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Response of Early Sowing Pea Crop to some Natural and Chemical Substances for Improving Yield and Quality and Components

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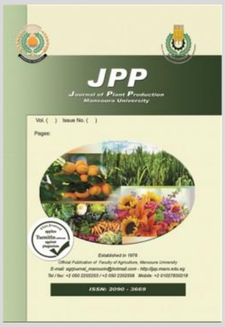

ABSTRACT

Two field experiments were conducted at Private Farm in El-Gammalia at District, Dakahlia at Governorate, Egypt during winter seasons of 2016 and 2017 to study the effect of some natural and chemical substances effective microorganisms (EM) at 2 l/fed, humic acid at 2kg/ fed, moringa leaf extract (MLE) at 1ml/ 32 ml, yeast extract at 50 ml/ l, potassium citrate 5 ml/ l as well as silicon 300 mg/ l and boron 50 mg/ l on vegetative growth, pod yield and quality of early sowing pea crop. The results showed that EM at 2 l/ fed + humic acid at 2kg/ fed gave rise to more number of leaves and branches, longest plant height, heaviest fresh and dry weight, largest leaf area, and gave the highest number of pods/plant, average weight of pod (gm), pod yield/plant (gm) and total pod yield (ton/fed.). pod length, pod diameter, pod thickness, total soluble solids (TSS), vitamin C (mg/100g fw), and protein contents (%) and the lowest in titrable acidity. All foliar applications significantly increased all the studied parameters compared with the control treatment. The superior application was moringa leaf extract (MLE) followed by yeast extract and potassium citrate in both seasons, respectively. From the obtained results it could be concluded that EM at 2L/ fed + humic acid at 2kg/ fed and sprayed moringa leaf extract at 15,25 and 35 days after sowing resulted in improving growth, yield and pod quality of pea plants grown under early sowing conditions.

Keywords: Pea, EM, humic acid, moringa leaf extract (MLE), yeast extract, boron and potassium citrate, silicon, growth, pod yield, quality.

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 contain a great amount of protein and carbohydrates, iron, phosphorus, calcium, zinc, copper, vitamins, A, B_{12} (Kent and Endres, 2003).

Pea is mainly grown in winter from mid October to mid November to produce high yield and good quality because of suitability of environmental conditions. However, the price is relatively low so some growers tend to cultivate pea in September for early producing to increase the economic income. High temperature is one of the most important abiotic stress factors affect plant growth and fruit set (Rivero *et al*., 2004). Higher temperature stress accelerates damaged chloroplast, reduces carbohydrate synthesis and exportation and hastens oxygen species, which attack cell membranes led to their degradation, leakage of cell solutes, denaturation of proteins and enzymes, damage of nucleic acids, degradation of chlorophyll and suppression of all metabolic processes finally senescence and death of cells and tissues, hence, stimulate flower abortion and reduction of yield Wahid *et al.*, (2007).

Some agricultural treatments were used to improve yield and quality of pea plants under heat stress conditions. To secure further information in this regard, this present study was carried. Recently, great attention has been focused on the possibility of using natural and safe substituents, i.e., EM, humic acid, moringa leaf extract, yeast extract, potassium citrate, silicon and boron in order to improve plant growth, flowering, fruit setting and total yield of pea plants.

Among the main microorganisms in EM culture are the species of photosynthetic bacteria (*Rhodopseudomonas plastris* and *Rhodobacter sphacrodes*), lactobacilli (*Lactobacillus plantarum*, *L. casei*, and *Streptococcus lactis*), yeasts (*Saccharomyces spp*.), and actinomycetes (*Strptomyces spp*.). Microorganisms in EM improve crop health and yield by increasing photosynthesis, producing bioactive substances such as hormones and enzymes, accelerating decomposition of organic materials, controlling soil-borne diseases, limiting putrefaction and increasing soil fertility (Hussain *et al*. 2002).

Humic is acid known to be involve in osmo-regulation and anti-oxidation processes, increasing vitamin contents of plant, stimulating plant enzymes, increasing the permeability of plant membranes, promoting the uptake of nutrients increasing cation exchange capacity (CEC), stimulation root growth, especially lengthwise, chelating and retention of elements and improving root formation (Mackowiak *et al*., 2001).

Natural bio stimulants compounds are considered the most important strategies for increasing production and improving quality of pea plants. These compounds prefer to be safety to the environment, inexpensive and harmless to humans. Moringa (*Moringa oleifera*) is known as a miracle plant due to its multiple uses. Secondary

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metabolites isolated from this plant promote the plant growth and defense mechanisms against abiotic stresses. Being rich in amino acids, ascorbate, zeatin, minerals and many other compounds, moringa has several applications in agriculture and medical sciences (Hussain *et al*., 2013).

Yeast extract is a natural bio-substance suggested to be of useful promotional and nutritional functions, due to their hormones, sugars, amino acids, nucleic acids, vitamins and minerals content. It contains a natural growth regulator, especially, cytokinin which play an important role and had a simulative effect on cell division, enlargement, protein and nucleic acids synthesis. The yeast also contains tryptophan which considered the precursor of IAA, Consequently, the application of yeast extract produced more IAA which increased plant growth (Abdel-Latif, 1987).

Potassium is a major plant nutrient, which is essential for a variety of physiological processes i.e. photosynthesis, protein synthesis, enzyme activation, maintenance of water status in plant tissues, location, transformation and storage of carbohydrates, tuber quality and processing characteristics as well as plant resistance to stresses and diseases (Marschner, 2012). Potassium citrate is potassium salt of citric acid which considered one of the most important organic acids in the respiratory pathways into plant cell (Ibrahim *et al*., 2015).

Silicon application is using as a tool for increasing productivity and quality of pea. Silicon can alleviate biotic and abiotic stresses in several crops, and it has beneficial effects on plants under nonstressed conditions (Pilon *et al*., 2013). Moreover, silicon is an element that forms Si-enzyme complex that act as protectors and photosynthesis regulators as well as influencing other enzymatic activities (Toresano-Sanchez *et al*., 2012).

