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Improving Sugar Pea Growth and Quality by using some Natural Substances

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ABSTRACT

Two field experiments were conducted at Private Farm in Wadi Al-Natroun Distrect, Beheira Governorate, Egypt during Winter seasons of 2016/2017 and 2017/2018, to study the effect of some natural foliar applications, *i.e.*, fulvic acid (20 ml/l), effective microorganisms (5 ml/l),yeast extract (25 ml/l), humic acid (2 g/l), brassinolide (5 mg/l) and chitosan (200 mg/l) on vegetative growth, pod yield and quality of snow pea cultivar "Snow Wind" and sugar snap pea cultivar "Sugar Snap". The results showed that Sugar Snap cultivar surpassed Snow Wind cultivar in all studied traits, except for number of pods/plant, pod length, pod diameter and protein content. However, all studied natural substances significantly increased vegetative growth, pod yield and pod quality compared with control in both seasons. Foliar applications can be arranged in decreasing order as follows: fulvic acid > effective microorganisms > humic acid > yeast extract > brassinolide > chitosan.

Keywords: sugar pea, fulvic acid, effective microorganisms, yeast extract, humic acid, brassinolide, chitosan, growth, yield, quality

INTRODUCTION

Sugar pea (*Pisum sativum* L.) is considered one of the most important vegetable crops belonging to the legume family. It is a seasonal crop in Egypt where it is a winter crop grown for export. Sugar peas include two types: the snow peas (*Pisum sativum* var. macrocarpon) and the sugar snap peas (*Pisum sativum* var. saccharatum), they are known as edible-podded peas because they don't have the same cross fiber in the wall of the pod as the conventional pea and pods can be eaten whole. Sugar pea pods contain a great amount of protein, carbohydrates, vitamins, minerals and other nutrients and can be eaten raw, lightly boiled, steamed or used in stri-frys (Burt, 2008).

Agrochemicals are considered as a powerful weapon or magic bullets in the developing countries in order to enhance the agriculture productivity. The excessive and indiscriminate use of agrochemicals, allowing continued environmental contamination and contamination of the human food chain (Wimalawansa and Wimalawansa, 2014).

In recent times, attention has been attracted towards natural growth bio-stimulating compounds, safety to the environment, inexpensive and harmless to humans, for achieving high productivity of vegetables. One of these components is yeast extract, a natural source of cytokinins and has a stimulatory effect on pea plants. It has a beneficial role in stimulating the growth of plants and is one of the richest sources of protein, especially the essential amino acids, the essential minerals and trace elements. It was reported that yeast extract increased plant growth and pod yield of pea plants (Mahmoud *et al.*, 2013). Likewise, chitosan is a natural, low toxic, inexpensive compound and environmentally friendly with various applications in agriculture. It also improves growth and development of tomato plants (El-Tantawy, 2009).

Too, brassinosteroids (BRs) are a group of steroidal plant hormones, has been noted as the sixth plant hormone subsequent to auxin, gibberellin, cytokinin, ethylene and abscisic acid (Hamada, 1986). They were first isolated and characterized from the pollen of rape plant (*Brassica napus* L.), and are considered as hormones with pleiotropic effects, as they influence varied developmental processes like germination of seeds, growth, rhizogenesis, flowering and senescence. As well as promote elongation of pea plant (Clouse *et al.*, 1992).

Moreover, humic acids (HAs) and fulvic acids (FAs) together are called "humic substances". These substances increase the availability of nutrient elements by promoting the conversion of mineral elements into available forms to plants and they have a role in improving conditions of the plant and increasing the yield and quality of crops (Selim *et al.,* 2009). Also, effective microorganisms (EM) are considered as natural substances where they consist of bacteria, fungus, algae and yeast. EM improve soil health and the growth, yield and quality of vegetable crops (Higa and Parr, 1994).

Therefore, this study aimed to study the effect of some natural bio-stimulants, *i.e.*, fulvic acid, effective microorganisms, yeast extract, humic acid, brassinolide and chitosan on growth, green pod yield and quality of some sugar pea cultivars under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted at Private Farm in Wadi Al-Natroun Distrect, Beheira Governorate, Egypt during Winter seasons of 2016/2017 and 2017/2018, to study the effect of some natural foliar applications, *i.e.*, fulvic acid (20 ml/l), effective microorganisms (5 ml/l),yeast extract (25 ml/l), humic acid (2 g/l), brassinolide (5 mg/l) and chitosan (200 mg/l) on vegetative growth, green pod yield and quality of snow pea cultivar "Snow Wind" and sugar snap pea cultivar "Sugar Snap". Representative samples were collected from the experimental soil before sowing at (0-30 cm) depth to determine some physical and chemical properties as shown in Table (1).

Table 1. Physical and chemical analyses of the soil before conducting the experiment.

