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Effect of Organic, Mineral Fertilization and Foliar Spraying with Some Biostimulants on Growth, Yield and Chemical Composition of Pea

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ABSTRACT

Two field experiments were carried out during 2013/2014 and 2014/2015 seasons to study the effect of organic fertilization (farmyard manure "FYM" at the rate of 20 t/fed and humic acid "HA" at the rate of 20 kg/fed), NPK fertilization (50 % of the recommended doses *i.e.* 40 kg N + 20 kg P_2O_5 + 40 K_2O/fed and 100 % of the recommended doses *i.e.* 80 kg N + 40 kg P_2O_5 + 80 K_2O/fed) and foliar spraying with some biostimulants (without, foliar spraying with Stemo at rate of 0.5 ml/liter water, potassium salicylate at rate of 2.0 ml/liter water, Super-grow at rate of 1.5 ml/liter water and mixture of Stemo at rate of 0.25 ml/liter water + K. Sal at rate of 1.00 ml/liter water + Super-grow at rate of 0.75 ml/liter water) as well as their interaction on growth, yield and its components and chemical composition of pea Master B cultivar. The experiment was carried out in a strip-split plot design with three replications. The obtained results could be summarized as follows:- The maximum means of all studied characters were recorded by humic acid (HA) at the rate of 20 kg/fed, while the minimum values were resulted from using farmyard manure (FYM) at the rate of 20 t/fed in both seasons. - Increasing NPK fertilization levels from 50 % of the recommended doses (40 kg N + 20 kg P_2O_5 + 40 K_2O/fed) to 100 % (80 kg N + 40 kg P_2O_5 + 80 K_2O/fed) was accompanied with significant increase in all studied characters. - Foliar spraying with mixture exceeded the other treatments with some biostimulants and resulted in the highest means of all studied parameters in both seasons. It could be recommended that organic fertilizing pea plants with humic acid at the rate of 20 kg/fed and mineral fertilizing with 80 kg N + 40 kg P_2O_5 + 80 K_2O/fed in addition to foliar spraying three times with the mixture of biostimulants *i.e.* Stemo at rate of 0.25 ml/liter water + K. Sal at rate of 1.00 ml/liter water + Super-grow at rate of 0.75 ml/liter water in order to maximizing pea growth, yield and quality.

Keywords: Pea, organic fertilization, FYM, humic acid, NPK Levels, foliar spraying, biostimulants, growth, yield, chemical composition.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important leguminous vegetable crops grown during winter season in Egypt. It occupies a great figure in the local consumption and export. The pods of pea have a great amount of protein and carbohydrates, therefore pea is considered as one of the most important sources in human food nutrition for such nutrients (El-Desuki, 2010)

Organic fertilizers could be accepted as a healthy fertilizers for different crops. The role of organic fertilizers is very important for plant growth and yield, because they provide stable supply of both macro- and micronutrients, and improve soil physical, chemical and biological properties, and consequently support the maximum yield (Belay *et al.*, 2001).

Farmyard manure (FYM) is the most important as it contains all the nutrients needed for crop growth including trace elements, albeit in small quantities. Sheng, Mao *et al.* (2006) and Sharma (2009) showed that application of FYM at the rate of 2.5 t/ha resulted in significant improvement in growth, yield, nutrient uptake and net returns of pea. Hameda *et al.* (2012) found that the fertilization with FYM was the most reliable treatment compared with chemical fertilizer and control treatments in both seasons. El-Sherbiny *et al.* (2014) indicated that organic fertilization had reduced the dependence of pea plants on mineral fertilizer and in the same time minimized the losses of fertilizer nitrogen anyhow. Uikey *et al.* (2015) revealed that 10 t FYM /ha showed significantly maximum plant height, number of leaves/plant, number of pods/plant, number of seeds/pod and green seeds yield of pea plants.

Humic acid is water-soluble organic acid naturally present in soil organic matter (Akinremi *et al.*, 2000). Gad El-Hak *et al.* (2012) found that foliar application with humic acid at 2g/L produced the highest plant dry weight, pod diameter, fresh seeds weight/pod, number of fresh seeds/pod, green pod yield, seeds weight/dry pod, dry seed yield and phosphorus percentages. Osmana and Mostafa (2012) showed that soil application of humic acid significantly increased shoot lengths, the number of branches/plant, leaf area/plant, shoot dry weight/plant, the contents of leaf pigments, leaf free proline, leaf macronutrients (N, P, and K), seed protein, and the total yields of pods and seeds/ha, when compared with control plants. Sarwar *et al.* (2012) revealed that soil application of humic acid at the rate of 50 mg/kg significantly enhanced seeds weight and number of pods/plant as compared with control treatment. Helmy (2013) found that spraying with humic acid increased values of plant height, number of branches per plant, number of leaves per plant, photosynthetic pigments (chlorophyll a, b, total chlorophyll a + b and carotene), nitrogen, phosphorus and potassium in leaf tissues, dry weight of plant, pod length, pod diameter, number of seeds per pod, weight of 100 seeds, green pods yield/plant and green pods yield/fed. Fahramand *et al.* (2014) revealed that humic acids are heterogeneous, which include in the same macromolecule, hydrophilic acidic functional groups and hydrophobic groups. A distinction on the effects of HA should be made between indirect and direct effects on plants growth. Under water stress, foliar fertilization with humic molecules increased leaf water retention and the photosynthetic and antioxidant metabolism. Kandil (2014) found that dry weight, weight of 100 seeds and yield of pea were significantly increased by increasing of humic acid levels. Humic acid decreased soil pH and increased the availability of phosphors and micronutrients.

