NPK-levels and bio-fertilizers) data presented in Tables 4, 7 and 9 found that the highest values of all studied parameters (chlorophyll content, chemical constituents, quality and yield) were recorded when okra plants treated with FYM at the rate of 20 m^3/fed, 75% NPK from recommended doses and addition of EM at the rate of 2ml/L except NO_3-N in both seasons. This treatment is desirable to obtained good yield with appropriate quality. These results are in agreement with those reported by Wangchuk and Chhetri (2016) on onion, Ganesh and Kumar (2016) on okra and Doklega and Abd El-Hady (2017) on broccoli.

Table 3. Chlorophyll a, chlorophyll b and chlorophylls a+b contents in okra leaves as affected by organic, mineral and bio-fertilizers as well as their interactions during 2014 and 2015 seasons.

Characters / Treatments	Chlorophyll a (mg/g FW)		Chlorophyll b (mg/g FW)		Chlorophylls a+b (mg/g FW)	
	2014	2015	2014	2015	2014	2015
A- Organic fertilization:						
Without	0.563	0.595	0.390	0.416	0.953	1.011
Farmyard manure (FYM)	0.648	0.660	0.457	0.462	1.105	1.122
F. test	*	*	*	*	*	*
B- Mineral fertilization (ratio of the recommended doses):						
100 %	0.611	0.631	0.425	0.441	1.036	1.072
75 %	0.620	0.635	0.434	0.443	1.055	1.078
50 %	0.585	0.618	0.411	0.432	0.995	1.050
LSD at 5%	0.004	0.002	0.004	0.002	0.005	0.002
C- Bio-fertilization:						
Without	0.539	0.603	0.376	0.421	0.915	1.024
Yeast extract	0.625	0.633	0.441	0.444	1.066	1.077
Seaweed extract	0.588	0.620	0.410	0.433	0.998	1.053
EM	0.670	0.654	0.466	0.458	1.136	1.112
LSD at 5%	0.003	0.003	0.003	0.002	0.005	0.004
D- Interactions:						
A × B	NS	*	NS	*	NS	*
A × C	*	*	*	*	*	*
B × C	*	*	*	*	*	*
A × B × C	*	NS	*	NS	*	NS

Table 4. Chlorophyll a, chlorophyll b and chlorophylls a+b contents in squash leaves as affected by the interaction among organic, mineral and bio-fertilizers during 2014 and 2015 seasons.

Characters / Treatments			Chlorophyll a (mg/g FW)		Chlorophyll b (mg/g FW)		Chlorophylls a+b (mg/g FW)	
			2014	2015	2014	2015	2014	2015
Without	100 %	Without	0.516	0.580	0.356	0.406	0.872	0.986
		Yeast extract	0.577	0.601	0.390	0.422	0.967	1.023
		Seaweed extract	0.547	0.590	0.370	0.412	0.916	1.003
		EM	0.634	0.621	0.443	0.432	1.077	1.053
	75 %	Without	0.503	0.570	0.350	0.396	0.853	0.966
		Yeast extract	0.589	0.608	0.411	0.425	1.000	1.033
		Seaweed extract	0.567	0.597	0.397	0.414	0.964	1.011
		EM	0.646	0.628	0.455	0.440	1.101	1.068
	50 %	Without	0.484	0.569	0.339	0.400	0.823	0.969
		Yeast extract	0.566	0.590	0.397	0.413	0.964	1.003
		Seaweed extract	0.533	0.576	0.370	0.404	0.904	0.979
		EM	0.592	0.611	0.403	0.429	0.995	1.040
FYM	100 %	Without	0.603	0.644	0.424	0.449	1.027	1.093
		Yeast extract	0.673	0.667	0.470	0.468	1.143	1.135
		Seaweed extract	0.627	0.655	0.443	0.458	1.070	1.113
		EM	0.715	0.688	0.504	0.482	1.219	1.170
	75 %	Without	0.580	0.633	0.408	0.441	0.988	1.074
		Yeast extract	0.691	0.679	0.483	0.476	1.174	1.155
		Seaweed extract	0.650	0.663	0.459	0.463	1.109	1.126
		EM	0.736	0.699	0.513	0.490	1.249	1.190
	50 %	Without	0.545	0.622	0.381	0.434	0.926	1.056
		Yeast extract	0.656	0.656	0.495	0.458	1.151	1.114
		Seaweed extract	0.603	0.641	0.421	0.447	1.024	1.088
		EM	0.696	0.678	0.481	0.474	1.177	1.152
LSD at 5%			0.007	NS	0.008	NS	0.011	NS

Table 5. Nitrogen (N), phosphorus (P) and potassium (K) percentages in okra leaves as affected by organic, mineral and bio-fertilizers as well as their interactions during 2014 and 2015 seasons.

