Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 56(4) (2018), 1045 – 1054 **http://aasj.bu.edu.eg/index.php**

Effect of Soil Addition and Foliar Spray with Some Safety Compounds on Growth, Productivity and Quality of Snap Bean (*Phaseolus Vulgaris* L.)

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Abstract

Two field experiments were carried out during the two successive autumn seasons of 2016 and 2017 in private sector farm at Qaha village, Kalubia Governorate, Egypt, to investigate the effect of soil addition of humic acid, seaweed extract and effective microorganisms (EM) as well as the foliar spray with calcium, jasmonic acid and chitosan on vegetative growth, chemical composition of plant foliage, fruit yield and its quality, of snap bean plants (phaseolus vulgaris L.) cv. Bronco. This experiment included 16 treatments as follows, four soil addition of humic acid at 10g/l, seaweed extract at 10ml/l, EM at 150ml/l beside the control treatment. In addition,four foliar spray treatments with calcium thiosulphate at 2ml/l, chitosan at 2g/l, jasmonic acid at 200 ppm and the control treatment (spray with tap water).The soil addition treatments were added three times started after 15 days from sowing and one week interval, while spray treatments were started after 30 days from sowing and every weekly interval for four times through the growing season. Treatments were arranged in a split plot design with three replicates. Soil additions were distributed in the main plots, while foliar spray treatments were randomly arranged in the sub- plots. Obtained results showed that,soil addition of snap bean plants with seaweed extract at 10ml/l three times combined with spraying the plants with calcium thiosulphate at 2ml/l four times are recommended to increase the vegetative growth, total produced early, exportable and total yield as well as chemical fruit quality.

Key words: - snap bean, safety compounds, soil addition, foliar spray

Introduction

Snap bean *(Phaseolus vulgaris L.)* is one of the most important economic vegetable member of Fabaceae crops in Egypt. It's grown for local consumption and export as an out of vegetable season to European countries. It does not consume large amounts of fertilizer, plus it is consider short season crop, whereas it produce green pod yield through short period after two months from sowing, as well as, it is considerd as one of the crops that cause soil fertility or neither consumes nor depletes soil nutrients. Moreover, snap bean also plays an important role for human nutrient as good source of protein and carbohydrate. According to the statistics of Ministry of Agriculture 2014.The total area devoted to snap beans during growth season of 2014 was 59687 fed, this area produced 253110 tons with an average yield of 4.24 ton/fed.

In recent years the world focused his attention to minimize environmental pollution and human health impacts by reducing the use of synthetic fertilizers and chemicals in crop production, especially, vegetables which are eaten as fresh by using natural alternatives **(FAO/TTC, 2001)**. Several investigations used some nutritional safety compounds such as natural extracts which are nontoxic and environmentally friendly, organic and costless either as foliar spray or soil application to enhance plant growth with maximizing the yield.

Pre-harvest plant nutrition is a major factor influencing fruit and vegetable quality (**Sames, 1999**). Increasing the productivity of snap bean pods with high quality and good storability is considered an important aim that could be achived through using some bio-stimulant, i.e., seaweed extract, humic acid and effective microorganisms(EM) as soil addition, which should improve physical-chemical and biological properties and increase soil organic matter, cation exchange capacity, available mineral nutrients (**Ouedaro*et al*., 2001** for seaweed extract(SWA), **Salman *et al*., 2005** for humic acid(HA) and **Hussain*et al*., 2002** for effective microorganisms(EM), and this, in turn, stimulates quantitative as well as qualitative characteristics and improves storability of snap beans(**Abou-El-Yazied*et al*., 2012** for seaweed extract, **Gad El-Hak*et al*., 2012** forhumic acid, and **El-Sayed*et al*., 2015** for humic acid or effective microorganisms).

Snap bean pods are susceptible to postharvest damage which limit their storage period and shelf life, therefore some pre-harvest treatments have been proposed for use in maintaining quality and improving storability of snap bean pods i.e., treatment with chitosan, calcium, Jasmonic acid which decreases respiration rate, weight loss, decay and maintains the overall quality and prolongs the shelf life of snap bean pods (**El-hamahmy*et al*., 2017**, Chitosan and jasmonic acid are considerd environmental friendly products that have been widely used in agricultural applications mainly for stimulation of plant

defense**(Ohta et al., 2001)**. It triggers a defense response within the plant, leading to the formation of physical and chemical barriers against invading pathogens, it has been used in seed, leaf, fruit and vegetable coating, as a fertilizer and in controlled agrochemical **release (Sukwattanasinitt et al., 2001)**, to increase plant product (**New et al., 2004**), to stimulate the immunity of plants, to protect plants against microorganisms (**Bautista et al., 2003**) and to stimulate plant growth and increase storability of fruits.