Nitrogen (N) is the most important plant nutrients, which play an important role in protein, protoplasm and chlorophyll formation as well as cell division. Phosphorus is important in root growth, phospho-proteins, phospholipids. Potassium is necessary element in enzymes activity (Marschner, 1995). Also, it enhances the ability of plants to resist stress such as diseases, pests, cold and drought. Many reports indicated that nitrogen, phosphorus and potassium are considered as the most affective factors in increasing growth, yield and yield components of pea. Mishra *et al.* (2010) reported that increasing NPK fertilizer levels increased plant height, number of branches and leaves/plant, dry weight of branches and leaves/plant and yield and its components of pea. Dawa *et al.* (2013) indicated that increasing NPK fertilizer levels up to 100% recommended dose caused significant increases in pea plant growth (plant height, number of branches and leaves/plant and dry weight/plant) and yield and its components (pod length, number of seeds/pod, weight of 100 seeds and green pods yield/fed). El-Waraky *et al.* (2013) revealed that increasing NPK rate up to 40 kg N + 30 kg P_2O_5 + native-K was accompanied with significant increases in vegetative growth characters, as well as green pods yield and its components, shelling ratio, seed yield and its components, seed germination percentage, leaf contents of chlorophyll and seed content of protein. El-Sherbiny *et al.* (2014) indicated that using of 100% mineral fertilizer gave the best value of seeds N uptake and yield as compared with either control (unfertilized, uninoculated) or other combined treatments. Kandil (2014) reported that growth and yield parameters of pea were significantly increased by increasing phosphorus levels up to 120 kg P_2O_5/ha. Singh *et al.* (2015) concluded that application of recommended level of NPK caused least changes in N metabolism leading to minimum yield losses of pea.

During the last decade, there is a great demand for agro-chemical residue free fresh agricultural products. There is a worldwide trend to explore new natural products and safety substances that act as biostimulants for plants, giving priority to that enhance the plant productivity and avoid negative and side effects on human health as a result of the excessive application of synthetic agro-chemicals. In this respect; Arafa *et al.* (2013) studied the effect of foliar spraying with biostimulants (seaweed extract and humic acid) and soil application of effective microrganisms (EM) on growth, carbohydrates concentration and ion percentage in the shoots of potato plants. They showed that foliar spraying with biostimulants significantly increased carbohydrate concentration of potato. Orabi *et al.* (2013) indicated that foliar spray with salicylic acid at the concentration of 2 mM followed by 1mM mitigated the harmful effects of salt stress through the enhancement of the protective parameters of faba bean, such as antioxidant enzymes, soluble sugars and proteins and consequently improved growth and yield. Abido and Seadh (2014) revealed that foliar spraying faba bean plants with YE and GA_3 resulted in the highest values of growth and yield of faba bean. Calvo *et al.* (2014) demonstrated that there was growing scientific evidence supporting the use of biostimulants as agricultural inputs on diverse plant species. Some commonalities in plant responses to different biostimulants, such as increased root growth, enhanced nutrient uptake, and stress tolerance. Rose *et al.* (2014) stated that biostimulants may enhance macro and micro nutrient uptake and have been ascribed to an effect on sink activity or stimulation of nitrogen metabolism. Shalaby and El-Ramady (2014) studied the influence of some bio-stimulant substances on plant growth, yield, yield components and storability of garlic plants. They found that foliar application with bio-stimulant substances increased plant height and bulb weight as compared with control. Saa *et al.* (2015) reported that biostimulants substances had a marked positive effect on shoot growth and leaf area per plant.

Therefore, this investigation aimed to study the effect of NPK and organic fertilization and foliar spraying with some biostimulants as well as their interaction on growth, yield and its components and chemical composition of pea Master B cultivar.

MATERIALS AND METHODS

The experiments were carried out at the Experimental Station Farm, Faculty of Agriculture, Mansoura University, Egypt, during 2013/2014 and 2014/2015 seasons to study the effect of organic, NPK fertilization and foliar spraying with some biostimulants as well as their interaction on growth, yield and its components and chemical composition of pea Master B cultivar.

The experiment was carried out in a strip-split plot design with three replications. The vertical-plots were allocated to two organic fertilization treatments (farmyard manure "FYM" at the rate of 20 t/fed and humic acid "HA" at the rate of 20 kg/fed). Farmyard manure (FYM) and humic acid (HA) were added after determining the experimental units on soil surface and then turned over via hack.

Chemical analysis of used FYM and HA in both seasons is presented in Tables 1 and 2, respectively.

The horizontal-plots were included two nitrogen, phosphorus and potassium (NPK) fertilization levels (50 and 100 % of the recommended doses *i.e.* 40 kg N + 20 kg P_2O_5 + 40 K_2O/fed and 80 kg N + 40 kg P_2O_5 + 80 K_2O/fed, respectively..

Table 1. Chemical analysis of used farmyard manure in both seasons.

Properties	Farmyard manure
OM (%)	39.8
C (%)	23.1
N (%)	0.79
C/N ratio	18.2
P (%)	0.38
K (%)	0.47
pH	6.03
EC m.mohs/cm	4.38

Table 2. Chemical analysis of used humic acid in both seasons.