Properties	Value	Properties	Value
Physical		Soluble anions (meq/100g soil)	
Soil texture	Sandy	HCO_3^-	1.41
Organic matter %	0.56	CL^-	3.39
Chemical		$SO4^{--}$	1.40
E.C. (mmohs/cm)	1.21	Macro-elements (ppm)	
pH	8.13	N	43.5
C/N ratio	75.9	P	4.96
Soluble cations (meq/100g soil)		K	78.3
Ca^{++}	1.29		
Mg^{++}	0.87	Micro-elements (ppm)	
Na^+	3.76	Fe^{++}	2.03
K^+	0.28	Mn^{++}	1.40
		Zn^{++}	0.76

Seeds were inoculated directly before sowing with root nodules bacteria (*Rhizobium leguminosarum*) and were sown as two seeds per hill on one side of the irrigation lines at 20 cm spacing in 24th and 30th of November in the first and the second seasons, respectively. This experiment included 14 treatments resulted from the combination among 2 cultivars and 7 foliar applications. The layout of the experiment was split-plot system in a randomized complete blocks design with three replicates.

The sugar pea cultivars were randomly occupied the main plots, and the foliar treatments were randomly arranged in the sub-plots. The experimental unit area was 12.0 m^2 (1 dripper lines, each 12 m long and 1m width). The agricultural practices for sugar pea production were followed according to Egyptian Ministry of Agriculture recommendations. The treatments were sorted as follow:

a. **Sugar pea cultivars**: Snow Wind and Sugar Snap.

b. **Foliar applications**:

1- Fulvic acid (20 ml/l).
2- Effective microorganisms (5 ml/l).
3- Yeast extract (25 ml/l).
4- Humic acid (2 g/l).
5- Brassinolide (5 mg/l).
6- Chitosan (200 mg/l).
7- Control (sprayed with tap water).

Sugar pea plants were sprayed with foliar treatments three times, 15 days after sowing and repeated each 15 days interval.

Data recorded:

1. Vegetative growth:

At 50 days after sowing, five plants from each experimental unit were randomly marked for determining plant height, leaf area/plant (cm^2) according to Koller (1972) and plant fresh and dry weights (g).

2. Pod yield and its components:

At the proper maturing stage, green pods of each experimental unit were harvested, counted and weighted in each harvest and the following parameters were recorded: Number of pods/plant, average weight of pod (gm), pod length (cm), pod diameter (mm), pod thickness (mm), green pod yield/plant (gm) and total green pod yield (ton/fed.).

3. Chemical composition of pods:

The following data were determined in pods: Total soluble solids (TSS) was determined by Carl Zeiss refractometer, vitamin C (mg/100 gfw), titrable acidity (%) and crude fibers (%) were determined according to (A.O.A.C., 1990), carbohydrates (%) according to Hedge and Hofreiter (1962) and reducing, non reducing and total sugars (%) according to Sadasivam and Manickam (1996).

Statistical Analysis:

All obtained data were subjected to the statistical analysis of variance according to Snedecor and Cochran (1968) and treatment means were compared using least significant difference (LSD) method described by Gomez and Gomez (1984) at 5 % significance level. The statistical analyses were performed using CoStat Computer Software program.

RESULTS AND DISCUSSION

1. Vegetative growth:

1- Effect of cultivars:

Data presented in Table (2) show that there were significant differences between Sugar Snap and Snow Wind cultivars with respect to plant height, leaf area/plant and fresh and dry weight/plant in both seasons. Sugar Snap cultivar had higher values of plant height, leaf area/plant and fresh and dry weight/plant than Snow Wind. In this regard, Weiss *et al*. (2014) and El- Sherbini (2015) evaluated some varieties of sugar peas and found that there were differences between varieties in their vegetative growth parameters. The differences among cultivars may be due to the different genetic makeup, which affects on growth habit.

2- Effect of foliar applications:

Table (2) illustrate that all natural substances foliar treatments significantly increased all studied characters compared with the control. The best application was fulvic acid followed by effective microorganisms, humic acid, yeast extract, brassinolide and chitosan, respectively. Similar results were obtained by Abdel-Baky *et al*. (2019) on faba bean for fulvic acid, Einizadeh and Shokouhian (2019) on strawberry for effective microorganisms, Shafeek *et al*. (2013) on broad bean for humic acid, Marzauk *et al*. (2014) on faba bean for yeast extract, Kiera (2018) on snap bean for brasinolide and Sultana *et al*. (2017) on tomato for chitosan.

The positive effect of fulvic acid on vegetative growth of sugar pea may be due to that fulvic acid accelerates cellular division, stimulates vegetable growth and development, increases cellular energy and regulates plant metabolism to prevent accumulation of nitrate compounds in plants (Jackson, 1993).

Regarding effective microorganism treatment, it improves plant growth by producing bioactive substances such as hormones and enzymes and increasing photosynthesis (Hussain *et al*., 2002).