Characters	N %		P %		K %	
Treatments	2014	2015	2014	2015	2014	2015
A- Organic fertilization:						
Without	1.300	1.416	0.229	0.214	1.688	1.724
Farmyard manure (FYM)	1.498	1.559	0.259	0.237	1.937	1.911
F. test	*	*	*	*	*	*
B- Mineral fertilization (ratio of the recommended doses):						
100 %	1.410	1.556	0.250	0.235	1.829	1.950
75 %	1.437	1.509	0.250	0.229	1.853	1.825
50 %	1.351	1.398	0.233	0.212	1.754	1.677
LSD at 5%	0.027	0.016	0.004	0.002	0.028	0.017
C- Bio-fertilization:						
Without	1.245	1.351	0.216	0.211	1.625	1.683
Yeast extract	1.441	1.534	0.257	0.230	1.865	1.858
Seaweed extract	1.352	1.436	0.236	0.220	1.749	1.768
EM	1.559	1.631	0.269	0.240	2.010	1.961
LSD at 5%	0.026	0.024	0.006	0.003	0.021	0.030
D- Interactions:						
A × B	NS	*	NS	NS	NS	NS
A × C	NS	NS	NS	NS	NS	NS
B × C	*	*	*	*	*	*
A × B × C	NS	NS	NS	NS	NS	NS

Table 6. Crude protein, total carbohydrates and crude fibers percentages in okra fruits as affected by organic, mineral and bio-fertilizers as well as their interactions during 2014 and 2015 seasons.

Characters	Crude protein (%)		Total carbohydrates (%)		Crude fibers (%)	
Treatments	2014	2015	2014	2015	2014	2015
A- Organic fertilization:						
Without	14.50	12.98	30.54	27.49	9.18	9.64
Farmyard manure (FYM)	16.47	14.46	34.65	30.70	10.39	9.03
F. test	*	*	*	*	*	*
B- Mineral fertilization (ratio of the recommended doses):						
100 %	15.62	14.36	32.88	30.51	9.87	9.83
75 %	15.91	13.99	33.53	29.44	10.07	9.53
50 %	14.93	12.82	31.36	27.33	9.42	8.65
LSD at 5%	0.03	0.05	0.03	0.003	0.03	0.02
C- Bio- fertilization:						
Without	13.87	13.48	29.29	28.55	8.79	9.07
Yeast extract	15.94	13.80	33.47	29.07	10.04	9.37
Seaweed extract	15.04	13.65	31.62	28.85	9.49	9.19
EM	17.10	13.96	35.98	29.91	10.82	9.73
LSD at 5%	0.05	0.06	0.03	0.03	0.03	0.03
D- Interactions:						
A × B	*	*	*	*	*	*
A × C	*	NS	*	*	*	*
B × C	*	*	*	*	*	*
A × B × C	*	*	*	*	*	*

Table 7. Crude protein, total carbohydrates and crude fibers percentages in okra fruits as affected by the interaction among organic, mineral and bio- fertilizers during 2014 and 2015 seasons.

Characters			Crude protein(%)		Total carbohydrates (%)		Crude fibers(%)	
Treatments			2014	2015	2014	2015	2014	2015
Without	100 %	Without	13.41	13.44	28.46	27.90	8.57	9.99
		Yeast extract	14.93	13.64	31.28	28.91	9.42	10.19
		Seaweed extract	14.25	13.51	29.98	28.74	9.05	9.98
		EM	16.04	13.48	33.73	29.18	10.11	10.30
	75 %	Without	13.00	12.95	27.94	27.17	8.42	9.49
		Yeast extract	15.20	13.30	31.93	27.65	9.57	9.82
		Seaweed extract	14.64	13.16	30.77	27.39	9.29	9.61
		EM	16.64	13.78	34.91	29.36	10.48	10.55
	50 %	Without	12.50	11.87	26.15	25.61	7.86	8.71
		Yeast extract	14.33	12.22	30.06	25.98	9.04	8.99
		Seaweed extract	13.57	12.05	28.52	25.75	8.54	8.90
		EM	15.53	12.37	32.72	26.26	9.84	9.17
FYM	100 %	Without	15.49	14.95	32.60	31.98	9.77	9.28
		Yeast extract	16.95	15.29	35.64	32.38	10.64	9.65
		Seaweed extract	15.88	15.15	33.42	32.17	9.98	9.42
		EM	17.99	15.42	37.97	32.86	11.46	9.83
	75 %	Without	14.95	14.44	31.43	30.24	9.41	8.86
		Yeast extract	17.45	14.73	36.75	30.63	11.04	9.10
		Seaweed extract	16.53	14.60	34.78	30.40	10.44	8.96
		EM	18.90	14.95	39.72	32.70	11.91	9.86
	50 %	Without	13.86	13.25	29.17	28.41	8.73	8.10
		Yeast extract	16.75	13.62	35.18	28.90	10.53	8.48
		Seaweed extract	15.37	13.42	32.27	28.67	9.65	8.25
		EM	17.53	13.78	36.85	29.11	11.14	8.65
LSD at 5%			0.11	0.15	0.08	0.07	0.07	0.06