Characteristics	Values	Macro-elements	Values (%)	Micro-elements	Values (ppm)
EC (ds/m^{-1})	1.13	Total N	2.14	Total Fe	3.93
pH	2.70	Total P	0.27	Total Zn	2.30
OM (%)	52.03				
Carbon	30.25	Total K	3.16	Total Mn	1.68
C / N	14 : 14				

The sub-plots were devoted to five foliar spraying with biostimulants as follows:

1- Without (control treatment).
2- Foliar spraying with Stemo at rate of 0.5 ml/liter water.
3- Foliar spraying with potassium salicylate (K. Sal) at rate of 2.0 ml/liter water.
4- Foliar spraying with Super-grow at rate of 1.5 ml/liter water.
5- Foliar spraying with mixture of Stemo at rate of 0.25 ml/liter water + K. Sal at rate of 1.00 ml/liter water + Super-grow at rate of 0.75 ml/liter water.

Stemo as a growth regulator, flower and fruit fixer contains: Citric acid 8.00 %, Ploy-saccharide 8.00 %, Zinc sulphate 3.00 %, Naphthalene acetic acid (NAA) 0.35 % and Salicylic acid 0.35 %. Super-grow as a growth regulator, stimulator and antioxidant contains; Ploy-saccharide 6.0%, Gibberellic acid (GA_3) 0.10 %, Naphthalene acetic acid (NAA) 0.10%, Cytokinins (BAP) 0.02 %, Ascorbate 0.80 % and Alpha-tocopherol 0.40 %. The foliar solution volume was 200 Liter/fed and spraying by hand sprayer (for experimental plots) until saturation point.

Each study season, has been taking soil samples at random from field experiments zone at a depth of 0-30 cm from the surface of the soil before the soil preparation to estimate the physical and chemical properties of the soil, according to Chapman and Pratt (1971) as shown in Table 3. Each experimental basic unit (7.35 m^2) included three ridges, each of 70 cm width and 3.5 m length.

Table3. Mechanical and chemical soil characteristics at the experimental site during the two growing seasons of 2013 /2014 and 2014/2015.

Soil analysis		2013/2014 Season	2014/2015 Season
A: Mechanical analysis			
Coarse sand		3.98	4.01
Fine sand		28.16	28.05
Silt		42.91	43.01
Clay		24.95	24.93
Texture class		SCL	SCL
B: Chemical analysis			
E.C. $dS.m^{-1}$(1:5)		1.13	1.11
pH (1:2.5)		7.87	7.81
SP %		56.8	56.6
OM %		1.53	1.62
Total $CaCO_3$ %		4.33	4.31
Available (mg/kg)	N	48.7	51.4
	P	5.09	6.01
	K	153.4	152.4
DTPA Extractable ppm	Zn	0.97	0.98
	Fe	3.13	3.15
	Mn	1.14	1.15

Pea seeds were immediately sown in the moderately moist soil on 24th and 26th November in the first and second seasons, respectively. Seeds were sown in hills (3 seeds/hill) by hand at 10 cm apart on 2 rows of each ridge.

Studied characters:

1. Vegetative growth characters:

After 50 days from the sowing, a sample of 10 plants were randomly taken from each experimental unit to determine the following parameters:

1. Plant height (cm).
2. Fresh weight of plant (g).
3. Dry weight of plant (g).
4. Number of leaves/plant.
5. Total leaf area/plant (cm^2).
6. Total chlorophylls (SPAD.

2. Chemical constituents in the leaves and seeds:

Samples from pea leaves after 50 days from sowing and green pods at proper maturity stage were dried in the oven at 70°C until constant weigh.

For determination of macro elements; 0.2g crude dried kept powder from each sample was wet digested with a mixture of concentrated sulphuric and perchloric acid (Peterburgski, 1968).

-Nitrogen content (N): was determined in dried plant materials by the wet digestion of dried and finally pulverized plant material using Keldahl methods described by Jackson (1967).

-Phosphorus content (P): was determined colouremitricaly using the chlorostannus reduce molybdo phosphoric blue colours method in sulphoric system (Jackson 1967)

-Potassium content (K): was determined in the digested plant materials using a flame photometer according to Black (1965).

-Calcium (Ca) contents. It were determined according to Jackson (1967).

-Total sugar percentages: It was determined according to the method of Forsee (1938).

-Carbohydrates percentage: It were determined according to Somogy (1952).

-Crude protein: It was calculated by multiplying the total nitrogen by the factor 6.25.

-Vitamin-C content (Ascorbic acid): It was determined by titration with 2.6 dichlorophenol blue dye according to the method reported in AOAC (1990).

- Nitrate content (NO_3): It was extracted by 2 % acetic acid using of N-1 naphthyle ethylene diamine dihydrochlorid as an indicator. A pinkish colour intensity of the filtrate was measured by a spectrophotometer at wave length 540 n.m according to the method described by Singh (1988).

3. Yield and its components:

1. 100-seed weight (g).
2. Total green seed yield (t/fed). It was calculated as the total weight of green pods (t/fed).

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip-split plot design as published by Gomez and Gomez (1984). Least significant of difference (LSD) method was used as described by Snedecor and Cochran (1980) to test the differences between treatment means.

RESULTS AND DISCUSSION

1- Effect of organic fertilization treatments:

Data in Tables 4, 6, 8 and 10 show that organic fertilization treatments (farmyard manure (FYM) at the rate of 20 t/fed and humic acid (HA) at the rate of 20 kg/fed) had significant effects on plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, nitrogen, phosphorus, potassium and calcium percentages in pea leaves, total sugar, total carbohydrates, protein, vitamin-C and nitrate (NO_3) in pea seeds, 100-seed weight and total green yield/fed of pea in the two growing seasons. The maximum means of these characters were recorded by humic acid (HA) at the rate of 20 kg/fed.in both seasons.These results due to application organic fertilizers (HA or FYM) may be ascribed to provide stable supply of both macro- and micronutrients, and improves soil physical, chemical and biological properties, and consequently supports the maximum yield (Belay *et al.,* 2001). These results came in the similar point of view with those reported by Hameda *et al.* (2012), Khan *et al.* (2013), El-Sherbiny *et al.* (2014), Fahramand *et al.* (2014), Kandil (2014) and Uikey *et al.* (2015).