In addition, the response of sugar pea growth to yeast extract may attributed to its content of cytokinins which had a stimulatory effect on cell division and enlargement, chlorophyll formation and protein and nuclecic acid synthesis (Spencer *et al*., 1983).

The positive effect of humic acid on growth may be due to its chemical structure and functional groups, which could interact with harmonic-binding proteins in the membrane system, evoking a hormone-like response (Nardi *et al*., 1999). Moreover, humic acid increases photosynthesis, stimulates nucleic acid metabolism of tomato (Turkmen *et al*., 2004).

As for brassinolide involved in cell enlargement process through its effects on gene expression and enzyme activity (Mussig and Altmann, 1999) and promotes lateral root development through increasing acropetal auxin transport (Davidtchuck, 1999) which result in better crop growth.

Concerning chitosan, it had molecular signals that served as plant growth promoters (Hadwiger *et al*., 2002) and had a role in increasing key enzymes activities of nitrogen metabolism. In addition, it improved nitrogen transportation in the functional leaves which enhanced plant growth and development of okra plants (Mondal *et al*., 2012).

3- Effect of the interaction:

As seen in Table (3), the interaction treatments had a positive effect on the studied vegetative growth parameters of sugar pea plants. Spraying Sugar Snap cultivar with fulvic acid accorded the highest values of plant height, leaf area and fresh and dry weigh in both seasons while the lowest values were recorded when Snow Wind sprayed with tap water in both seasons.

Table 2. Effect of cultivars and foliar applications with some natural substances on plant height, leaf area/plant and fresh and dry weight/plant of sugar pea in the two seasons of 2016/2017and 2017/2018.

Treatments	Plant height (cm)		Leaf area/plant (cm)^2		Fresh weight /plant (gm)		Dry weight /plant (gm)	
	S1	S2	S1	S2	S1	S2	S1	S2
Sugar Snap	91.19	94.41	4666.24	5101.19	243.80	253.04	36.15	39.82
Snow Wind	71.61	76.29	4069.82	4569.11	179.09	185.76	25.53	27.76
F. test	***	***	***	***	***	***	***	***
Fulvic acid at (20 ml/l)	85.76	87.93	5249.62	5623.48	237.50	243.66	38.66	41.50
EM at (5 ml/l)	83.53	87.65	4974.45	5271.76	234.00	239.83	35.16	38.50
Yeast extract at (25 ml/l)	81.38	85.10	4162.84	4930.90	211.33	220.50	30.83	35.83
Humic acid at (2 g/l)	82.21	86.20	4605.66	5100.66	216.16	224.83	32.00	35.83
Brassinolide at (5 mg/l)	80.43	84.93	4153.44	4564.97	205.16	211.00	29.66	31.33
Chitosan at (200 mg/l)	78.83	84.15	3964.05	4431.61	200.83	207.83	26.00	29.00
Control	77.66	81.53	3466.17	3922.68	175.16	188.16	23.60	24.56
LSD at 5%	1.457	1.482	42.648	54.272	2.093	2.133	1.417	1.291

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

Table 3. Effect of the interaction between cultivars and foliar applications with some natural substances on plant height, leaf area/plant and fresh and dry weight/plant of sugar pea in the two seasons of 2016/2017 and 2017/2018.

Treatments		Plant height (cm)		Leaf area/plant (cm)^2		Fresh weight /plant (gm)		Dry weight /plant (gm)	
		S1	S2	S1	S2	S1	S2	S1	S2
Sugar Snap	Fulvic acid at (20 ml/l)	96.33	98.2	5267.58	5698.83	274.33	276.66	45.33	47.66
	EM at (5 ml/l)	92.76	97.66	5209.30	5457.81	268.66	272.66	39.33	43.33
	Yeast extract at (25 ml/l)	91.20	93.86	5041.07	5228.87	241.66	261.66	36.00	42.66
	Humic acid at (2 g/l)	91.96	95.66	5152.92	5439.73	257.00	262.33	38.00	43.33
	Brassinolide at (5 mg/l)	90.10	93.33	4302.07	5015.34	233.00	241.33	35.66	37.66
	Chitosan at (200 mg/l)	89.00	92.10	3967.10	4539.11	233.00	241.33	30.66	34.66
	Control	87.00	90.10	3723.67	4328.68	199.00	215.33	28.10	29.45
Snow Wind	Fulvic acid at (20 ml/l)	75.20	77.66	5231.65	5548.14	200.66	210.66	32.00	35.33
	EM at (5 ml/l)	75.10	77.63	4795.97	5103.78	199.33	207.00	31.00	33.66
	Yeast extract at (25 ml/l)	71.66	76.73	4002.02	4743.52	177.33	180.66	25.66	28.33
	Humic acid at (2 g/l)	72.66	76.86	4004.81	4846.46	181.00	187.33	26.00	29.00
	Brassinolide at (5 mg/l)	69.66	76.20	3961.01	4590.83	175.33	179.33	23.66	25.00
	Chitosan at (200 mg/l)	68.66	76.00	3284.60	3634.36	168.66	174.33	21.33	23.33
	Control	66.33	72.96	3208.68	3516.69	151.33	161.00	19.10	19.67
LSD at 5%		2.061	2.096	60.313	76.753	2.960	3.017	2.004	1.826