Boron is unique, not only in its chemical properties, but also in its roles in biology. Boron is directly or indirectly involved in several physiological and biochemical processes during plant growth (Singh *et al*., 2012). Boron plays an important role in cell wall synthesis and structure, signification membranes, carbohydrate metabolism, sugar translocation, phenol or RNA metabolism, respiration, IAA and other phytohormone metabolism (Parr and Loughman, 1983).

Thereby, the present study was designed to investigate the effect of soil and foliar applications of some natural and chemical substances, EM, humic acid, moringa leaf extract, yeast extract, potassium citrate, silicon and boron on growth, pod yield and quality of pea grown in clay soil.

MATERIALS AND METHODS

Two field experiments were conducted at Private Farm in El-Gammalia District, Dakahlia Governorate, Egypt during winter seasons of 2016 and 2017 to study the effect of some natural and chemical substances (EM, humic acid, moringa leaf extract, yeast extract, potassium citrate, silicon and boron) on vegetative growth, pod yield, quality and storability of early sowing pea crop.

The physical and chemical analysis of the experimental soil are shown in Table (1).

The experimental layout was split-plot system in a randomized complete block design with three replicates. The experiment included 24 treatments which were the combination among 4 soil applications and 6 foliar applications.

Table 1. The physical and chemical analysis of the experimental soil.

Properties	Value	Properties	Value
Physical		Soluble anions (meq/100g soil)	
Soil texture	Clay	HCO_3^-	0.40
Organic matter %	1.0085	CL^-	0.33
Chemical		SO_4^{--}	0.04
E.C. (mmohs/cm)	1.15	Macro-elements (ppm)	
pH	7.53	N	23.625
Soluble cations (meq/100g soil)		P	21.00
Ca^{++}	0.33	K	140.00
Mg^{++}	0.25		
Na^+	0.12		
K^+	0.07		

Soil applications were randomly arranged in the main plots, while foliar applications were randomly distributed in the sub-plots. The sub -plot area was 11.0 m^2 (2 ridge, each 5.5 m long and 100 cm width). The treatments were arranged as follow:

a. Soil applications:

1- EM 2 L/ fed..
2- Humic acid 2 kg/fed.
3- Humic acid 2kg/ fed + EM ٢/l/ fed.
4- Control.

b. Foliar applications:

1- Moringa leaf extract at 1 ml/ 32ml.
2- Yeast extract at 50 ml/l.
3- Potassium citrate at 5 ml/ l.
4- Silicon in form of (silicic acid, Si $(OH)_4$) at 300 mg/l.
5- Boron at 50 mg/L.
6- Control (sprayed with tap water).

All above chemicals obtained from El-Gomhoria Chemical Company. Except, EM was obtained from Egyptian Ministry of Agriculture and humic acid was obtained from private company.

Moringa leaf extract prepared according to Culver *et al.* (2012) as follow: An amount of 20 g of young moringa leaves (shoots were harvested at 35 days after emergence) was mixed with 675 ml of 80% ethanol. The suspension was stirred using a homogenizer to help maximize the amount of the extract. The solution was then filtered by wringing the solution using a mutton cloth. The solution was re-filtered using Whatman No. 2 filter paper. The extract was diluted with distilled water at a ratio 1:32 (v/v) and then sprayed directly onto plants.

The plants were sprayed with foliar treatments at 15,25 and 35 days after sowing. As for soil application, EM and HA were added at 10 and 20 days after sowing.

During preparing the soil, ditches of 20 cm width were performed. Organic manure (15 ton compost/fed.) and basal fertilizers (50, 200, 50 and 25 kg/fed. of ammonium sulphate, calcium super-phosphate, potassium sulphate and sulfur fertilizers, respectively) were added through the ditches and then were covered by soil.

Seeds of Master B cultivar were obtained from Hort. Res. Inst. Seeds were sown immediately with in hills (3-4 seeds/hill) on 10th and 15th of September in the first and the second seasons, respectively and thinned on two plants/ hill. Seedlings were sowing at 20 cm apart on four side of ridge.

The normal agricultural practices of pea production were followed according to the recommendations of Egyptian Ministry of Agriculture.

Data recorded:

a.Vegetative growth:

At 45 days after sowing, five plants were randomly taken from each plot for determining the following data:

Plant height (cm), number of branches/plant, number of leaves/plant, leaf area (cm^2/plant), fresh weight (gm/plant) and dry weight (gm/plant).

b. Pod yield and its components:

The mature green pods of pea plants were harvested at 60 days after sowing, then counted and weighed in each harvest and the following parameters were collected: Number of pods/plant, average weight of pod (gm), pod yield/plant (gm) and total pod yield (ton/fed.).

c. Pod quality:

Pod length (cm), pod diameter (mm), pod thickness (mm), total soluble solids (TSS) was determined by Carl Zeiss refractometer, vitamin C (mg/100 gfw) was determined in juice using 2,6-dichlorophenolindophenol dye (A.O.A.C., 1990), titrable acidity (%) was determined by the titration method with 0.1 sodium hydroxide using phenolphthalein indicator (A.O.A.C., 1990) and crude protein content was determined as total nitrogen multiplied by 6.25 to calculated total crude protein.

All collected data were subjected to the statistical analysis according to the method mentioned by Snedecor and Cochran (1968). The data of treatment means were compared using least significant difference (LSD) method as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Vegetative growth characters:

Data in tables (2 and 3) show the effect of soil and foliar applications of some natural and chemical substances and interactions on vegetative growth parameters, i.e., plant height, number of leaves and branches/plant, leaf area/plant and fresh and dry weight/plant of pea grown in clay soil.

Effect of soil applications:

Data presented in Table (2) show that soil applications had significant effect on plant height, number of leaves and branches/plant, leaf area/plant and fresh and dry weight/plant in both seasons. However, EM+ humic acid had higher values than other soil applications in all aforementioned characters followed by EM, whereas the least one was control in both seasons.