Therefore, this investigation was carried out to study the effect of seaweed extract, humic acid and effective microorganisms as a soil addition as well as using some natural safety compounds (calcium, chitosan and jasmonic acid) as foliar application on vegetative growth, chemical composition, yield and its components, as well as pods quality and storability of snap bean plants under the conditions of Qalubia Governorate.

Materials and Methods

Two field experiments were carried out during the two successive autumn seasons of 2016 and 2017 in private sector farm at Qaha village, Kalubia Governorate, Egypt, to investigate the effect of soil addition of humic acid, seaweed extract and effective microorganisms (EM) as well as the foliar spray with calcium, jasmonic acid and chitosan on vegetative growth, chemical composition of plant foliage, fruit yield and its quality, of snap bean plants *(phaseolus vulgaris* L.) cv. Bronco. The soil of the experimental field was clay. Soil samples were randomly taken from 30 cm soil surface and the mechanical and chemical analyses according to **Jackson (1973) and Black *et al.* (1982)** are shown in Table (1).

Table 1. Soil mechanical and chemical analyses of the used soil.

Physical analysis		**Chemical analysis**			
		Cationsmeq/l		Anions meq/l	
Coarse sand	8.25%	Ca^{++}	9.65	CO_3^{--}	Zero
Fine sand	16.15%	Mg^{++}	3.16	HCO_3^-	5.38
Silt	24.60%	Na^+	6.53	Cl^-	5.93
Clay	51%	K^+	1.16	SO_4^{--}	9.19
Texture class clay loam					
Soil pH	7.9	Available N	22.5 mg/kg		
E.C, dS/m	2.16	Available P	9.1 mg/kg		
Organic matter	3.1%	Available K	120 mg/kg		

The Seeds of cv. Bronco were obtained from Hort. Res. Inst., Agric. Res. Center, Egypt and sown on September 18th and August 23rd in the first and second season respectively on one side of ridge (two seeds/hill) at 10 cm apart. The area of the experimental plot was 21.12 m^2, it contained 5 lines with 6.5 meters in long and 0.65 meters in width. One line was left between each two experimental plots without spraying as a guard row to avoid the overlapping of spraying solution. The experiment included sixteen treatments which were the combination between four soil addition and four foliar sprays. Treatments were arranged in a split plot design with three replicates. Soil additions were distributed in the main plots, while foliar spray treatments were randomly arranged in the sub- plots.

Treatments as follows:

- **Main plots (Soil addition treatments)**:
  1- Effective microorganisms (EM) at 150ml/L.
  2- Humic acid at 10g/L.
  3- Seaweed extract at 10ml/L.
  4- Tap water (control).
- **Sub-plots (Foliar spray treatments) :**
  1- Calcium thiosulphate at 2 cm^3/L.
  2- Chitosan at 2g/L.
  3- Jasmonic acid at 200ppm.
  4- Tap water (control).

Effective microorganisms :- (EM as commercial name)

Was obtained from Ministry of Agriculture and Land Reclamation it includes: Effective Microorganisms (EM) preparation contains photosynthetic bacteria (Rhodopseudomonaspalustrus and Rhodobacter space), milk bacteria (Lactobacillus casei, Streptococcus lactis), yeast (Saccharomyces albus and Candida utilis), actinomycetes (Streptomyces albus and Streptomyces griseus) and moulds (Aspergillusoryzae and Mucomhiemalis).

Seaweed extract: - (Rootmost as commercial name)
Rootmost:-seaweed root growth promoter. It is commercial product by LeiliAgrochemistry Co. Ltd. It includes: seaweed extract at100g/l. organic matter at 20g/l., total nitrogen at 0.4g/l, phosphate(P_2O_5) at 12g/l, potash (K_2O) at 30g/l, GA3at 0.001%, IAA at 0.1% and Cytokinin at 0.008%
Humic Total: -80%soluble potassium humate. It is a commercial product by LeiliAgrochemistry Co. Ltd. It includes: humic acid at 80%, K_2O at 11-13% and moisture at 5-7%.
Chitosan: - It is a commercial product by Oxford Laboratory India. It includes chitosan 90-95%.
Calcium thiosulphate:-It is a commercial product by TessenderloKerley USA. it includes; Ca at 7.5%**,** CaO at 10% and S at 12%.

The soil addition treatments were added three times started after 15 days from sowing and every week intervals, while spray treatments were started after 30 days from sowing and every week intervals for four times through the growing season.

The agricultural practices concerning cultivation, fertilization, irrigation, pest, disease and weed control were conducted as commonly followed according to the recommendation of the ministry of Agriculture for the commercial production of fresh snap bean.

Data on vegetative growth, yield and its components, and physical and chemical fruits characteristics were recorded as follows:

Data recorded:

1. Vegetative growth characteristics.

Five plants were randomly taken from each experimental plot as a representative sample after 52 days from sowing and the following data were recorded. plantlength (cm)**,**number of branches/plant, number of leaves/plant, fresh weight per plant (g), dry weight per plant (g).