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

2. Green pod yield and its components:

1- Effect of cultivars:

Data are presented in Table (4) show that Sugar Snap cultivar recorded the heaviest average green pod weight, green pod yield/plant and total green pod yield/fed. in the two studied seasons, respectively. In addition, Table (5) clearly show that Snow Wind cultivar recorded the highest values of pod length and pod diameter in both studied seasons, whereas Sugar Snap cultivar recorded the highest values of pod thickness in both seasons.

Similar results were obtained by El- Sherbini (2015) who stated that total green pod yield and its components of sugar pea recorded statistical variations among all the tested varieties.

2- Effect of foliar applications:

As seen in Table (4), all foliar application with some natural substances significantly affected all studied parameters, *i.e.*, average green pod weight, number of green pods/plant, green pod yield/plant and total green pod yield/fed. compared to control in both seasons of the study.

The heaviest average green pod weight, green pod yield/plant and total green pod yield/fed. were obtained when sugar pea plants sprayed with fulvic acid followed by effective microorganisms, humic acid, yeast extract, brassinolide and chitosan foliar applications in both seasons, respectively.

In addition, Table (5) show that all foliar application with some natural substances had positive effect on pod length, diameter and thickness in both seasons. The highest values in all previous studied characters were obtained when sugar pea plants sprayed with fulvic acid followed by effective microorganisms, humic acid, yeast extract, brassinolide and chitosan, respectively. Moreover, control plants recorded the lowest values in all studied parameters.

These results are in accordance with those obtained by Abdel-Baky *et al*. (2019) on faba bean for fulvic acid, Einizadeh and Shokouhian (2019) on strawberry for effective microorganisms, Shafeek *et al*. (2013) on broad bean for humic acid, Marzauk *et al*. (2014) on faba bean for yeast extract, Kiera (2018) on snap bean for brasinolide and Sultana *et al*. (2017) on tomato for chitosan.

The promotive effect of fulvic acid on yield may be attributed to increasing chlorophyll content and net photosynthesis rates (Chen *et al*., 2004) and thereby increased translocation and accumulation of certain metabolites in plant organs.

The favorable effect of effective microorganisms on yield of sugar pea may be due to its effect on flower initiation in legume crops that resulted in increasing number of pods, and hence the total yield was increased (Javaid, 2006).

The positive response of sugar pea yield and its components to yeast extract may be due to its high content of cytokinins, Vit.B, organic compounds and nutrients (Nagodawithana, 1991), which increase distribution and translocation of metabolites from leaves towards the reproductive organs, thereby increasing sugar pea yield.

Increasing sugar pea pod yield in response to humic acid foliar application is a result of its positive physiological effects on cell metabolism and increased chlorophyll concentrations which promotes photosynthetic

activities which, in turn, diverts more photo-assimilates towards higher number of sinks (Nardi *et al*., 2002).

Regarding the increase in sugar pea yield in response to brassinolide, it mainly due to the role of brassinolide in increasing the endogenous level of auxins resulting in the enhancement of pod set (Susila *et al*., 2012).

Concerning the effect of chitosan, it may be a result of protecting plants against microorganisms (Nge *et al*., 2006), stimulation of roots, shoots and leaves and increasing chlorophyll content and photosynthetic rate (Khan *et al*., 2002) which led to increasing the vegetative growth followed by active translocation of photoassimilates from source to sink tissues and hence increasing total green yield.

3- Effect of the interaction:

Tables (6 and 7) show that different interaction treatments between cultivars and foliar treatments had a promotive impact on sugar pea yield and its components expressed as average green pod weight, green pod yield/plant, total green pod yield/feddan and pod length, diameter and thickness of sugar pea. The best interaction treatment for pod length and diameter of sugar pea was (Snow wind × fulvic acid) in the two seasons while the lowest one was (Sugar snap × control) in both seasons. But the best interaction treatment for average pod weight, pod yield/plant, total pod yield/fed. and pod thickness of sugar pea was (Sugar snap × fulvic acid) while the lowest one was (Snow wind × control) in both seasons.

Table 4. Effect of cultivars and foliar applications with some natural substances on number of green pods/plant, average green pod weight, green pod yield/plant and total green pod yield/fed. of sugar pea in the two seasons of 2016/2017and 2017/2018.