Effect of foliar applications:

Data presented in Table (2) show that foliar applications, i.e., moringa leaf extract, yeast extract, potassium citrate, silicon and boron significantly increased plant height, number of leaves and branches/plant, leaf area/plant and fresh and dry weight/plant of pea compared to control. The best application in all studied characters was moringa leaf extract followed by yeast extract.

Table 2. Effect of some natural and chemical substances as soil and foliar applications on plant height, number of leaves/ plant, number of branches/ plant, leaf area, fresh and dry weight of pea at 45 days after sowing during 2016 and 2017 seasons.

Treatments		Plant height (cm)		No of leaves/plant		No of branches/plant		Leaf area/ plant (cm^2)		Fresh weight/ plant (gm)		Dry weight/ plant (gm)	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
soil	EM at 2 l/F	63.33	64.23	17.11	19.35	1.86	1.88	557.08	675.16	9.59	14.78	2.97	4.50
	Humic acid at 2 kg/F	62.54	62.47	16.22	18.18	1.69	1.61	513.28	636.58	8.95	13.20	2.85	4.24
	EM at 2 l/F + Humic acid at 2kg/F	64.50	69.12	18.13	16.69	2.08	2.21	611.85	724.01	10.61	16.38	3.11	4.82
	Control	61.83	60.83	15.72	16.02	1.63	1.61	470.78	582.16	8.10	12.53	2.76	3.88
L.S.D at 5 %		1.80	0.95	0.63	0.63	1.81	0.42	57.62	54.39	0.89	1.40	0.15	0.36
Foliar	MLE at 1ml/ 32 ml	65.73	70.73	19.33	20.62	2.25	2.49	673.71	792.78	11.96	18.11	3.23	5..28
	Yeas t extract at 50ml/l	65.50	69.23	18.62	20.23	2.08	2.33	661.14	772.25	11.05	17.70	3.13	5.14
	Potassium citrate at 5 ml/l	64.58	67.69	18.08	19.83	2.04	2.27	625.33	747.75	10.58	15.70	3.07	4.98
	Silicon at 300 ppm	61.62	61.36	15.54	15.92	1.62	1.55	461.87	571.75	7.91	12.15	2.80	3.81
	Boron at 50 ppm	61.37	60.24	15.29	15.2	1.58	1.33	435.56	554.62	7.71	11.94	2.77	3.69
	Control	59.50	55.66	13.91	13.57	1.33	1.00	365.87	487.62	6.63	9.75	2.50	3.25
L.S.D at 5 %		1.79	2.12	1.33	2.31	0.39	0.39	60.12	47.14	0.95	1.67	0.24	0.31

S1: 2016 season, S2: 2017 season, EM: effective microorganisms and MLE: moringa leaf extract

Effect of the interactions:

Data in Table (3) show that the interactions between soil and foliar applications had significant effect on plant height, number of leaves and branches/plant, leaf area/plant and fresh and dry weight/plant of pea in both seasons compared with the control.

In general, the best interaction in all studied characters was the interaction between EM + humic acid and moringa leaf extractfollowed by the interaction between EM + humic acid × yeast extract in the two seasons. While, the lowest one was resulted from control in both seasons.

Initiation of sprouting liberates certain amounts of sugars and other organic compounds thanks to the association with microorganisms synthesising vitamins, auxins or substances similar to gibberellins (Myszka and Czaczyk, 2006).

EM application exhibited variable eff ects on plant vegetative and reproductive growth in different soil amendment (Javaid and Bajwa, 2010). According to Mayer *et al.* (2010), who observed that checking of plant growth following EM application caused by an increase in nitrogen and crop plants. An absence of the EM effect on crop plants was also demonstrated by Javaid *et al.* (2008) in his investigations, in which rye was cultivated in containers with a substrate treated with EMs. Adding EM and HA to clay soil (Table 1) as soil amendment for increasing soil fertility

Table 3. Effect of the interaction between soil and foliar applications of some natural and chemical substances on plant height, number of leaves and number of branches, leaf area, fresh and dry weight of pea at 45 days after sowing during 2016 and 2017 seasons.

Treatments		Plant height (cm)		No of leaves/ plant		No of branches/ plant		Leaf area /plant (cm^2)		Fresh weight/plant (gm)		Dry weight/plant (gm)	
		S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
	interaction												
EM at 2L/F	MLE at 1ml/ 32 ml	65.50	68.63	19.16	21.93	2.33	2.66	710.19	809.01	12.52	18.50	3.29	5.39
	Yeast extract at 50ml	65.33	68.38	19.14	21.18	2.16	2.33	682.15	798.04	11.85	18.00	3.16	5.24
	Potassium citrate at 5 ml/L	66.00	68.01	18.33	20.72	2.12	2.32	630.93	786.011	10.63	17.16	309	5.32
	Silicon at 300 ppm	61.83	64.26	16.22	16.12	1.66	1.66	485.53	572.04	8.04	12.21	2.88	3.98
	Boron at 50 ppm	61.33	62.37	16.03	15.5	1.66	1.33	455.51	551.06	7.91	12.31	2.86	3.81
	Control	59.66	56.11	14.16	13.64	1.33	1.00	378.31	488.71	6.57	10.52	2.53	3.25
Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	64.43	67.35	18.11	19.65	2.05	2.01	617.51	768.52	11.16	16.55	3.05	5.12
	Yeast extract at 50ml	65.66	66.23	17.83	19.2	1.83	1.99	631.12	763.55	10.73	16.44	3.05	5.09
	Potassium citrate at 5 ml/L	63.50	66.12	17.83	18.37	1.83	1.99	596.59	713.08	10.36	15.29	3.03	4.75
	Silicon at 300 ppm	61.33	62.18	15.16	15.1	1.66	1.33	434.11	541.51	7.54	11.86	2.76	3.67
	Boron at 50 ppm	61.00	62.07	14.83	14.32	1.50	1.33	429.32	525.21	7.46	11.66	2.74	3.61
	Control	59.33	55.44	13.66	13.51	1.33	1.00	371.02	482.62	6.44	7.39	2.50	3.21
EM at 2L/F + Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	69.16	81.33	22.5	22.65	2.83	2.99	805.12	899.51	13.99	22.44	3.59	5.99
	Yeast extract at 50ml	67.00	77.66	20.56	22.46	2.58	2.89	751.98	864.02	13.06	21.80	3.34	5.76
	Potassium citrate at 5 ml/L	66.00	72.33	19.16	22.05	2.51	2.82	720.19	852.51	12.57	16.84	3.31	5.68
	Silicon at 300 ppm	62.50	60.31	16.33	18.15	1.66	1.66	503.32	604.12	8.68	13.23	2.94	4.09
	Boron at 50 ppm	62.33	59.38	16.16	16.95	1.66	1.66	486.86	597.56	8.43	13.01	2.92	4.02
	Control	60.00	56.82	14.16	13.86	1.33	1.00	403.56	510.45	6.96	10.99	2.56	3.40
Control	MLE at 1ml/ 32 ml	64.00	65.84	17.66	18.25	1.83	2.33	586.04	694.53	10.18	14.96	3.01	4.63
	Yeast extract at 50ml	63.83	64.68	17.16	18.08	1.83	2.03	579.33	675.52	8.37	14.55	2.97	4.50
	Potassium citrate at 5 ml/L	62.83	64.33	17.00	18.18	1.83	1.78	553.62	627.42	8.76	13.50	2.95	4.18
	Silicon at 300 ppm	60.83	58.71	14.66	14.32	1.50	1.55	424.52	524.23	7.37	11.31	2.62	3.50
	Boron at 50 ppm	60.50	57.16	14.16	14.05	1.50	1.00	370.66	501.24	7.02	10.79	2.57	3.34
	Control	59.00	54.29	13.66	13.28	1.33	1.00	310.52	469.32	6.57	10.11	2.50	3..13
L.S.D at 5 %		3.59	4.25	2.67	4.62	0.79	0.78	120.24	94.28	1.90	3.34	0.49	0.62