2. Chemical composition of plant foliage:

Total Nitrogen%: was determined in the digested dry matter of plant leaves using microkjeldahl method according to **Pregl (1945).**

The Phosphorus content: was determined by using spectrophotometer method as described by **John (1970).**

The Potassium content: was determined by using flame photometer method as described by **Brown and Lilleland (1946).**

Total chlorophyll: reading of the fifth mature leaf from the top of the plant was measured at 60 days from seed sowing using Minolta chlorophyll meter SPAD -502 according to **Hoel and Solhaug (1998).**

3. Green pods yield and its components:

Early yield (kg/fed): It was determined as weight of all harvested pods at the suitable maturity stage in the first picking.

Total yield (ton/fed): It was calculated using plot yield and plot area.

Total Pod yield (g/ plant): It was calculated from pod yield/plot and number of plants/plot all over the growing season.

4. Chemical fruit quality:

Total soluble solids (T.S.S.): A random sample of 10 pods from each experimental plot at suitable maturity stage was taken to determine the percentage of soluble solid content by using the hand refractmeter.

A represented sample of green pods (10 pods) was taken and oven dried at $70c^0$ till constant weight and the dry matter was taken to determine the chemical constituents of pods as follows.

Total protein%: it was determined according to **Pregl (1945**) using the micro-kyeldahl apparatus. A factor of 6.25 was used for conversion of total nitrogen to protein percentage.

Total carbohydrates%: it was determined in the dry matter samples according to **Herbert *et al.* (1971)**

Fiber percentage: it was determined as g/100 g dry weight according to **A.O.A.C. (1990)**

Statistical analysis:

All collected data were subjected to statistical analysis according to **Sndecor and Cochran (1991)** where the least significant difference was considered when even possible.

Results and Discussion

1. Vegetative growth characteristics.

1.1. Effect of soil addition treatments.

Data recorded in Table 2 indicate that soil addition of Humic acid at the rate of 10g/l, seaweed extract at 10ml/l and EM at 150ml/l three times during the growing season starting after 15 days from sowing and one week by intervals significantly increased all the studied growth traits expressed as plant height, number of branches/ plant, number of leaves/plant as well as fresh and dry weight per plant compared with the control during both seasons of study. In this respect, the highest values in all aforementioned growth traits were recorded as a result of treating the soil with seaweed extract followed by humic acid and EM. Obtained results were true during both seasons of study. In this connection, such increment in growth aspects due to amendment with tested organic compounds may be due to enhancing root growth, improving soil physical conditions and increasing organic acids which affect soil PH and nutrient availability and decreasing the microbial diseases infection and increasing the activity of beneficial microorganisms which in turn affect

positivelythe efficiency of mineral nutrients absorption by root and consequently increased morphological growth characteristics of plant. Also it contain some natural growth hormones (auxins and cytokinins)that promote plant growth via increasing a number of metabolic events which in turn leading to increase plant growth. In addition play an important role in the activation of many enzymes and coenzymes which are involved in several biological processes leading to cell division and enlargement and improved total chlorophyll in leaves. Obtained results are similar to those obtained by **Abou El-Yazied*et al.* 2012), El-Sayed*et al.* (2015), Ibrahim and Ramadan (2015), Talaat*et al.* (2015), Abo Sedera*et al.* (2016), Seif*et al.* (2016) andShehata*et al.* (2017)** indicated that seaweed extracts significantly increased vegetative growth characteristics of plants.

Table 2. Effect of soil addition and foliar spray treatments as well as their interactions on vegetative growth characteristics of snap bean plants during the two seasons 2016 and 2017.