Treatments	No of green pods /plant		Average green pod weight (gm)		Green pod yield /plant (gm)		Total green Pod yield (ton/fed.)	
	S1	S2	S1	S2	S1	S2	S1	S2
Sugar Snap	47.04	48.04	7.36	7.45	350.81	358.43	7.016	7.168
Snow Wind	75.52	76.90	3.43	3.49	262.91	265.08	5.258	5.301
F. test	***	***	***	***	***	***	***	***
Fulvic acid at (20 ml/l)	65.00	66.00	5.54	5.60	328.18	337.40	6.563	6.748
EM at (5 ml/l)	63.33	64.50	5.50	5.57	323.2	328.38	6.464	6.567
Yeast extract at (25 ml/l)	61.33	62.16	5.39	5.45	304.76	309.60	6.095	6.192
Humic acid at (2 g/l)	62.16	63.33	5.46	5.50	313.47	318.37	6.269	6.367
Brassinolide at (5 mg/l)	60.00	61.33	5.30	5.42	298.23	302.54	5.964	6.050
Chitosan at (200 mg/l)	59.00	60.50	5.31	5.38	294.25	296.21	5.885	5.924
Control	58.16	59.50	5.26	5.37	285.96	289.79	5.719	5.795
LSD at 5%	1.095	0.903	0.083	0.083	3.703	4.288	0.074	0.085

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

Table 5. Effect of cultivars and foliar applications with some natural substances on pod length, diameter and thickness of sugar pea in the two seasons of 2016/2017 and 2017/2018.

Treatments	Pod length (cm)		Pod diameter (mm)		Pod thickness (mm)	
	S1	S2	S1	S2	S1	S2
Sugar Snap	7.30	7.34	13.46	13.55	12.24	12.41
Snow Wind	9.00	9.18	18.63	18.73	3.76	3.87
F. test	***	***	***	***	***	***
Fulvic acid at (20 ml/l)	8.37	8.45	16.44	16.47	8.50	8.71
EM at (5 ml/l)	8.30	8.38	16.30	16.36	8.31	8.43
Yeast extract at (25 ml/l)	8.19	8.27	16.01	16.16	8.07	8.15
Humic acid at (2 g/l)	8.25	8.32	16.18	16.31	8.19	8.35
Brassinolide at (5 mg/l)	8.18	8.25	15.95	16.05	7.87	8.02
Chitosan at (200 mg/l)	8.15	8.18	15.85	15.93	7.80	7.90
Control	7.85	7.98	15.58	15.70	7.28	7.42
LSD at 5%	0.049	0.046	0.078	0.068	0.085	0.099

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

Table 6. Effect of the interaction between cultivars and foliar applications with some natural substances on number of green pods/plant, average green pod weight, green pod yield/plant and total green pod yield/fed. of sugar pea in the two seasons of 2016/2017 and 2017/2018.

Treatments		No of green pods / plant		Average green pod weight (gm)		Green pod yield /plant (gm)		Total green Pod yield (ton/fed.)	
		S1	S2	S1	S2	S1	S2	S1	S2
Sugar Snap	Fulvic acid at (20 ml/l)	49.66	50.66	7.56	7.63	372.53	383.36	7.450	7.667
	EM at (5 ml/l)	48.66	49.33	7.46	7.56	368.20	376.60	7.364	7.532
	Yeast extract at (25 ml/l)	47.33	48.00	7.36	7.43	348.73	356.80	6.974	7.136
	Humic acid at (2 g/l)	48.00	49.00	7.46	7.50	358.50	367.50	7.170	7.350
	Brassinolide at (5 mg/l)	46.33	47.33	7.23	7.40	342.33	350.20	6.846	7.004
	Chitosan at (200 mg/l)	45.33	46.66	7.26	7.33	339.03	342.16	6.780	6.843
	Control	44.00	45.33	7.20	7.33	326.4	332.43	6.528	6.648
Snow Wind	Fulvic acid at (20ml/l)	80.33	81.33	3.53	3.58	283.83	291.45	5.676	5.829
	EM at (5 ml/l)	78.00	79.66	3.51	3.56	278.2	280.16	5.564	5.603
	Yeast extract at (25 ml/l)	75.33	76.33	3.41	3.48	260.80	262.40	5.216	5.248
	Humic acid at (2 g/l)	76.33	77.66	3.46	3.51	268.45	269.25	5.369	5.385
	Brassinolide at (5 mg/l)	73.66	75.33	3.38	3.45	254.13	254.88	5.082	5.097
	Chitosan at (200 mg/l)	72.66	74.33	3.36	3.43	249.48	250.26	4.989	5.005
	Control	72.33	73.66	3.33	3.41	245.53	247.15	4.910	4.943
LSD at 5%		1.549	1.278	0.117	0.118	5.237	6.064	0.104	0.121

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

Table 7. Effect of the interaction among cultivars and foliar applications with some natural substances on pod length, diameter and thickness of sugar pea in the two seasons of 2016/2017 and 2017/2018.