2- Effect of NPK fertilization levels:

Regarding the effect of NPK fertilization levels on plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, nitrogen, phosphorus, potassium and calcium percentages in pea leaves, total sugar, total carbohydrates, protein, vitamin-C and nitrate (NO_3) in pea seeds, 100-seed weight and total green yield/fed of pea, the obtained results in Tables 4, 6, 8 and 10 apparently cleared that there were significant effects in both seasons. It could be noticed that increasing NPK fertilization levels from 50 % of the recommended doses (40 kg N + 20 kg P_2O_5 + 40 K_2O/fed) to 100 % (80 kg N + 40 kg P_2O_5 + 80 K_2O/fed) was accompanied with significant increase in all studied characters.

Therefore, the highest values of aforementioned parameters were resulted from mineral fertilizing pea plants with 100 % of the recommended doses (80 kg N + 40 kg P_2O_5 + 80 K_2O/fed) in both seasons. These increases allied with increasing NPK fertilization levels may be recognized to the role of nitrogen in protoplasm and chlorophyll formation, enhancement meristematic activity and cell division (Marschner, 1995). These results are in harmony with those recorded by El-Waraky *et al.* (2013), El-Sherbiny *et al.* (2014), Kandil (2014) and Singh *et al.* (2015).

Table 4. Plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls in pea leaves as affected by organic, NPK fertilization and foliar spraying with some biostimulants as well as their interaction during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Plant height (cm)		Fresh weight/plant (g)		Dry weight/plant (g)		Number of leaves/plant		Total leaf area/plant (cm^2)		Total chlorophylls (SPAD)	
	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
A- Organic fertilization treatments:												
FYM	50.72	52.08	12.72	12.89	1.81	1.83	12.36	13.80	31.67	32.29	16.88	17.06
HA	54.91	56.37	13.19	13.36	2.00	2.03	13.30	14.73	34.29	34.97	18.27	18.43
F. test	*	*	*	*	*	*	*	*	*	*	*	*
B- NPK fertilization levels:												
50 % NPK	49.45	50.77	12.50	12.67	1.74	1.76	12.03	13.50	30.88	31.49	16.46	16.61
100 % NPK	56.18	57.68	13.41	13.59	2.06	2.10	13.63	15.03	35.08	35.77	18.69	18.88
F. test	*	*	*	*	*	*	*	*	*	*	*	*
C- Foliar spraying with some biostimulants:												
Without	49.40	50.71	12.74	12.91	1.79	1.82	12.08	13.50	30.85	31.46	16.44	16.61
Stemo	53.13	54.55	12.98	13.16	1.92	1.94	12.66	14.08	33.17	33.82	17.67	17.84
K. Sal	50.91	52.27	12.84	13.01	1.85	1.87	12.41	13.83	31.80	32.43	16.95	17.12
Super-grow	54.43	55.88	13.06	13.24	1.95	1.98	13.25	14.66	33.97	34.64	18.11	18.30
Mixture	56.19	57.69	13.15	13.33	2.00	2.03	13.75	15.25	35.10	35.79	18.70	18.83
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.48	0.49	0.04	0.04	0.03	0.02	0.60	0.70	0.30	0.31	0.16	017
D- Interactions (F. test):												
A × B	*	*	*	NS	*	NS	NS	NS	*	*	*	*
A × C	NS	NS	NS	*	*	*	NS	NS	NS	NS	NS	NS
B × C	*	*	*	NS	*	*	NS	NS	*	*	*	NS
A × B × C	NS	NS	*	*	NS	NS	NS	NS	*	*	*	*

FYM = Farm yard manure. HA = Humic acid.

Table 5. Plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls in pea leaves as affected by the interaction among organic, NPK fertilization and foliar spraying with some biostimulants during 2013/2014 and 2014/2015 seasons.