Treatments		First season (2016)					Second season (2017)				
		Plant height (cm)	Branches number/ Plant	Leaves number/ Plant	Total fresh weight (g)	Total dry weight (g)	Plant height (cm)	Branches number/ Plant	Leaves number/ Plant	Total fresh weight (g)	Total dry weight (g)
Soil Addition	EM	52.0	4.3	10.4	90.4	15.28	58.7	5.1	18.0	187.2	25.44
	Humic	54.7	4.6	10.9	105.0	14.78	59.9	5.4	20.3	227.2	33.28
	Seaweed	56.5	4.6	12.5	122.2	18.39	62.7	5.7	20.9	244.7	35.85
	Control	46.1	4.2	9.8	82.4	12.38	48.7	3.8	14.0	135.4	21.99
L.S.D at 0.05		1.4	0.4	0.9	1.3	0.89	0.8	0.4	0.7	1.9	0.97
Foliar Spray	Calcium	54.3	4.6	12.2	114.2	17.95	59.5	5.4	19.9	220.1	33.33
	Chitosan	52.5	4.3	10.5	94.5	14.70	57.6	4.9	17.7	197.0	28.10
	Jasmonic	53.6	4.5	10.8	103.6	14.57	58.0	5.2	19.0	211.2	30.50
	Control	48.9	4.3	10.1	87.7	13.61	55.1	4.5	16.6	166.2	24.62
L.S.D at 0.05		1.4	0.4	0.9	1.3	0.89	0.8	0.4	0.7	1.9	0.97
The interaction											
EM	Calcium	53.8	4.4	11.7	98.8	23.83	60.3	5.3	21.0	201.3	29.67
	Chitosan	52.0	4.3	10.4	89.5	12.79	57.8	5.1	16.6	179.1	25.42
	Jasmonic	53.3	4.4	10.2	98.5	12.99	60.1	5.3	18.3	199.1	26.08
	Control	48.7	4.3	9.4	74.7	11.50	56.6	4.6	16.3	169.1	20.58
Humic acid	Calcium	58.2	4.8	13.2	144.6	16.21	61.1	5.8	21.6	250.0	40.32
	Chitosan	55.7	4.5	10.0	88.2	13.98	60.5	5.3	20.5	237.1	32.06
	Jasmonic	56.6	4.7	10.7	102.7	14.67	60.8	5.8	21.3	249.1	36.12
	Control	48.3	4.3	9.8	84.4	14.24	57.1	4.6	17.8	172.5	24.60
Seaweed	Calcium	58.4	4.8	12.7	128.3	18.99	67.5	6.5	22.1	273.3	38.47
	Chitosan	55.6	4.5	12.5	120.2	17.98	61.1	5.5	20.3	235.8	34.73
	Jasmonic	58.0	4.6	12.5	124.8	18.58	62.8	5.8	22.1	249.1	36.60
	Control	54.0	4.4	12.2	115.5	18.01	59.6	5.3	19.1	220.8	33.61
Control	Calcium	46.7	4.4	11.3	84.9	12.75	49.0	4.1	15.0	155.8	24.86
	Chitosan	46.5	4.1	9.3	80.3	14.04	51.0	3.6	13.6	135.8	20.17
	Jasmonic	46.6	4.2	9.8	88.3	12.02	48.1	3.8	14.1	147.5	23.21
	Control	44.7	4.1	9.0	76.3	10.70	47.0	3.6	13.1	102.5	19.70
L.S.D at 0.05		2.9	0.8	1.9	2.6	1.78	1.6	0.8	1.5	3.8	1.94

1.2. Effect of foliar spray treatments.

As for the effect of foliar spray treatments on vegetative growth characteristics such data in Table 2 indicate that all measured growth traits ,i.e., plant height, number of branches/ plant, number of leaves/plant as well as fresh and dry weight per plant were significantly affected as a result of spraying plant with calcium thiosulphate at 2 ml/l, chitosan at 2g/l and Jasmonic acid at 200ppm four times during the growing season starting 30 days from sowing and every week intervals compared with the control treatment. In this regard, treating the plants with calcium thiosulphate exhibited the highest values for all measured growth aspects compared with other tested treatments. In this connection, such increases in morphological characteristics of plant due to spraying with calcium thiosulphate, chitosan or Jasmonic acid may be due to their constituents which play main role as cell component which affect cell formation, cell division and elongation which consequently increased plant growth. Furthermore, the superiority of calcium thiosulphatemay be due to the effect of calcium which play an important role in plant metabolism and protein assimilation which is necessary for cells formation and consequently increased fresh and dry matter of plant which are good indicator for plant growth. In this connection**, Sheikha and Malki (2011), Abu-Muriefah (2013), El-Gawad*et al.* (2013), Byan (2014), Ibrahim and Ramadan (2015) and Abo Sedera *et al.* (2016)** reported similar resuts.

1.3. Effect of the interaction.

As for the effect of the interaction between soil addition and foliar spray treatments the same data in

Table 2 indicate that plant height, number of branches/ plant, number of leaves/plant as well as fresh and dry weight per plant were significantly increased as a result of the interaction treatment. In this connection, the highest values were reported as a result of soil addition of seaweed extract of 10ml/l three times during the growing season 15 days from sowing and one week by intervals combined with spraying the plants four times with calcium thiosulphate at rate 2 ml/l starting 30 days from sowing and every week interval during both seasons of study.

2. Chemical constituents of plant foliage.

2.1. Effect of soil addition treatments.

Data presented in Table 3 show clearly that total nitrogen, phosphorus, potassium and chlorophyll reading were significantly increased as a result of addition of tested organic compound three times during the growing season starting after 15 days from sowing ,and one week by intervals during the growing season compared with the control treatment. In addition, applying seaweed extract at 10ml/l exhibited the highest concentration of all assayed macronutrients followed by humic acid at 10g/L and EM at 150ml/l during both seasons of study. Such results are connected with those obtained on vegetative growth of plant (Table,2).

Table 3. Effect of soil addition and foliar spray treatments as well as their interactions on chemical constituents of plant foliage of snap bean plants during the two seasons 2016 and 2017.