Treatments		Pod length (cm)		Pod diameter (mm)		Pod thickness (mm)	
		S1	S2	S1	S2	S1	S2
Sugar Snap	Fulvic acid at (20ml/l)	7.44	7.51	13.82	13.84	12.80	13.13
	EM at (5 ml/l)	7.43	7.43	13.70	13.73	12.66	12.76
	Yeast extract at (25 ml/l)	7.26	7.33	13.40	13.66	12.31	12.37
	Humic acid at (2 g/l)	7.36	7.40	13.63	13.70	12.51	12.70
	Brassinolide at (5 mg/l)	7.26	7.30	13.37	13.46	12.10	12.23
	Chitosan at (200 mg/l)	7.21	7.25	13.26	13.36	12.00	12.10
	Control	7.13	7.17	13.03	13.13	11.34	11.56
Snow Wind	Fulvic acid at (20ml/l)	9.30	9.40	19.06	19.10	4.20	4.30
	EM at (5 ml/l)	9.16	9.33	18.90	19.00	3.96	4.10
	Yeast extract at (25 ml/l)	9.12	9.21	18.63	18.66	3.83	3.93
	Humic acid at (2 g/l)	9.14	9.23	18.73	18.93	3.86	4.00
	Brassinolide at (5 mg/l)	9.11	9.20	18.53	18.63	3.65	3.82
	Chitosan at (200 mg/l)	9.10	9.11	18.43	18.49	3.60	3.71
	Control	8.58	8.80	18.13	18.28	3.21	3.28
LSD at 5%		0.069	0.065	0.110	0.097	0.121	0.140

S1: 2016/2017season, S2: 2017/2018season,
EM: effective microorganisms.

3. Chemical composition of pods:

1- Effect of cultivars:

Table (8) show that Sugar Snap pods recorded the highest values of TSS and vitamin C and the lowest content of fiber and titrable acidity in both seasons.

As for reducing, non-reducing and total sugars contents, data in Table (9) show that the differences between cultivars were significant in the two studied seasons. However, Sugar Snap pods were the highest in aforementioned characters followed by Snow Wind in both seasons.

Similar results were obtained by Weiss *et al.* (2014) and El- Sherbini (2015) on sugar pea, they showed that sugar pea cultivars differed in their pod chemical composition.

2- Effect of foliar applications:

Data shown in Table (8) reveal that spraying sugar pea plants with studied natural substances significantly increased TSS and vitamin C and decreased the content of fiber and titrable acidity in pods compared to control in both studied seasons. Humic acid followed by fulvic acid were the best treatments recording the highest content of TSS, vitamin C and the lowest content of fiber and titrable acidity contents in pods. On the other hand, pods of control treatment recorded the lowest total soluble solids (TSS) and vitamin C content and the highest fiber and titrable acidity content in both studied seasons.

Concerning the effect of foliar applications on reducing, non-reducing and total sugars, Table (9) indicate that previous studied characters significantly affected by foliar applications compared with the control in both season. Sugar pea plants treated with humic acid gave the highest values of reducing, non-reducing and total sugars followed by fulvic acid, effective microorganisms, yeast extract, brassinolide and chitosan, respectively while the lowest content was obtained in control pods.

These results are agreed with those recorded by Abdel-Baky *et al*. (2019) on faba bean for fulvic acid, Einizadeh and Shokouhian (2019) on strawberry for effective microorganisms, Eid and Abbas (2013) on common beans for humic acid, Marzauk *et al*. (2014) on faba bean for yeast extract, Kiera (2018) on snap bean for brassinolide and Sultana *et al*. (2017) on tomato for chitosan.

Additionally, fulvic acid increases the uptake of N, P, K, Ca, Mg of cucumber (Rauthan and Schnitzer, 1981) and is one of the most efficient transporters of vitamins into the cell (Fahramand *et al*. 2014).

The positive effect of effective microorganisms on chemical contents of pods may be attributed to that EM are effective during crop production (Ncube, 2008) and enhance photosynthetic, and protein synthetic activity (Olle and Williams, 2013).

The increase of pods chemical content in response to yeast extract might be attributed to its high content of macro and micro nutrients which increases the capacity of plants to absorb nutrients by increasing root surface in soil and building up plant metabolients (Nagodawithana, 1991).

The favorable effect on chemical composition of pods induced by humic acid foliar application might be due to increasing availability of nutrients and accumulation of pigments resulting in greener leaves with greater photosynthetic efficiency which produce more assimilates depicted in terms of total soluble solids (Abdel-Mwgoud *et al*., 2007).

The positive effects of brassinosteroid (BRs) on chemical content of sugar pea pods may be referring to activation of translational processes of specific stress tolerance genes (Kagale *et al*., 2007) and increasing nucleic acid and protein synthesis (Kalinich *et al*., 1985).