Table 8. Vitamin C, beta carotene and nitrate (NO_3-N) contents and total yield/fed of okra as affected by organic, mineral and bio-fertilizers as well as their interactions during 2014 and 2015 seasons.

Characters / Treatments	Vitamin C (mg/100 g)		B. carotene (mg/100 g)		NO_3-N (ppm)		Total yield (t/fed)	
	2014	2015	2014	2015	2014	2015	2014	2015
A- Organic fertilization:								
Without	43.57	39.28	4.80	4.89	33.88	28.11	1.797	1.925
Farmyard manure (FYM)	49.27	43.98	5.44	5.38	37.41	29.40	2.233	2.306
F. test	*	*	*	*	*	*	*	*
B- Mineral fertilization (ratio of the recommended doses):								
100 %	46.98	42.46	5.17	5.73	41.76	33.09	2.287	2.550
75 %	47.46	42.75	5.26	5.64	36.41	29.11	2.150	2.362
50 %	44.82	39.70	4.93	4.05	28.76	24.07	1.608	1.433
LSD at 5%	0.36	0.38	0.04	0.03	0.25	0.22	0.061	0.077
C- Bio-fertilization:								
Without	41.73	40.41	4.59	4.66	43.10	30.22	1.711	1.817
Yeast extract	47.66	42.01	5.26	5.28	34.34	28.26	2.033	2.200
Seaweed extract	45.27	41.57	4.96	5.16	38.18	29.13	2.006	2.039
EM	51.02	42.54	5.66	5.45	26.95	27.41	2.311	2.406
LSD at 5%	0.63	0.35	0.03	0.03	0.49	0.45	0.081	0.073
D- Interactions:								
A × B	NS	*	NS	*	*	*	*	*
A × C	NS	NS	*	NS	*	NS	*	*
B × C	*	*	*	*	*	NS	*	*
A × B × C	*	NS	NS	NS	*	NS	*	*

Table 9. Vitamin C, beta carotene and nitrate (NO_3-N) contents and total yield/fed of okra as affected by the interaction among organic, mineral and bio-fertilizers during 2014 and 2015 seasons.