Treatments			Plant height (cm)		Fresh weight/plant (g)		Dry weight/plant (g)		Number of leaves/plant		Total leaf area/plant (cm^2)		Total chlorophylls (SPAD)	
Organic	NPK levels	Spraying with biostimulants	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
FYM	50 % NPK	Without	43.76	44.93	12.10	12.26	1.58	1.60	11.00	13.00	27.33	27.88	14.56	14.73
		Stemo	46.80	48.04	12.30	12.47	1.64	1.66	11.00	13.00	29.20	29.79	15.56	15.73
		K. Sal	44.31	45.49	12.26	12.43	1.62	1.64	11.00	13.00	27.66	28.22	14.73	14.90
		Super-grow	48.10	49.38	12.40	12.57	1.68	1.71	12.00	14.33	30.00	30.60	16.03	16.20
		Mixture	49.34	50.66	12.47	12.64	1.72	1.74	12.00	14.33	30.83	31.46	16.43	16.60
	100 % NPK	Without	51.89	53.27	12.95	13.12	1.86	1.89	12.66	13.33	32.43	33.06	17.26	17.43
		Stemo	55.03	56.50	13.19	13.37	1.97	2.00	13.00	14.00	34.36	35.03	18.30	18.46
		K. Sal	53.24	54.66	12.99	13.16	1.89	1.92	13.00	13.66	33.26	33.91	17.73	17.93
		Super-grow	56.60	58.11	13.25	13.43	2.02	2.05	14.00	14.66	35.33	36.01	18.83	19.03
		Mixture	58.17	59.72	13.32	13.49	2.08	2.11	14.00	14.66	36.30	37.00	19.36	19.56
HA	50 % NPK	Without	48.15	49.43	12.53	12.70	1.74	1.76	11.66	12.66	30.06	30.64	16.03	16.20
		Stemo	52.70	54.11	12.72	12.89	1.87	1.90	12.66	13.33	32.93	33.56	17.53	17.70
		K. Sal	50.37	51.72	12.58	12.75	1.76	1.79	12.00	13.00	31.50	32.10	16.76	16.93
		Super-grow	54.33	55.78	12.79	12.96	1.85	1.88	13.00	13.66	33.93	34.59	18.06	18.26
		Mixture	56.66	58.16	12.88	13.06	1.92	1.95	14.00	14.66	35.36	36.04	18.86	18.83
	100 % NPK	Without	53.79	55.22	13.37	13.55	2.00	2.03	13.00	15.00	33.60	34.28	17.90	18.10
		Stemo	58.01	59.55	13.72	13.90	2.19	2.23	14.00	16.00	36.20	36.93	19.30	19.46
		K. Sal	55.74	57.23	13.53	13.71	2.12	2.15	13.66	15.66	34.80	35.50	18.56	18.73
		Super-grow	58.71	60.28	13.82	14.01	2.24	2.27	14.00	16.00	36.63	37.37	19.53	19.73
		Mixture	60.61	62.22	13.94	14.13	2.29	2.32	15.00	17.33	37.90	38.66	20.16	20.33
LSD at 5 %			0.98	0.99	0.09	0.08	0.05	0.04	NS	NS	0.60	0.65	0.32	0.36

FYM = Farm yard manure. HA = Humic acid.

Table 6. Nitrogen, phosphorus, potassium and calcium percentages in pea leaves as affected by organic, NPK fertilization and foliar spraying with some biostimulants as well as their interaction during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	N (%)		P (%)		K (%)		Ca (%)	
	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
A- Organic fertilization treatments:								
FYM	3.12	3.18	0.278	0.295	3.50	3.58	1.54	1.61
HA	3.37	3.44	0.294	0.312	3.66	3.75	1.69	1.76
F. test	*	*	*	*	*	*	*	*
B- NPK fertilization levels:								
50 % NPK	3.04	3.10	0.272	0.289	3.42	3.50	1.48	1.54
100 % NPK	3.45	3.52	0.300	0.319	3.75	3.84	1.75	1.82
F. test	*	*	*	*	*	*	*	*
C- Foliar spraying with some biostimulants:								
Without	3.04	3.10	0.264	0.280	3.43	3.51	1.72	1.79
Stemo	3.27	3.33	0.289	0.307	3.57	3.66	1.62	1.69
K. Sal	3.13	3.19	0.276	0.293	3.68	3.76	1.55	1.62
Super-grow	3.35	3.41	0.296	0.314	3.49	3.58	1.68	1.76
Mixture	3.45	3.52	0.306	0.325	3.74	3.83	1.50	1.56
F. test	*	*	*	*	*	*	*	*
LSD at 5 %	0.03	0.03	0.003	0.003	0.04	0.04	0.03	0.03
D- Interactions (F. test):								
A × B	*	*	*	NS	NS	NS	NS	NS
A × C	NS	NS	NS	NS	*	*	*	*
B × C	*	*	NS	NS	NS	NS	NS	NS
A × B × C	NS	NS	*	*	*	*	NS	NS

FYM = Farm yard manure. HA = Humic acid.

Table 7. Nitrogen, phosphorus, potassium and calcium percentages in pea leaves as affected by the interaction among organic, NPK fertilization and foliar spraying with some biostimulants during 2013/2014 and 2014/2015 seasons.

Treatments			N (%)		P (%)		K (%)		Ca (%)	
Organic	NPK levels	Spraying with biostimulants	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
FYM	50 % NPK	Without	2.69	2.74	0.241	0.256	3.16	3.23	1.50	1.56
		Stemo	2.88	2.93	0.263	0.280	3.32	3.40	1.44	1.50
		K. Sal	2.72	2.78	0.253	0.268	3.41	3.49	1.36	1.41
		Super-grow	2.96	3.02	0.267	0.284	3.24	3.31	1.50	1.57
		Mixture	3.03	3.10	0.278	0.295	3.50	3.58	1.31	1.36
	100 % NPK	Without	3.19	3.25	0.272	0.289	3.52	3.60	1.80	1.87
		Stemo	3.38	3.45	0.299	0.317	3.68	3.76	1.64	1.71
		K. Sal	3.27	3.34	0.285	0.303	3.76	3.85	1.60	1.67
		Super-grow	3.48	3.55	0.306	0.326	3.58	3.67	1.73	1.80
		Mixture	3.58	3.65	0.315	0.335	3.87	3.97	1.56	1.62
HA	50 % NPK	Without	2.96	3.02	0.261	0.277	3.39	3.47	1.64	1.70
		Stemo	3.24	3.30	0.286	0.304	3.52	3.61	1.59	1.65
		K. Sal	3.10	3.16	0.268	0.285	3.61	3.69	1.47	1.54
		Super-grow	3.34	3.41	0.294	0.312	3.47	3.55	1.61	1.68
		Mixture	3.48	3.55	0.307	0.326	3.58	3.66	1.42	1.48
	100 % NPK	Without	3.31	3.37	0.282	0.300	3.65	3.74	1.94	2.02
		Stemo	3.57	3.64	0.308	0.327	3.77	3.86	1.82	1.89
		K. Sal	3.43	3.50	0.296	0.315	3.93	4.02	1.79	1.86
		Super-grow	3.61	3.68	0.315	0.335	3.70	3.78	1.90	1.98
		Mixture	3.73	3.80	0.322	0.342	4.02	4.12	1.70	1.77
LSD at 5 %			NS	NS	0.006	0.006	0.07	0.08	NS	NS

FYM = Farm yard manure. HA = Humic acid.