Treatments		First season (2016)				Second season (2017)			
		N%	P %	K %	Leaf chlorophyll reading	N%	P %	K %	Leaf chlorophyll reading
Soil Addition	EM	2.49	0.51	2.81	36.3	2.53	0.49	2.73	39.4
	Humic	2.69	0.52	2.95	37.7	2.70	0.52	2.99	40.1
	Seaweed	2.72	0.54	2.97	39.1	2.80	0.52	3.09	41.5
	Control	2.34	0.47	2.72	35.2	2.44	0.4	2.49	38.7
L.S.D at 0.05		0.08	0.02	0.18	1.1	0.06	0.02	0.14	1.2
Foliar Spray	Calcium	2.71	0.57	3.12	40.8	2.79	0.58	3.14	44.0
	Chitosan	2.52	0.48	2.82	35.5	2.57	0.46	2.66	38.0
	Jasmonic	2.63	0.55	2.96	38.1	2.65	0.51	2.97	40.6
	Control	2.38	0.44	2.55	33.9	2.45	0.43	2.53	37.0
L.S.D at 0.05		0.08	0.02	0.18	1.1	0.06	0.02	0.14	1.2
The interaction									
EM	Calcium	2.67	0.54	3.06	38.8	2.73	0.61	3.07	41.9
	Chitosan	2.47	0.46	2.86	35.3	2.49	0.43	2.63	38.4
	Jasmonic	2.50	0.61	2.96	36.8	2.52	0.51	2.98	39.9
	Control	2.33	0.44	2.36	34.4	2.40	0.41	2.26	37.3
Humic acid	Calcium	2.79	0.62	3.07	41.5	2.88	0.52	3.44	44.4
	Chitosan	2.69	0.48	2.88	37.3	2.67	0.51	2.78	38.0
	Jasmonic	2.76	0.54	3.00	37.6	2.77	0.64	2.97	40.7
	Control	2.52	0.47	2.86	34.4	2.50	0.43	2.78	37.2
Seaweed	Calcium	2.89	0.64	3.30	43.3	2.96	0.64	3.34	45.7
	Chitosan	2.64	0.52	2.83	37.6	2.71	0.48	2.88	39.9
	Jasmonic	2.80	0.59	3.05	40.0	2.84	0.49	3.27	42.4
	Control	2.57	0.42	2.70	35.6	2.69	0.48	2.88	38.0
Control	Calcium	2.49	0.50	3.04	39.8	2.61	0.57	2.74	43.9
	Chitosan	2.30	0.46	2.73	31.7	2.43	0.42	2.35	35.9
	Jasmonic	2.48	0.49	2.83	38.2	2.50	0.42	2.66	39.4
	Control	2.10	0.44	2.30	31.1	2.24	0.41	2.23	35.7
L.S.D at 0.05		0.16	0.05	0.36	2.2	0.12	0.05	0.29	2.4

In this regard, such increment in concentration of determined macronutrients may be due to the enhancing effect of such organic compounds on root growth and elongation as well as increasing root zone which increase uptake capability of roots and in turn availability of macronutrients to absorption and

accumulation processes by plant. Obtained results are in agreement with those reportedby**El-Sayed *et al.* (2015), Ibrahim and Ramadan (2015)**,**Talaat*et al.* (2015)**, **Abo-Sedera *et al.* (2016)**,**Seif*et al.* (2016)** and**Shehata*et al.* (2017)**.

2.2. Effect of foliar spray treatments.

Concerning the effect of foliar spray treatments on macronutrients concentration (N, P, K and chlorophyll reading), such data in Table 3 reveal that spraying four times with calcium thiosulphate at 2 ml/l, chitosan at 2g/l and Jasmonic acid at 200ppm starting 30 days from sowing and every week intervals through the growing season significantly increased such assayed macronutrients compared with the control treatment during both seasons of study. In this respect, the highest concentration of N, P, K and chlorophyll reading were obtained in case of using calcium thiosulphate. Obtained results are in the same trend during both seasons of growth. In this respect, the increments in macronutrients concentration due to the application of plant stimulants may be due to their content of mineral and organic constituents which may affect root growth and development and consequently increase the absorption surface of root to these macronutrients and in turn increased its concentration in roots and their migration and accumulation in plant foliage. Obtained results are in agreement with those reported by **Abu-Muriefah(2013)**,**El-Gawad*et al.* (2013)**,**Byan (2014)**, **Ibrahim and Ramadan (2015)**,**Abo Sedera *et al.* (2016)** and **Farhangi-Abriz and Ghassemi-Golezani (2018)**.

2.3. Effect of the interaction.

With regard to the effect of the interaction between soil addition and foliar spray treatments, recorded data in Table3 show that the highest values in total N, P, K and chlorophyll reading concentration were obtained as a result of soil addition of seaweed extract combined with calcium thiosulphate foliar spray. Such results are the same in both growth seasons.