Concerning chitosan, its favorable impact on chemical contents of pods might be referred to its high content of amino compounds (Chibu and Shibayama, 2001).

Table 8. Effect of cultivars and foliar applications with some natural substances on fiber, TSS, vitamin C and acidity contents of sugar pea pods in the two seasons of 2016/2017 and 2017/2018.

Treatments	Fiber (%)		TSS		Vitamin C (mg/100gfw)		Acidity (%)	
	S1	S2	S1	S2	S1	S2	S1	S2
Sugar Snap	9.15	8.70	8.55	9.38	78.17	84.60	0.439	0.397
Snow Wind	9.57	9.39	8.03	8.91	66.94	73.80	0.453	0.405
F. test	***	***	***	***	***	***	***	***
Fulvic acid at (20 ml/l)	8.91	8.61	8.68	9.61	76.50	81.94	0.426	0.387
EM at (5 ml/l)	9.69	9.32	8.50	9.36	75.08	80.83	0.442	0.389
Yeast extract at (25 ml/l)	9.53	9.24	8.30	9.30	72.00	80.06	0.443	0.391
Humic acid at (2 g/l)	8.95	8.66	8.76	9.69	78.74	82.77	0.429	0.390
Brassinolide at (5 mg/l)	9.37	9.08	8.14	9.05	71.33	79.15	0.445	0.393
Chitosan at (200 mg/l)	9.20	8.91	8.04	8.85	69.02	77.56	0.446	0.423
Control	9.87	9.49	7.64	8.18	65.21	72.08	0.476	0.435
LSD at 5%	0.035	0.039	0.053	0.105	0.695	0.541	0.003	0.001

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

Table 9. Effect of cultivars and foliar applications with some natural substances on reducing, non-reducing and total sugars contents of sugar pea pods in the two seasons of 2016/2017 and 2017/2018.

Treatments	Reducing sugars (%)		Non-Reducing sugars (%)		Total sugars (%)	
	S1	S2	S1	S2	S1	S2
Sugar snap	4.79	4.84	15.53	15.60	20.28	20.43
Snow wind	4.70	4.79	14.46	14.61	19.32	19.41
F. test	***	***	***	***	***	***
Fulvic acid at (20ml/l)	5.13	5.23	15.43	15.54	20.73	20.82
EM at (5 ml/l)	5.03	5.09	15.28	15.37	20.20	20.38
Yeast extract at (25 ml/l)	4.78	4.85	15.04	15.18	19.91	20.05
Humic acid at (2 g/l)	5.17	5.27	15.53	15.63	20.80	20.90
Brassinolide at (5 mg/l)	4.59	4.65	14.82	14.97	19.50	19.63
Chitosan at (200 mg/l)	4.46	4.51	14.65	14.75	19.15	19.23
Control	4.06	4.12	14.21	14.34	18.31	18.42
LSD at 5%	0.014	0.051	0.009	0.010	0.012	0.029

S1: 2016/2017season, S2: 2017/2018season,
EM: effective microorganisms.

3- Effect of the interaction:

Table (10) show the impact of different interactions between cultivars and foliar applications with some natural substances on pods content of fiber, total soluble solids (TSS), vitamin C and titrable acidity. The interaction treatment (Sugar snap × fulvic acid) recorded the highest TSS and vitamin C content in the two seasons while the lowest one was (Snow wind × control) in both seasons. But the interaction treatment (Sugar snap × fulvic acid) recorded the lowest values of fiber and titrable acidity in both season while, the highest one was (Snow wind × control) in both seasons.

Table (11) show that the interaction treatment between Sugar Snap and humic acid recorded the highest values of reducing, non-reducing and total sugars in both season while, the lowest one was (Snow wind × control) in both seasons.

From the foregoing results, it could be concluded that, sowing sugar pea cultivars, i.e., Snow Wind and Sugar Snap under sandy soil and similar conditions and spraying with fulvic acid at 20 ml/l or effective microorganisms at 5 ml/l or humic acid at 2 g/l, three times, i.e., 15 days after sowing then repeated each 15 days interval was able to achieve the highest productivity and produced high quality of sugar pea.

Table 10. Effect of the interaction between cultivars and foliar applications with some natural substances on fiber, TSS, vitamin C and acidity contents of sugar pea pods in the two seasons of 2016/2017 and 2017/2018.