S1: 2016 season, S2: 2017 season, EM: effective microorganisms and MLE: moringa leaf extract.

In addition, HA may stimulate plant growth by acting as a plant growth regulator (Rady and Osman, 2011). HA led to higher rates of uptake of K+ ions and therefore a corresponding increase in chlorophyll fluorescence, which can serve as an indicator of the stress induced by alterations in the balance of endogenous hormones (Marschner, 1995).

The stimulative effect of moringa leaf extract on vegetative growth might be due to its role as a plant growth stimulator. It being a rich source of amino acids, essential macro and micro plant minerals, vitamins, natural antioxidants and plant growth regulators such as zeatin (cytokinins) and gibberellins, it can be effectively exploited as plant growth enhancer (Basra *et al*., 2011). Zeatin is a plant growth hormone from the cytokinines group, it plays an important role in cell division and cell elongation (Taiz and Zeiger, 2006) and involved in carbohydrate mobilization as well as distribution to the sink where more carbohydrate are needed to meet the needs of rapidly increasing growth (Iqbal, 2014). Moreover, Hussain *et al*. (2013) reported that moringa extracts accelerate the growth of plants, strengthen plants and improve resistance against pests and diseases.

Regarding yeast extract, studied the effect of yeast as a natural source of cytokinins might enhance cell division and cell enlargement so far increasing the leaf surface area for common bean as well as enhancing the accumulation of soluble metabolites (Amer, 2004). Also yeast is natural source of Bs vitamin and most of the essential elements. Also, El- Sherbeny *et al*. (2007) mentioned that enhancement effect of yeast extract might be attributed to its stimulating effect on photosynthetic pigments and improvement of photosynthesis process and enzyme activity which in turn encourage vegetative growth of plants.Also, yeast can induce thermo tolerance due to its content of heat shock proteins (HSPS) (Weiderrecht *et al*., 1988). It is a natural source of many growth substances (thiamine, riboflavin, niacin, pyridoxine Hel, panththenate, bioten, cholin, folic acid and vit.B 12) and most nutritional elements (Na, Ca, Fe, Mg, K, P, S, Zn, Si) as well as organic compounds (protein, carbohydrate, nucleic acids and lipids (Nagodawithana, 1991).

The most growth encourages effect of potassium citrate may be due to that this formulation contain K and B of the similar and harmonic synergetic action, complexes with organic moiety of citrate, ensuring potent K and B nutrition for more enhancement of carbohydrates, proteins, enzymes and energy synthesis (Marschner, 1995).

Pod yield and its components:

Tables (4 and 5) show the effect of soil and foliar applications of natural and chemical substances as well as their interactions on pod yield and its components, i.e., number of pods/plant, average pod weight, pod yield/plant and total pod yield/feddan of pea grown in clay soil.

Effect of soil applications:

Obtained data in Tables (4) illustrated that all studied soil applications had significant effect on pod yield and its components in both seasons.

It is clear from data in Table (4) that EM + humic acid recorded the highest number of pods/plant (13.44 and

16.47), heaviest average pod weight (4.81 and 5.01 gm), heaviest pod yield/plant (65.57 and 82.51 gm) and total pod yield/fed. (3.22 and 3.50 ton) at the two studied seasons, respectively. The lowest values in all studied parameters was control.

Effect of foliar applications:

Data in Tables (4) show that foliar applications, i.e., moringa leaf extract, yeast extract, potassium citrate, silicon and boron significantly affected on number of pods/plant, average pod weight, pod yield/plant, total pod yield/fed compared to control in both seasons.

The highest number of pods/plant (14.14 and 17.71) and heaviest average pod weight (5.01 and 5.21 gm), pod yield/plant (71.11 and 92.26 gm) and total pod yield/fed (3.38 and 4.12 ton) were obtained when pea plants sprayed with moringa leaf extract followed by yeast extract and potassium citrate in both seasons, respectively.

Table 4. Effect of some natural and chemical substances as soil and foliar applications on yield parameters of pea during 2016 and 2017 seasons.