3. Fruit yield and its components

3.1. Effect of soil addition treatments.

Data recorded in Table 4 indicate that total produced fruit yield and its components expressed as early yield, total pod yield per plant, plot and feddan were significantly increased as a result of humic acid, seaweed extract and EM soil addition at 10g/l, 10ml/l and 150ml/l for each of them, respectively three times during the growing season compared to the control (without addition) during both season of study. In addition, application of seaweed extract as a soil addition exhibited the highest values in all measured yield parameters compared with other tested treatments during the two seasons of growth. Moreover, using humic acid treatment ranked second followed by EM. Obtained results are true during both seasons of experiment. The increment in total yield and its components as a result of using such tested organic constituents are connected with the increase in vegetative growth characteristics in Table2 and macronutrients concentration in Table3 which affected positively vegetative growth of plant and consequently produced yield. In this regard, obtained results are in parallel to that reported by **Alfoldi*et al.* (2000),Senanayake and Sangakkara (2001)**,**Hanafy*et al.* (2010), El-Bassiony et al. (2010), Fawzy et al. (2010)**, **Dawa*et al.* (2013)**,**Zewail (2014), Barakat*et al.* (2015)**, **El -Atabany (2015), El-Sayed*et al.* (2015)**, **Ibrahim and Ramadan (2015), Khattab*et al.* (2015)**,**Kocira*et al.* (2016), Seif*et al.* (2016)** and **Shehata*et al.* (2017)**.

3.2. Effect of foliar spray treatments.

Concerning the effect of spraying snap bean plants with Calcium thiosulphate, chitosan and Jasmonic acid on total fruit yield and its components ,i.e., early yield as well as total yield per plant, plot and feddan the same data in Table4 reveal that all the aforementioned yield components were significantly increased as a result of spraying plants four times using the different tested growth stimulants in comparison with the control treatment during both seasons of study. In addition, the highest early and total yield for both plant and feddan were obtained as a result of spraying plants with calcium thiosulphate at 2ml/l. Such results are similar during the two seasons of study. In this regard, the superiority of the total produced and early yield due to calcium application are connected with the highest increments in vegetative growth rate in Table2 and increasing the chemical constituents of plant foliage Table 3 which in turn affected positively produced yield. Similar results were reported by each of **Pieta *et al.* (2003),Badawy*et al.* (2004),Abu-Muriefah (2013), El-Gawad*et al.* (2013),Ibrahim and Ramadan (2015),Abo Sedera *et al.* (2016)**and**Farhangi-Abriz and Ghassemi-Golezani (2018)**

3.3. Effect of the interaction.

As for the effect of the interaction on total produced yield and its components, i.e., early yield as well as total fruit yield either per plant or feddan, the same data in Table 4 reveal that the highest early and total produced yield for both plant and feddan were recorded as a result of using seaweed extract as a soil addition combined with foliar spray with calcium thiosulphate during the both seasons of study.

4. Chemical fruit quality

4.1. Effect of soil addition treatments.

Data recorded in Table 5 indicate that all assayed fruit chemical constituents (T.S.S, carbohydrate, protein and fibers) concentrations were significantly increased during the two seasons of study as a result of soil application for humic acid at 10g/l, seaweed extract at 10ml/l and EM at 150ml/l three times during the growing season compared with the control treatment. In addition, the highest values of all measured chemical constituents were reported as a

result of using seaweed extract, humic acid and EM in distending order. Such increasing effect of using seaweed extract on chemical constituents of fruit may be due to the increasing of root growth and availability of nutrient element in the soil which inturn affect macronutrients concentration of plant foliage and consequently affected the assimilation of such constituents of fruit. Also, its effect on the concentration of N, P, K and chlorophyll which may play the main role on constituent of photosynthetic pigments molecules which intrun affect the formation and acclimation of such photosynthetic products in fruits. Obtained results are similar reported **El-Atabany (2015), El-Sayed*et al.* (2015)** and**Shehata*et al.* (2017).**

Table 4. Effect of soil addition and foliar spray treatments as well as their interactions on Total fruit yield and its components of snap bean plants during the two seasons 2016 and 2017.