Characters / Treatments			Vitamin C (mg/100 g)		B. carotene (mg/100 g)		NO_3-N (ppm)		Total yield (t/fed)	
			2014	2015	2014	2015	2014	2015	2014	2015
Without	100 %	Without	39.90	39.26	4.43	5.24	47.63	33.36	1.967	2.167
		Yeast extract	44.86	39.96	4.92	5.49	36.76	31.50	2.033	2.467
		Seaweed extract	43.60	39.60	4.71	5.36	40.96	32.73	2.067	2.300
		EM	48.40	40.13	5.32	5.68	30.43	30.83	2.267	2.467
	75 %	Without	39.46	38.33	4.34	4.38	43.43	30.70	1.533	1.833
		Yeast extract	44.86	41.20	5.03	5.70	34.06	28.83	1.767	1.933
		Seaweed extract	43.76	40.63	4.83	5.59	37.53	29.50	1.667	1.800
		EM	49.83	42.00	5.54	5.88	24.23	28.20	2.233	2.500
	50 %	Without	37.30	36.76	4.02	3.64	35.30	24.13	1.167	1.133
		Yeast extract	43.43	37.86	4.79	3.89	26.70	22.50	1.667	1.500
		Seaweed extract	41.06	37.30	4.45	3.79	29.30	23.30	1.400	1.300
		EM	46.40	38.36	5.19	4.08	20.20	21.76	1.800	1.700
FYM	100 %	Without	47.60	44.43	5.15	5.83	53.50	35.76	2.167	2.400
		Yeast extract	50.20	45.16	5.62	6.08	42.56	33.73	2.400	2.867
		Seaweed extract	47.66	45.20	5.26	5.97	47.26	34.56	2.667	2.800
		EM	53.66	45.93	5.95	6.21	34.96	32.26	2.733	2.933
	75 %	Without	44.80	42.83	4.98	4.87	45.76	30.50	2.033	2.267
		Yeast extract	51.06	45.70	5.71	6.21	36.56	28.46	2.533	2.867
		Seaweed extract	49.76	45.26	5.44	6.08	40.90	29.20	2.500	2.600
		EM	56.16	46.03	6.18	6.38	28.80	27.50	2.933	3.100
	50 %	Without	41.36	40.86	4.64	4.03	33.00	26.86	1.400	1.100
		Yeast extract	51.53	42.20	5.46	4.32	29.40	24.56	1.800	1.567
		Seaweed extract	45.80	41.43	5.08	4.18	33.13	25.53	1.733	1.433
		EM	51.66	42.80	5.77	4.47	23.06	23.93	1.900	1.733
LSD at 5%			1.56	NS	NS	NS	1.19	NS	0.197	0.178

CONCLUSION

Fertilizing okra plants with FYM (20 m^3/fed), 75% NPK from recommended doses and EM addition (2ml/L) produce a good yield, and qualities as well as decreasing the production costs. Thus this recommended treatment achieved important additional advantages included saving of chemical fertilization, reducing the accumulation of harmful NO_3 levels in fruits, protected the ecosystem against chemical pollution and gave clean and healthy fruits for human.

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استجابة نباتات الباميا للسماد البلدى والمعدنى وبعض الأسمدة الحيوية

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أجريت تجربتان حقليتان بمزرعة كلية الزراعة جامعة المنصورة خلال الموسمين الزراعيين ٢٠١٤ و ٢٠١٥ لدراسة تأثير التسميد العضوى (بدون – سماد بلدى) والتسميد المعدنى (١٠٠% ، ٧٥% ، ٥٠% من الكمية الموصي بها من النتروجين والفوسفور والبوتاسيوم) والتسميد الحيوى (بدون ، الخميرة ، مستخلص الطحالب ، EM) وكذلك التفاعل بينها على الصفات الكيميائية و المحصول وصفات الجودة لنبات الباميا صنف هوايت فلفيت.وقد اظهرت النتائج ان استخدام السماد البلدى بمعدل ٢٠م^{٣}/الفدان سبب زيادة معنوية لقياسات الكلوروفيل أ و ب والكلي والنسبة المئوية لكل من النتروجين والفوسفور والبوتاسيوم (فى الأوراق) والبروتين الخام والكربوهيدرات الكلية والألياف الخام و فيتامين C والبيتا كاروتين ومحتوى النترات علاوة على المحصول الكلى للفدان مقارنة بمعاملة المقارنة ما عدا البروتين الخام فى الموسم الثانى.أوضحت النتائج ايضا أن التسميد المعدني بمعدل ٧٥% NPK من الكمية الموصي بها أعطي زيادة معنوية لكل القياسات المذكوره سابقا في الموسم الأول ما عدا النترات والمحصول الكلي بينما أعطي التسميد بمعدل ١٠٠% NPK من الكمية الموصي بها تفوقا معنويا لنفس القياسات فى الموسم الثاني ما عدا المحتوي من الكلوروفيل. كما وجد أن معاملة النباتات بالتسميد الحيوي سببت زيادة معنوية لكل القياسات المذكورة ماعدا محتوى النترات. وبخصوص تأثير التداخل بين المعاملات قد أظهرت النتائج أن التسميد بالسماد البلدى بمعدل ٢٠م^{٣}/الفدان و ٧٥% NPK من الكمية الموصي بها بالإضافة للتسميد الحيوى بإستخدام EM بمعدل ٢مل/التر أعطي أعلي قيم لصفات المحصول والجودة فى كلا الموسمين. لذلك نوصي بإستخدام تلك المعاملة لنباتات الباميا تحت نفس ظروف محافظة الدقهلية لتقليل كميات الاسمدة المعدنية المستخدمة وزيادة المحصول وتحسين صفات الجوده مع تقليل التلوث البيئى.