Treatments		No of pod/plant		Average pod weight (gm)		Pod yield/ plant (gm)		Total pod yield (ton/fed.)	
		S1	S2	S1	S2	S1	S2	S1	S2
soil	EM at 2L/F	13.09	15.32	4.59	4.79	60.66	73.38	3.05	3.49
	Humic acid at 2Kg/F	12.70	14.46	4.40	4.60	56.28	66.56	2.89	3.11
	EM at 2L/F + Humic acid at 2Kg/F	13.44	16.47	4.81	5.01	65.57	82.51	3.22	3.50
	Control	12.19	13.91	4.24	4.44	52.10	61.76	2.78	2.88
L.S.D at 5 %		0.27	1.35	0.32	0.32	5.28	3.66	0.15	0.32
Foliar	MLE at 1ml/ 32 ml	14.14	17.71	5.01	5.21	71.11	92.26	3.38	4.12
	Yeas t extract at 50ml	13.97	16.92	4.89	5.09	68.56	86.12	3.28	3.76
	Potassium citrate at 5 ml/L	13.84	16.44	4.80	5.00	66.70	82.20	3.20	3.66
	Silicon at 300 ppm	12.20	13.72	4.30	4.50	52.69	61.74	2.86	2.79
	Boron at 50 ppm	11.98	13.30	4.22	4.42	50.76	58.78	2.81	2.71
	Control	10.99	12.17	3.82	4.02	42.09	48.92	2.37	2.45
L.S.D at 5 %		0.39	1.40	0.23	0.23	3.62	3.51	0.18	0.34

S1: 2016 season, S2: 2017 season, EM: effective microorganisms and MLE: moringa leaf extract.

Effect of the interactions:

Data in Tables (5) show that the interactions between soil and foliar applications had significant on number of pods/plant, average pod weight, pod yield/plant, total pod yield/feddan of pea compared with the control in both seasons.

In general, the best interaction in all studied characters was the interaction between EM + humic acid and moringa leaf extract followed by EM + humic acid and yeast extract) in the two seasons. While the lowest one was without soil addition and without spraying (control).

Table 5. Effect of the interaction between soil and foliar applications of some natural and chemical substances on yield parameters of pea during 2016 and 2017 seasons.

Treatments		No of pod/plant		Average pod weight (gm)		Pod yield/ plant (gm)		Total pod yield (ton/fed.)	
		S1	S2	S1	S2	S1	S2	S1	S2
		interaction							
EM at 2L/F	MLE at 1ml/ 32 ml	14.46	18.05	5.03	5.23	72.83	94.40	3.43	4.03
	Yeast extract at 50ml	14.33	17.20	4.96	5.16	71.27	88.75	3.35	3.93
	Potassium citrate at 5 ml/L	14.03	16.60	4.88	5.08	68.65	84.32	3.18	3.91
	Silicon at 300 ppm	12.41	14.20	4.40	4.60	54.67	65.32	2.97	2.86
	Boron at 50 ppm	12.22	13.70	4.36	4.56	53.29	62.47	2.90	2.75
	Control	11.09	12.20	3.90	4.10	43.25	50.02	2.48	2.46
Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	13.91	16.50	4.75	4.95	66.10	81.67	3.16	3.83
	Yeast extract at 50ml	13.77	16.30	4.70	4.90	64.80	79.87	3.09	3.72
	Potassium citrate at 5 ml/L	13.75	16.00	4.66	4.86	64.16	77.76	3.05	3.45
	Silicon at 300 ppm	12.03	13.20	4.30	4.50	51.74	71.79	2.80	2.62
	Boron at 50 ppm	11.81	12.60	4.16	4.36	49.19	54.93	2.76	2.60
	Control	10.93	12.20	3.81	4.01	41.68	48.92	2.47	2.45
EM at 2L/F + Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	14.88	20.40	5.63	5.83	83.78	118.93	3.90	4.23
	Yeast extract at 50ml	14.67	18.70	5.30	5.50	77.80	102.85	3.64	4.13
	Potassium citrate at 5 ml/L	14.64	18.07	5.13	5.33	75.12	96.31	3.60	4.12
	Silicon at 300 ppm	12.72	14.80	4.46	4.66	56.80	68.96	2.98	3.08
	Boron at 50 ppm	12.63	14.40	4.41	4.61	55.82	66.38	2.97	2.97
	Control	11.13	12.50	3.96	4.16	44.08	52.00	2.23	2.48
Control	MLE at 1ml/ 32 ml	13.34	15.90	4.63	4.83	61.72	76.79	3.10	3.38
	Yeast extract at 50ml	13.11	15.50	4.60	4.80	60.36	74.40	3.03	3.26
	Potassium citrate at 5 ml/L	12.96	15.10	4.55	4.75	58.88	71.72	2.98	3.17
	Silicon at 300 ppm	11.67	12.70	4.06	4.26	47.54	54.10	2.69	2.59
	Boron at 50 ppm	11.28	12.50	3.96	4.16	44.74	52.00	2.63	2.51
	Control	10.82	11.80	3.63	3.83	39.38	45.19	2.33	2.40
L.S.D at 5 %		0.78	2.80	0.46	0.46	7.24	7.03	0.37	0.68

S1: 2016 season, S2: 2017 season, EM: effective microorganisms, MLE: moringa leaf extract.

Accumulation of dry matter and its distribution into different plant components is an important consideration in achieving desirable economic yield from crop plants (Singh and Yadav, 1989).

The positive influence of HA on plant growth and yield could be due to the hormone-like activities present in HA that are involved indirectly in respiration, photosynthesis, oxidative phosphorylation, protein synthesis, anti-oxidant reactions, and various enzyme activities (Zhang *et al*., 2003).

The favorable effect of moringa leaf extract on yield might be connected with the role of plant growth regulators in improving crop growth and hence yield (Muhamman *et al*., 2013). It contains endogenous cytokinins (zeatin, dihydrozeatin and isopentyladenine) which affect on assimilate mobilization and/or distribution (Emongor, 2015). Moreover, Emongor (2015) on snap bean reported that moringa leaf extract increased leaf area chlorophyll content and that might have increased net photosynthesis resulting in more photo assimilates in snap bean plants, hence higher pod yield.