Treatments		First season (2016)				Second season (2017)			
		Early Yield (ton/Fed)	Pod Yield (kg/plot)	Pod Yield (g/plant)	Total Pod yield (ton/Fed)	Early Yield (ton/Fed)	Pod Yield (kg/plot)	Pod Yield (g/plant)	Total Pod yield (ton/Fed)
Soil Addition	EM	3.15	28.07	193.37	5.58	4.03	33.45	210.11	6.65
	Humic	3.16	28.66	206.22	5.68	4.52	35.57	235.67	7.07
	Seaweed	3.42	30.88	210.69	6.12	5.09	37.50	244.43	7.42
	Control	2.93	26.09	165.71	5.18	2.30	26.83	169.14	5.33
L.S.D at 0.05		0.58	1.20	1.93	0.61	0.54	1.14	1.85	0.54
Foliar Spray	Calcium	3.51	30.47	205.52	6.06	4.75	36.96	229.35	7.31
	Chitosan	3.15	28.07	189.05	5.60	4.07	32.71	211.38	6.50
	Jasmonic	3.16	29.25	198.01	5.76	4.28	34.95	215.93	6.95
	Control	2.85	25.90	183.43	5.15	2.83	28.74	202.68	5.71
L.S.D at 0.05		0.58	1.20	1.93	0.61	0.54	1.14	1.85	0.54
The interaction									
EM	Calcium	3.59	30.95	204.5	6.15	4.84	38.27	214.48	7.61
	Chitosan	3.25	27.97	189.21	5.56	4.00	31.31	208.67	6.22
	Jasmonic	3.03	28.80	199.88	5.72	4.12	33.92	212.62	6.74
	Control	2.72	24.54	179.84	4.88	3.15	30.31	204.66	6.02
Humic acid	Calcium	3.28	29.60	212.19	5.88	5.04	37.97	252.66	7.55
	Chitosan	3.11	28.90	206.01	5.77	4.71	35.54	233.50	7.06
	Jasmonic	3.20	29.32	211.56	5.74	4.78	36.20	236.89	7.19
	Control	3.07	26.81	195.12	5.33	3.54	32.56	219.62	6.47
Seaweed	Calcium	3.69	32.63	213.93	6.48	6.03	42.70	266.66	8.35
	Chitosan	3.38	30.38	207.73	6.09	5.30	37.41	237.00	7.43
	Jasmonic	3.47	30.97	213.64	6.04	5.75	41.79	244.23	8.31
	Control	3.15	29.55	207.48	5.87	3.27	28.09	229.81	5.58
Control	Calcium	3.46	28.70	191.38	5.70	3.10	28.89	183.59	5.74
	Chitosan	2.89	25.04	153.25	4.98	2.26	26.58	166.34	5.28
	Jasmonic	2.94	27.92	166.94	5.55	2.48	27.88	169.99	5.54
	Control	2.43	22.69	151.27	4.51	1.34	23.98	156.62	4.77
L.S.D at 0.05		**1.17**	**2.40**	**3.86**	**1.22**	**1.07**	**2.28**	**3.70**	**1.09**

4.2. Effect of foliar spray treatments.

Concerning the effect of foliar spray treatments, the same data in Table 5 show that spraying snap bean plants four times starting 30 days after sowing and every 7 days interval with calcium thiosulphate (2 ml/l), chitosan (2g/l) and jasmonic acid at 200ppm significantly increased the concentrations of assayed organic constituents of fruits i.e., total soluble solids (T.S.S), carbohydrate, protein and fibers concentration compared to the control during both season of study. In this regard, the highest concentration in all the assayed organic constituents was recorded in case of using calcium thiosulphate followed by jasmonic acid and chitosan, respectively. Such enhancing effect due to using such tested growth stimulants on measured chemical constituents may be attributed to the constituents of growth stimulants, i.e., calcium thiosulphate, jasmonic acid and chitosan

which affect positively photosynthetic rate which in turn affect on acclamation of such chemical quality induces in storage organs (plant fruit). Obtained results are in the same direction to those recorded by **El-Gawad *et al.* (2013)** and **Abo Sedera *et al.* (2016).**

4.3. Effect of the interaction.

Concerning the interaction between soil and foliar spray treatment, data in Table5 indicate that the highest concentration in all determined organic constituents (T.S.S, carbohydrate and protein) and the lowest content of fibers were recorded as a result of using seaweed extract as soil application combined with calcium thiosulphate foliar spray as compared with other interaction treatments in both seasons of study.

Table 5. Effect of soil addition and foliar spray treatments as well as their interactions on chemical quality of snap bean pods during the two seasons 2016 and 2017.