Table 8. Total sugar, total carbohydrates, protein, vitamin-C and nitrate (NO_3) in pea seeds as affected by organic, NPK fertilization and foliar spraying with some biostimulants as well as their interaction during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Total sugars (%)		Total carbohydrates (%)		Protein (%)		Vitamin-C (mg/100g F.W.)		NO_3 (ppm)	
	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
A- Organic fertilization treatments:										
FYM	17.08	17.36	51.10	52.16	21.38	21.45	40.38	40.19	15.66	15.71
HA	17.55	17.85	51.56	52.62	22.17	22.26	43.30	43.10	15.45	15.50
F. test	*	*	*	*	*	*	*	*	*	*
B- NPK fertilization levels:										
50 % NPK	16.86	17.14	50.73	51.78	20.91	20.98	38.70	38.52	15.31	15.36
100 % NPK	17.76	18.07	51.93	53.01	22.65	22.74	44.98	44.77	15.81	15.86
F. test	*	*	*	*	*	*	*	*	*	*
C- Foliar spraying with some biostimulants:										
Without	16.61	16.90	50.42	51.47	20.72	20.80	40.02	39.84	15.70	15.74
Stemo	17.40	17.69	51.31	52.37	21.82	21.91	41.98	41.79	15.61	15.66
K. Sal	17.01	17.28	50.77	51.82	21.26	21.34	40.99	40.80	15.57	15.62
Super-grow	17.67	17.95	51.82	52.89	22.32	22.41	42.70	42.51	15.50	15.55
Mixture	17.89	18.20	52.32	53.41	22.77	22.82	43.50	43.29	15.41	15.46
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.05	0.05	0.04	0.03	0.17	0.16	0.46	0.45	0.05	0.05
D- Interactions (F. test):										
A × B	*	NS	*	NS	*	*	NS	NS	NS	NS
A × C	NS	NS	*	*	NS	NS	NS	NS	NS	*
B × C	NS	NS	*	*	NS	*	NS	NS	NS	NS
A × B × C	*	*	*	*	NS	*	NS	NS	NS	*

FYM = Farm yard manure. HA = Humic acid.

Table 9: Total sugar, total carbohydrates, protein percentages, vitamin-C and nitrate (NO_3) in pea seeds as affected by the interaction among organic, NPK fertilization and foliar spraying with some biostimulants during 2013/2014 and 2014/2015 seasons.

Treatments			Total sugars (%)		Total carbohydrates (%)		Protein (%)		Vitamin-C (mg/100g F.W.)		NO_3 (ppm)	
Organic	NPK levels	Spraying with biostimulants	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
FYM	50 % NPK	Without	15.95	16.20	49.66	50.69	19.43	19.51	35.83	35.67	15.50	15.55
		Stemo	16.62	16.89	50.59	51.63	20.62	20.71	37.33	37.16	15.43	15.47
		K. Sal	16.30	16.55	49.88	50.92	19.85	19.93	36.80	36.63	15.42	15.46
		Super-grow	16.94	17.19	50.97	52.02	20.92	21.00	37.76	37.59	15.36	15.41
		Mixture	17.19	17.49	51.46	52.53	21.31	21.25	38.16	37.99	15.33	15.38
	100 % NPK	Without	16.85	17.14	50.66	51.71	21.10	21.19	41.60	41.40	16.07	16.11
		Stemo	17.67	17.96	51.61	52.67	22.50	22.59	43.53	43.33	16.00	16.04
		K. Sal	17.25	17.50	50.97	52.03	21.77	21.86	42.83	42.63	15.95	16.00
		Super-grow	17.93	18.24	52.30	53.38	23.04	23.13	44.53	44.33	15.87	15.91
		Mixture	18.10	18.45	52.91	54.04	23.29	23.38	45.43	45.22	15.74	15.78
HA	50 % NPK	Without	16.41	16.69	50.17	51.21	20.46	20.54	38.30	38.12	15.34	15.38
		Stemo	17.28	17.54	50.91	51.96	21.23	21.31	40.13	39.95	15.27	15.32
		K. Sal	16.77	17.04	50.44	51.48	20.81	20.89	39.16	38.98	15.23	15.27
		Super-grow	17.50	17.80	51.32	52.38	21.81	21.90	41.20	41.01	15.15	15.20
		Mixture	17.72	18.02	51.90	52.98	22.64	22.73	42.33	42.13	15.07	15.12
	100 % NPK	Without	17.22	17.58	51.21	52.26	21.87	21.96	44.36	44.16	15.88	15.93
		Stemo	18.03	18.39	52.14	53.22	22.96	23.05	46.93	46.71	15.76	15.81
		K. Sal	17.72	18.02	51.80	52.87	22.60	22.69	45.16	44.95	15.70	15.75
		Super-grow	18.32	18.60	52.70	53.79	23.52	23.61	47.33	47.11	15.63	15.68
		Mixture	18.55	18.86	53.00	54.10	23.85	23.94	48.06	47.84	15.51	15.56
LSD at 5 %			0.09	0.11	0.07	0.08	NS	NS	NS	0.27	NS	0.07

FYM = Farm yard manure. HA = Humic acid.