The positive effects of applying yeast extract was attributed to its own contents of different nutrients, high percentage of protein, large amount of vitamin B and natural plant growth regulators such as cytokinins. Physiological roles of vitamins and amino acids in the yeast extract which increased the metabolic processes role and levels of endogenous hormones that may promote the vegetative growth parameters and reflected on enhancing yield. Also increasing pods yield response to yeast extract could be attributed to the increasing of total leaf area and dry matter accumulation, photosynthetic pigments and assimilates supply and hence enhancement of pods growth rates. This observation agrees with the report of Dawa *et al.* (2008) on pea.

These increases in response to potassium citrate may be ascribed to the role of potassium in increasing photosynthetic activity which accounts much for high translocation of photoassim ilates from leaves to the roots (Marschner, 1995). These Effects could be attributed to the importance of potassium in improving the translocation of carbohydrates from sources to the tubers. Additionally, potassium ion transport across chloroplast and mitochondrial membranes is related closely to the energy status of plants, aid in protein synthesis in the ribosomes (Barker and Pilbeam, 2007)

The favorable effect of boron on fruit setting under heat stress might be due to its effect on pollen germination, pollen tube growth and fertilization (Vaughen, 1977) by increasing the pollen producing capacity of the anthers and pollen grain ability (Agarwala *et al*., 1981).

Pod quality:

The effect of soil and foliar applications of some natural and chemical substances and interactions on pod length, pod diameter, pod thickness, total soluble solids (TSS), vitamin C, titrable acidity and protein contents are presented in Tables (6,7,8 and 9).

Effect of soil applications:

Data in Tables (6 and7) show the effect of soil applications had significant effect on pod length, pod diameter, pod thickness, total soluble solids (TSS), vitamin C, titrable acidity and protein contents in both seasons.

Data in Table (6) clearly show that EM + humic acid recorded the highest values of pod length, pod diameter and pod thickness in both seasons.

Data shown in Table (7) reveal that all soil applications significantly increased total soluble solids (TSS) and vitamin C, protein contents and decreased titrable acidity contents compared with control in both seasons.

EM+ humic acid recorded the highest content of pods in total soluble solids (TSS), vitamin C and protein contents in pods recorded the lowest values of titrable acidity contents followed by EM and humic acid in both seasons. respectively, meanwhile the control treatment recoded the lowest values of total soluble solids (TSS) and vitamin C and protein contents the highest values of titrable acidity contents in both seasons.

Effect of foliar applications:

Data shown in Table (6) show that all foliar applications, i.e., moringa leaf extract, yeast extract, potassium citrate, silicon and boron had positive effect on pod length, diameter and thickness in both seasons. The highest values in all previous studied parameters were obtained when pea plants sprayed with moringa leaf extract followed by yeast extract and potassium citrate, respectively. The lowest application in all studied parameters was control.

Table 6. Effect of some natural and chemical substances as soil and foliar applications on pod length, diameter and thickness of pea during 2016 and 2017seasons.

Treatments		Pod length (cm)		Pod diameter (cm)		Pod thickness (cm)	
		S1	S2	S1	S2	S1	S2
soil	EM at 2L/F	8.23	8.75	1.43	1.52	1.09	1.10
	Humic acid at 2Kg/F	8.22	8.52	1.42	1.52	1.06	1.09
	EM at 2L/F + Humic acid at 2Kg/F	8.56	8.99	1.46	1.57	1.11	1.12
	Control	7.94	8.28	1.41	1.48	1.00	1.08
L.S.D at 5 %		0.49	0.71	0.09	0.07	0.07	0.05
Foliar	MLE at 1ml/ 32 ml	8.75	9.30	1.47	1.60	1.12	1.13
	Yeast extract at 50ml	8.73	9.28	1.48	1.55	1.13	1.14
	Potassium citrate at 5 ml/L	8.63	9.16	1.45	1.61	1.11	1.15
	Silicon at 300 ppm	8.04	8.33	1.41	1.52	1.06	1.07
	Boron at 50 ppm	7.85	8.20	1.41	1.48	1.05	1.06
	Control	7.42	7.55	1.36	1.40	1.00	1.02
L.S.D at 5 %		0.60	0.45	0.08	0.08	1.07	0.04

S1: 2016 season, S2: 2017 season, EM: effective microorganisms and MLE: moringa leaf extract.

Data shown in Table (7) reveal that all foliar applications treatments significantly increased total soluble solids (TSS) and vitamin C, protein contents and decreased titrable acidity contents compared with control in both seasons.

Spraying pea plants with moringa leaf extract gave the highest values of total soluble solids (TSS) and vitamin C, protein contents and recorded the lowest values of titrable acidity contents followed by yeast extrat and potassium citrate in both seasons, respectively, On the other hand, control treatment recoded the lowest values of total soluble solids (TSS) and vitamin C, protein contents and the highest values of titrable acidity contents in both seasons.

Table 7. Effect of some natural and chemical substances as soil and foliar applications on TSS, vitamin C, acidity and protein contents of pea seeds during 2016 and 2017 seasons.

Treatments		TSS		Vitamin C (mg/100gfw)		Acidity (%)		Protein (%)	
		S1	S2	S1	S2	S1	S2	S1	S2
Soil	EM at 2L/F	8.14	8.40	86.26	90.04	0.389	0.401	22.87	22.38
	Humic acid at2Kg/F	7.91	8.24	81.33	86.90	0.402	0.407	22.04	21.70
	EM at 2L/F + Humic acid at 2Kg/F	8.31	8.61	90.08	94.26	0.381	0.393	23.37	23.72
	Control	7.76	8.09	78.02	84.45	0.407	0.420	19.89	20.90
L.S.D at 5 %		0.23	0.33	6.18	2.69	0.007	0.011	1.34	1.10
Foliar	MLE at 1ml/ 32 ml	8.50	8.81	92.41	97.36	0.373	0.384	26.31	26.56
	Yeast extract at 50ml	8.46	8.72	92.24	95.52	0.376	0.389	26.21	26.32
	Potassium citrate at 5 ml/L	8.31	8.63	89.66	94.10	0.381	0.384	25.77	25.63
	Silicon at 300 ppm	7.81	8.13	79.47	84.48	0.407	0.417	22.06	19.35
	Boron at 50 ppm	7.76	8.05	77.64	83.65	0.408	0.420	20.15	18.95
	Control	7.33	7.65	72.12	78.37	0.424	0.436	16.80	16.25
L.S.D at 5 %		0.33	0.29	5.24	4.96	0.013	0.014	1.01	0.59

S1: 2016 season, S2: 2017 season, EM: effective microorganisms and MLE: moringa leaf extract.