Treatments		First season (2016)				Second season (2017)			
		T.S.S %	Carbohydrate %	Protein %	Fiber %	T.S.S %	Carbohydrate %	Protein %	Fiber %
Soil Addition	EM	7.58	26.35	14.58	9.35	8.36	28.19	15.63	10.01
	Humic	7.75	28.03	15.26	9.18	8.23	29.98	16.25	9.82
	Seaweed	7.99	29.42	16.60	8.74	8.40	31.48	17.76	9.36
	Control	5.83	23.97	14.01	9.59	7.85	25.64	14.99	10.26
L.S.D at 0.05		0.32	0.79	0.64	0.34	0.56	0.95	0.69	0.38
Foliar Spray	Calcium	7.88	27.45	15.81	8.88	8.62	29.36	16.92	9.50
	Chitosan	7.27	28.20	15.07	9.13	8.06	30.17	16.00	9.77
	Jasmonic	7.31	26.66	15.27	9.29	8.43	28.51	16.34	9.95
	Control	6.68	25.46	14.30	9.56	7.73	27.24	15.38	10.23
L.S.D at 0.05		**0.32**	**0.79**	**0.64**	**0.34**	**0.56**	**0.95**	**0.69**	**0.38**
The interaction									
EM	Calcium	8.26	26.66	15.21	9.21	8.90	28.52	16.27	9.86
	Chitosan	7.76	27.77	14.32	9.28	8.06	29.71	15.32	9.93
	Jasmonic	7.60	26.09	14.80	9.35	8.43	27.91	15.83	10.01
	Control	6.70	24.89	13.84	9.59	8.06	26.63	15.13	10.26
Humic acid	Calcium	8.60	28.74	16.03	8.86	8.83	30.74	17.15	9.48
	Chitosan	7.43	29.18	15.34	9.12	7.80	31.21	16.12	9.76
	Jasmonic	7.80	27.89	15.27	9.31	8.53	29.83	16.34	9.96
	Control	7.16	26.31	14.40	9.44	7.76	28.14	15.41	10.10
Seaweed	Calcium	8.46	29.77	17.41	8.15	8.66	31.85	18.63	8.72
	Chitosan	8.13	30.23	16.41	8.67	8.30	32.34	17.56	9.28
	Jasmonic	8.16	29.09	16.94	8.89	8.76	31.12	18.12	9.51
	Control	7.20	28.62	15.64	9.28	7.86	30.62	16.73	9.93
Control	Calcium	6.20	24.64	14.61	9.32	8.10	26.36	15.63	9.97
	Chitosan	5.76	25.64	14.04	9.47	8.10	27.43	15.02	10.13
	Jasmonic	5.70	23.57	14.09	9.64	8.00	25.21	15.07	10.32
	Control	5.66	22.04	13.32	9.94	7.23	23.58	14.25	10.64
L.S.D at 0.05		**0.65**	**1.58**	**1.29**	**0.68**	**1.12**	**1.90**	**1.39**	**0.76**

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تأثير الإضافة الأرضية والرش ببعض المركبات الآمنة على نمو وإنتاجية وجودة الفاصوليا

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أجريت تجربتان حقليتان خلال الموسم النيلي لعامي 2016 – 2017 بمزرعه خاصه بقريه قها محافظة القليوبية – مصر. لدراسة تأثير الاضافات الارضية (حامض الهيومك، مستخلص الطحالب ، الكائنات الحية الدقيقة EM) مع الرش الورقي ببعض المركبات الآمنة (الكالسيوم ،حامض الجاسمونيك ،الشيتوزان) والتفاعل بينهما وتأثير ذلك علي النمو الخضري والخصائص الكيميائية للمجموع الخضري ،ومحصول القرون الخضراء ومكوناته وجوده الثمار للفاصوليا الخضراء (صنف برونكو) .وقد أشتملت التجربة علي 16 معاملة ناتجة من التداخل بين أربع معاملات من الاضافة الأرضية "حامض الهيوميك 10جم/ لتر ،مستخلص الطحالب 10 مل/ لتر ، الكائنات الحية الدقيقة 150مل/ لتر) بالاضافة لمعاملة الكنترول (بدون اضافة) " مع أربعة معاملات من الرش الورقي (ثيوسلفات الكالسيوم 2مل/ لتر، حامض الجاسمونيك 200 جزء في المليون ،الشيتوزان 2جم/لتر بالأضافة إلي معاملة الكنترول "الرش بالماء فقط".وقد أتبع في تصميم التجربة نظام القطع المنشقة علي ثلاث مكررات حيث تم وضع المعاملات الأرضية في القطع الرئيسية ومعاملات الرش في القطع الفرعية وقد اوضحت النتائج المتحصل عليها وجود اختلافات معنوية بين معاملات الاضافة الارضية والرش الورقى وكانت افضل النتائج أدت الاضافة الارضية لمستخلص الطحالب بمعدل10مل/لتر، ثلاث مرات خلال موسم النمو بعد 15 يوم من الزراعة وبفاصل اسبوع بين كل رشة والاخرى الى زيادة معنوية في كافة صفات النمو الخضري المدروسة والتكيب الكيميائى للمجموع الخضرى والمحصول وصفات الجودة للثمار الناتجة بينما وجد ان أدى رش نباتات الفاصوليا بثوسلفات الكالسيوم بمعدل 2مل/لتراربع مرات أثناء موسم النمو بعد 30 يوم من الزراعة وبفاصل اسبوع بين كل رشة والاخرى الى زيادة معنوية في جميع القياسات الخضريةوالمحصول وصفات الجودة بينما ادى التفاعل بإستخدام مستخلص الطحالب بمعدل 10مل/لتر كإضافة أرضية ثلاث مرات مع الرش الورقي للنباتات بمركب ثيو سلفات الكالسيوم بمعدل 2مل/لتر أربع مرات لزيادة النمو الخضري والانتاج الكلي والمبكر وكذلك زيادة الجودة الكلية للثمار.