Table 10: 100-seed weight and total green yield/fed of pea as affected by organic, NPK fertilization and foliar spraying with some biostimulants as well as their interaction during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	100-seed weight (g)		Total green yield (t/fed)	
	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
A- Organic fertilization treatments:				
FYM	53.38	55.51	4.027	4.106
HA	57.78	60.09	4.359	4.445
F. test	*	*	*	*
B- NPK fertilization levels:				
50 % NPK	52.04	54.12	3.925	4.002
100 % NPK	59.12	61.48	4.461	4.548
F. test	*	*	*	*
C- Foliar spraying with some biostimulants:				
Without	51.98	54.06	3.921	3.998
Stemo	55.91	58.15	4.219	4.302
K. Sal	53.58	55.72	4.042	4.121
Super-grow	57.28	59.57	4.322	4.407
Mixture	59.13	61.50	4.461	4.549
F. test	*	*	*	*
LSD at 5 %	0.50	0.51	0.038	0.040
D- Interactions (F. test):				
A × B	*	*	*	*
A × C	NS	NS	*	*
B × C	*	*	*	*
A × B × C	*	*	*	*

FYM = Farm yard manure. HA = Humic acid.

3- Effect of foliar spraying with some biostimulants:

The obtained data presented in Tables 4, 6, 8 and 10 show that foliar spraying treatments with some biostimulants *i.e.* without (control treatment), foliar spraying with Stemo at rate of 0.5 ml/liter water, potassium salicylate (K. Sal) at rate of 2.0 ml/liter water, Super-grow at rate of 1.5 ml/liter water and the mixture of Stemo at rate of 0.25 ml/liter water + K. Sal at rate of 1.00 ml/liter water + Super-grow at rate of 0.75 ml/liter water significantly affected plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, nitrogen, phosphorus, potassium and calcium percentages in pea leaves, total sugar, total carbohydrates, protein, vitamin-C and nitrate (NO_3) in pea seeds, 100-seed weight and total green yield/fed of pea. This observation was true during the two growing seasons of 2013/2014 and 2014/2015. Foliar spraying with mixture exceeded other foliar spraying treatments with some biostimulants and produced the highest values of all studied characters in both seasons. Followed by foliar spraying with Super-grow then Stemo and K. Sal in both seasons. Whereas, the lowest values of these characters were resulted from control treatment (without foliar application) both seasons. These results by three times foliar spraying with the mixture of Stemo + K. Sal + Super-grow may be due to the favourable effects of Stemo as a growth regulator + K. Sal + Super-grow as a growth regulator, stimulator and antioxidant. Where, growth regulator promotes hypocotyls growth, cell division and leaves size (Spaepen *et al.*, 2009). Besides, the role of plant growth biostimulants in regulating a number of physiological processes such as growth, photosynthesis, nitrate metabolism, ethylene production, flowering and also provide protection against biotic and abiotic stresses such as salinity in plants, which was reflected on increases in plant growth characters such as plant height, fresh and dry weights/plant of pea plants. These results were parallel with those reported by Calvo *et al.* (2014), Rose *et al.* (2014), Shalaby and El-Ramady (2014) and Saa *et al.* (2015).

4- Effect of interactions:

The various interactions among the three studied factors *i.e.* organic, NPK fertilization and foliar spraying with some biostimulants had many significant effects on plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, nitrogen, phosphorus, potassium and calcium percentages in pea leaves, total sugar, total carbohydrates, protein, vitamin-C and nitrate (NO_3) in pea seeds, 100-seed weight and total green yield/fed of pea in both seasons as presented in Tables 4, 6,8 and 10.

The interaction among organic, NPK fertilization and foliar spraying with some biostimulants had significant effects on plant height, fresh and dry weights/plant, total leaf area/plant and total chlorophylls, plant height, fresh and dry weights/plant, number of leaves/plant, total leaf area/plant and total chlorophylls, phosphorus and potassium percentages in pea leaves, total sugar, total carbohydrates, protein and nitrate (in the second season) in pea seeds, 100-seed weight and total green yield/fed of pea in both seasons. The highest values of these characters were resulted from organic fertilizing with HA at the rate of 20 kg/fed and mineral fertilizing with 80 kg N + 40 kg P_2O_5 + 80 K_2O/fed in addition to foliar spraying three times with the mixture of biostimulants *i.e.* Stemo at rate of 0.25 ml/liter water + K. Sal at rate of 1.00 ml/liter water + Super-grow at rate of 0.75 ml/liter water in both seasons as shown from data presented in Tables 5, 7, 9 and 11.

Table 11. 100-seed weight and total green yield/fed of pea plants as affected by the interaction among organic, NPK fertilization and foliar spraying with some biostimulants during 2013/2014 and 2014/2015 seasons.

Treatments			100-seed weight (g)		Total green yield (t/fed)	
Organic	NPK levels	Spraying with biostimulants	2013/ 2014	2014/ 2015	2013/ 2014	2014/ 2015
FYM	50 % NPK	Without	46.05	47.90	3.473	3.543
		Stemo	49.25	51.22	3.717	3.790
		K. Sal	46.62	48.48	3.513	3.583
		Super-grow	50.61	52.64	3.817	3.893
		Mixture	51.93	54.01	3.917	3.997
	100 % NPK	Without	54.60	56.79	4.120	4.200
		Stemo	57.91	60.23	4.370	4.453
		K. Sal	56.03	58.27	4.227	4.307
		Super-grow	59.56	61.95	4.493	4.580
		Mixture	61.22	63.66	4.620	4.710
HA	50 % NPK	Without	50.67	52.70	3.820	3.893
		Stemo	55.46	57.68	4.183	4.263
		K. Sal	53.01	55.12	4.000	4.077
		Super-grow	57.17	59.45	4.313	4.397
		Mixture	59.62	62.01	4.497	4.583
	100 % NPK	Without	56.60	58.87	4.270	4.353
		Stemo	61.05	63.49	4.607	4.700
		K. Sal	58.65	61.00	4.427	4.517
		Super-grow	61.78	64.25	4.663	4.757
		Mixture	63.78	66.33	4.810	4.907
LSD at 5 %			1.01	1.03	0.077	0.079

FYM = Farm yard manure. HA = Humic acid.