Effect of the interactions:

Data in Tables (8 and 9) show that the effects of all interactions were significant in pod length, pod diameter, pod thickness, total soluble solids (TSS), vitamin C, protein contents and decreased titrable acidity contents compared with control in both seasons.

Tretment pea plants with EM+ humic acid and sprayed with moringa extract gave the highest values of pod length, pod diameter, pod thickness, total soluble solids (TSS), vitamin C, protein contents and recorded the lowest values of titrable acidity contents followed by EM+ humic acid and sprayed with yeast extract and EM+ humic acid and sprayed with potassium citrate, respectively, On the other hand, (control × control) treatment recoded the lowest values of total soluble solids (TSS) and vitamin C, protein and the highest values of titrable acidity contents in both seasons.

Sahain *et al.* (2007) reported a positive and stimulating influence of effective microorganisms on the status of nutrition with nitrogen, magnesium and zinc. Our own research results are corroborated by Khaliq *et al.* (2006), who found a positive effect of EMs on plant nitrogen nutrition.

These results may be due to the role of humic acids in protein synthesis, nutrients translocation, antioxidantal enzymes, root proliferation and foliar growth (Chen *et al.*, 2004). The positive effect of moringa leaf extract on chemical composition of sugar pea pods might be due to cytokinins present in the extract, which facilitates the mobilization of nutrients to the fruit and improves lycopene contents (Yasmeen *et al.*, 2014). Also, zeatin involved in carbohydrate mobilization as well as distribution to the sink where more carbohydrate are needed to cater the needs of rapidly increasing growth (Iqbal, 2014).

Table 8. Effect of the interaction between soil and foliar applications of some natural and chemical substances on pod length, diameter and thickness of pea during 2016 and 2017 seasons.

Treatments		Pod length (cm)		Pod diameter (mm)		Pod thickness (mm)	
		S1	S2	S1	S2	S1	S2
		interaction					
EM at 2L/F	MLE at 1ml/ 32 ml	8.76	9.33	1.47	1.58	1.13	1.13
	Yeast extract at 50ml	8.76	9.45	1.48	1.57	1.15	1.17
	Potassium citrate at 5 ml/L	8.70	9.37	1.46	1.62	1.12	1.15
	Silicon at 300 ppm	8.13	8.42	1.42	1.53	1.07	1.08
	Boron at 50 ppm	7.46	8.36	1.42	1.53	1.06	1.06
	Control	7.58	7.60	1.36	1.40	1.00	1.02
Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	8.68	9.12	1.45	1.62	1.09	1.12
	Yeast extract at 50ml	8.67	9.07	1.44	1.53	1.10	1.13
	Potassium citrate at 5 ml/L	8.63	9.03	1.44	1.60	1.09	1.14
	Silicon at 300 ppm	7.98	8.24	1.41	1.52	1.06	1.07
	Boron at 50 ppm	7.92	8.15	1.41	1.48	1.06	1.06
	Control	7.46	7.55	1.36	1.38	1.00	1.03
EM at 2L/F + Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	9.19	9.83	1.49	1.63	1.16	1.17
	Yeast extract at 50ml	9.14	9.76	1.57	1.57	1.17	1.17
	Potassium citrate at 5 ml/L	8.91	8.54	1.48	1.71	1.16	1.17
	Silicon at 300 ppm	8.23	8.65	1.42	1.55	1.08	1.09
	Boron at 50 ppm	8.25	8.47	1.42	1.53	1.08	1.08
	Control	7.64	7.71	1.36	1.43	1.02	1.03
Control	MLE at 1ml/ 32 ml	8.37	8.92	1.47	1.57	1.08	1.12
	Yeast extract at 50ml	8.34	8.85	1.42	1.53	1.09	1.12
	Potassium citrate at 5 ml/L	8.30	8.72	1.42	1.51	1.09	1.13
	Silicon at 300 ppm	7.83	8.04	1.40	1.47	1.04	1.06
	Boron at 50 ppm	7.79	7.83	1.40	1.45	1.02	1.05
	Control	7.02	7.35	1.35	1.38	0.99	1.03
L.S.D at 5 %		1.21	0.91	0.17	0.16	0.15	0.09

S1: 2016 season, S2: 2017 season, EM: effective microorganisms, MLE: moringa leaf extract

Table 9. Effect of the interaction between soil and foliar applications of some natural and chemical substances on TSS, vitamin C, acidity and protein contents of pea seeds during 2016 and 2017 season.

Treatments		TSS		Vitamin C (mg/100gfw)		Acidity (%)		protein (%)	
		S1	S2	S1	S2	S1	S2	S1	S2
				interaction					
EM at 2L/F	MLE at 1ml/ 32 ml	8.65	8.96	93.65	98.76	0.366	0.375	27.62	27.00
	Yeast extract at 50ml	8.74	8.87	98.53	96.82	0.367	0.379	27.35	26.81
	Potassium citrate at 5 ml/L	7.45	8.70	90.20	96.60	0.370	0.382	27.31	26.12
	Silicon at 300 ppm	7.83	8.12	84.14	85.24	0.404	0.416	18.31	19.12
	Boron at 50 ppm	7.81	8.10	78.78	84.13	0.407	0.420	18.00	18.81
	Control	7.41	7.67	72.27	78.74	0.424	0.436	18.64	16.43
Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	8.34	8.65	89.82	93.85	0.383	0.395	27.12	26.06
	Yeast extract at 50ml	8.24	8.56	86.10	92.45	0.389	0.401	26.87	26.06
	Potassium citrate at 5 ml/L	8.10	8.49	85.54	89.80	0.393	0.372	26.68	25.50
	Silicon at 300 ppm	7.78	8.10	78.73	84.05	0.409	0.414	17.68	18.31
	Boron at 50 ppm	7.72	8.06	75.75	83.92	0.409	0.422	17.62	18.00
	Control	7.28	8.58	72.09	77.37	0.429	0.441	16.25	16.31
EM at 2L/F + Humic acid at 2Kg/F	MLE at 1ml/ 32 ml	8.96	9.26	101.26	107.12	0.353	0.363	28.75	27.62
	Yeast extract at 50ml	8.86	9.16	100.50	104.63	0.357	0.370	28.31	27.31
	Potassium citrate at 5 ml/L	8.75	9.09	99.36	102.34	0.363	0.374	27.89	27.18
	Silicon at 300 ppm	7.94	8.25	80.70	86.38	0.401	0.412	19.43	22.06
	Boron at 50 ppm	7.93	8.19	81.91	85.02	0.404	0.416	19.25	21.81
	Control	7.43	7.72	76.75	80.11	0.413	0.425	16.62	16.37
Control	MLE at 1ml/ 32 ml	8.07	8.39	84.92	89.74	0.393	0.405	21.77	25.56
	Yeast extract at 50ml	8.00	8.32	83.85	88.21	0.393	0.408	22.31	25.12
	Potassium citrate at 5 ml/L	7.97	8.26	83.55	87.67	0.400	0.410	21.18	23.70
	Silicon at 300 ppm	7.72	8.05	74.32	82.25	0.415	0.424	21.00	17.93
	Boron at 50 ppm	7.58	7.88	74.11	81.56	0.412	0.429	17.25	17.18
	Control	7.22	7.65	67.38	77.29	0.433	0.445	15.68	15.89
L.S.D at 5 %		0.66	0.59	10.48	9.93	0.026	0.028	2.03	1.18

S1: 2016 season, S2: 2017 season, EM: effective microorganisms and MLE: moringa leaf extract

Moreover, moringa leaf extract is rich in vitamins A, B (1, 2, 3, 6 and7), C, D, E and K, minerals include calcium, copper, iron, potassium, magnesium, manganese and zinc and more than 40 natural antioxidants (Mahmood *et al*., 2010).

Stimulative effect of yeast extract on photosynthetic pigments may be due to a beneficial role during vegetative growth through enhancement the chlorophyll formation and photosynthetic efficiency due to its content of vitamins and amino acids. This increased the metabolic processes role and levels of endogenous hormones, i.e., IAA and endogenous cytokinins which have been established to induce the biosynthesis of chloroplast pigments, in turn retard senescence. Khedr and Farid (2002) reported that, yeast preparation contained carbohydrates, sugars, proteins, fatty acids, amino acids, hormones, macro and micro elements in suitable balance. The obtained results are in harmony with those of Abd El-Hady (2014) .

Moreover, the increase in protein percentage under the effect of yeast application could be attributed to the growth hormones and stimulation the synthesis of protein produced by yeast Stino (2009), Furthermore, Hayat (2007) indicated that the positive effect of yeast treatment under water stress conditions may be due to that yeast provided plants with essential nutrients elements required for protein formation. In addition, El-Lethy *et al*. (2011) mentioned that yeast extract pronouncedly increased total phenols, total flavonoids and the antioxidant activity of Pelargonium graveolens at both cuttings.

Potassium has very important role in plant metabolism and many regulatory processes in the plant.

Moreover, potassium could be increased mineral uptake by plants (Marschner, 1995).

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استجابة محصول البسلة المنزرع مبكرا لبعض المواد الطبيعية والكيماوية لتحسين المحصول ومكونات الجودة.

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أجريت التجربة بمزرعة خاصة فى الجمالية - محافظة الدقهلية– مصر خلال موسمى الزراعة ٢٠١٦ و ٢٠١٧ بهدف دراسة تأثير ببعض المواد الطبيعية والكيماوية (الكائنات الحية الدقيقة النشطة بتركيز ٢ لتر/ فدان و الهيوميك أسيد ٢ كيلو/ فدان و مستخلص المورينجا ١ مل/ ٣٢ مل ،مستخلص الخميرة بتركيز ٥٠ مل/ لتر ، سترات البوتاسيوم بتركيز ٥ مل/ لتر ، السيليكون بتركيز ٢٠٠ جزء فى المليون والبورون بتركيز ٥٠ جزء في المليون) على صفات النمو ، المحصول ، الجودة لمحصول البسلة المنزرع مبكرا.من خلال هذه النتائج تبين أن معاملة التربة بالكائنات الحية الدقيقة والهيوميك أسد تؤدى الى تحسين في عدد الاوراق وعدد الافرع وطول النبات والوزن الطازج والجاف والمساحة الورقية كما أعطت نفس المعاملة أعلي القيم في عدد القرون للنبات، متوسط وزن القرن، محصول النبات، إجمالي محصول القرون للفدان، طول القرن ،قطر القرن وسمك القرن ، المواد الصلبة الكلية، فيتامين سي، والمحتوي من البروتين وكانت أقل القيم في الحموضة . كما أعطت جميع معاملات الرش زيادة معنوية في حميع الصفات المدروسة عدا معاملة الكنترول. وكانت أحسن النتائج المعاملة بمستخلص المورنيجا يليها مستخلص الخميرة ويليها سترات البوتاسيوم خلال موسمي الدراسة، علي التوالي. من خلال النتائج يمكن التوصية بالمعاملة بالكائنات الحية الدقيقة والهيوميك أسد والرش بمستخلص المورنيجا بعد ١٥، ٢٥ و٣٥ يوم من الزراعة أدت الي تحسين النمو نالمحصول وجودة القرون انبات البسله النامي تحت ظروف الزراعة المبكرة .