The second best interaction treatment was organic fertilizing with HA and mineral fertilizing with100% of the recommended doses(80 kg N + 40 kg P_2O_5 + 80 K_2O/fed) in addition foliar spraying three times with Super-grow in both seasons. While, organic fertilizing with FYM and mineral fertilizing with 50 % of the recommended doses (40 kg N + 20 kg P_2O_5 + 40 K_2O/fed) without foliar spraying with biostimulants resulted in the lowest values of these characters in both seasons.

CONCLUSION

This study conclude that organic fertilizing pea plants with humic acid at the rate of 20 kg/fed and mineral fertilizing with 80 kg N + 40 kg P_2O_5 + 80 K_2O/fed in addition to foliar spraying three times with the mixture of biostimulants *i.e.* Stemo at rate of 0.25 ml/liter water + K. Sal at rate of 1.00 ml/liter water + Super-grow at rate of 0.75 ml/liter water in order to maximizing pea growth, yield and quality under the environmental conditions of Dakahlia Governorate, Egypt.

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تـأثير التسـميد العضـوى والمعدنى والـرش الـورقى بـبعض المنشـطات الحيويـة علـى النمـو والمحصـول والتركيـب الكيميائي للبسلة

حسام محمد السعيد عبد النبى ، السعيد لطفى السيد فتحى ، السيد إبراهيم الجميلى ونورجيهان محمود سالم
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أجريت تجربتان حقليتان بالمزرعة البحثية بمحطة التجارب والبحوث الزراعية بكلية الزراعة، جامعة المنصورة، مصر، خلال موسمى ٢٠١٣/٢٠١٤ و٢٠١٤/٢٠١٥ لدراسة تأثير التسميد العضوى (السماد البلدى"FYM" بمعدل ٢٠ طن / فدان وحمض الهيومك "HA" بمعدل ٢٠ كجم / فدان) والمعدنى (٥٠٪ من المعدل الموصى به من النيتروجين والفوسفور والبوتاسيوم "NPK"، أي ٤٠ كجم N + ٢٠ كجم P_2O_5 + ٤٠ كجم K_2O / فدان و ١٠٠٪ من الجرعات الموصى بها أي ٨٠ كجم N + ٤٠ كجم P_2O_5 + ٨٠ كجم K_2O / فدان) والرش الورقى ببعض منشطات النمو (بدون (كنترول) - الرش الورقي بـ Stemo بمعدل ٠.٥ مل / لترماء ، سالسيلات البوتاسيوم بمعدل ٢.٠ مل / لتر ماء، Super-grow بمعدل ١.٥ مل / لتر ماء ومزيج من Stemo بمعدل المياه ٠.٢٥ مل / لتر + سالسيلات البوتاسيوم بمعدل ١.٠٠ مل / لتر ماء + Super-grow بمعدل المياه ٠.٧٥ مل / لتر) على النمو والمحصول والتركيب الكيميائي للبسلة صنف ماستر بى. وقد أجريت التجربة في تصميم الشرائح المتعامدة المنشقة فى ثلاث مكررات. ويمكن تلخيص النتائج المتحصل عليها كما يلي: سجلت أعلى القيم من جميع الصفات المدروسة نتيجة التسميد العضوى لنباتات البسلة بحمض الهيومك (HA) بمعدل ٢٠ كجم / فدان .- أدت زيادة مستويات التسميد المعدنى بالنيتروجين والفوسفور والبوتاسيوم "NPK" ٥٠٪ من المعدل الموصى به (٤٠ كجم نيتروجين + ٢٠ كغ P2O5 + 40 K2O / فدان) إلى ١٠٠٪ من المعدل الموصى به (٨٠ كجم N + ٤٠ كجم P_2O_5 + ٨٠ كجم K_2O / فدان) إلى زيادة معنوية فى جميع الصفات تحت الدراسة فى كلا الموسمين.- أظهر الرش الورقى بخليط من منشطات النمو (Stemo بمعدل المياه ٠.٢٥ مل / لتر + سالسيلات البوتاسيوم بمعدل ١.٠٠ مل / لتر ماء + Super-grow بمعدل المياه ٠.٧٥ مل / لتر) تفوق معنوى على معاملات الرش الورقى الأخرى بمنشطات النمو والحصول على أعلى القيم من جميع الصفات المدروسة في كلا الموسمين.- توصى نتائج هذه الدراسة بتسميد نباتات البسلة عضوية بحمض الهيومك بمعدل ٢٠ كجم / فدان والتسميد المعدني بـ ٨٠ كجم N + ٤٠ كجم P_2O_5 + ٨٠ كجم K_2O / فدان بالإضافة إلى الرش الورقى ثلاث مرات بخليط من Stemo بمعدل ٠.٢٥ مل / لتر ماء+ ساليسيلات البوتاسيوم بمعدل ١.٠٠ مل / لتر ماء + Super-grow بمعدل ٠.٧٥ مل / لترماء للحصول على أقصى قدر من النمو والمحصول والجودة لمحصول البسلة تحت الظروف البيئية لمحافظة الدقهلية، مصر.