Treatments		Fiber (%)		TSS		Vitamin C (mg/100gfw)		Acidity (%)	
		S1	S2	S1	S2	S1	S2	S1	S2
Sugar Snap	Fulvic acid at (20 ml/l)	8.70	8.31	9.03	9.88	82.55	88.26	0.412	0.384
	EM at (5 ml/l)	9.53	9.02	8.75	9.66	81.15	86.08	0.440	0.384
	Yeast extract at (25 ml/l)	9.34	8.90	8.53	9.58	77.11	85.34	0.440	0.384
	Humic acid at (2 g/l)	8.64	8.25	9.03	9.91	84.22	89.38	0.412	0.384
	Brassinolide at (5 mg/l)	9.16	8.75	8.25	9.26	76.44	84.15	0.440	0.384
	Chitosan at (200 mg/l)	8.99	8.57	8.25	9.16	76.03	83.97	0.461	0.419
	Control	9.71	9.12	8.03	8.21	69.71	75.02	0.469	0.440
Snow Wind	Fulvic acid at (20 ml/l)	9.13	8.92	8.33	9.33	70.45	75.63	0.441	0.391
	EM at (5 ml/l)	9.86	9.63	8.25	9.06	69.01	75.58	0.445	0.394
	Yeast extract at (25 ml/l)	9.73	9.58	8.06	9.03	66.89	74.78	0.447	0.398
	Humic acid at (2 g/l)	9.27	9.08	8.50	9.46	73.26	76.15	0.446	0.397
	Brassinolide at (5 mg/l)	9.58	9.41	8.03	8.83	66.22	74.16	0.451	0.402
	Chitosan at (200 mg/l)	9.42	9.25	7.83	8.53	62.01	71.15	0.453	0.406
	Control	10.04	9.87	7.25	8.16	60.72	69.15	0.492	0.451
LSD at 5%		0.050	0.055	0.075	0.142	0.983	0.750	0.005	0.002

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

Table 11. Effect of the interaction between cultivars and foliar applications with some natural substances on reducing, non-reducing and total sugars contents of sugar pea pods in the two seasons of 2016/2017 and 2017/2018.

Treatments		Reducing sugars (%)		Non-Reducing sugars (%)		Total sugars (%)	
		S1	S2	S1	S2	S1	S2
Sugar snap	Fulvic acid at (20 ml/l)	5.21	5.28	15.97	16.02	21.25	21.35
	EM at (5 ml/l)	5.04	5.08	15.82	15.87	20.56	20.83
	Yeast extract at (25 ml/l)	4.82	4.88	15.57	15.68	20.38	20.56
	Humic acid at (2 g/l)	5.28	5.32	16.09	16.14	21.31	21.42
	Brassinolide at (5 mg/l)	4.65	4.69	15.33	15.47	19.98	20.15
	Chitosan at (200 mg/l)	4.47	4.51	15.19	15.23	19.67	19.76
	Control	4.09	4.13	14.73	14.83	18.83	18.94
Snow wind	Fulvic acid at (20 ml/l)	5.05	5.17	14.90	15.06	20.21	20.29
	EM at (5 ml/l)	5.02	5.11	14.74	14.87	19.85	19.93
	Yeast extract at (25 ml/l)	4.75	4.82	14.52	14.68	19.44	19.54
	Humic acid at (2 g/l)	5.05	5.21	14.98	15.12	20.29	20.38
	Brassinolide at (5 mg/l)	4.54	4.62	14.31	14.47	19.03	19.12
	Chitosan at (200 mg/l)	4.45	4.51	14.11	14.26	18.63	18.71
	Control	4.04	4.10	13.69	13.85	17.8	17.90
LSD at 5%		0.020	0.072	0.014	0.015	0.017	0.041

S1: 2016/2017season, S2: 2017/2018season, EM: effective microorganisms.

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تحسين نمو وجودة البسلة السكرية باستخدام بعض المواد الطبيعية

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أجريت تجربتان حقليتان بمزرعة خاصه بمنطقة وادى النطرون-محافظة البحيرة-مصر خلال موسمى الزراعة الشتويين ٢٠١٦\٢٠١٧ و٢٠١٧\٢٠١٨ بهدف دراسة تأثير معاملات الرش ببعض المواد الطبيعية مثل حمض الفولفيك (٢٠ مل / لتر) ، الكائنات الحية الدقيقة (إى إم) (٥ مل / لتر) ، مستخلص الخميرة (٢٥ مل / لتر) ، حمض الهيوميك (٢ جرام / لتر) ، البراسينولايد (٥ ملجم / لتر) ، الشيتوزان (٢٠٠ ملجم / لتر) على صفات النمو, المحصول والجودة لبعض اصناف البسلة السكرية (شوجر سناب وسنو ويند).أوضحت النتائج أن صنف شوجر سناب تفوق في كل الصفات المدروسة ، باستثناء عدد القرون / النبات ، طول القرون ، قطر القرن حيث تفوق فيها صنف سنو ويند .من ناحية أخرى أدت جميع معاملات الرش إلى زيادة معنوية فى صفات النمو الخضرى, المحصول والجودة. وكانت أفضل معاملات الرش كالتالى حمض الفولفيك يليها الكائنات الحية الدقيقة الفعالة ومستخلص الخميرة وحمض الهيوميك والبراسينولايد والشيتوزان, على التوالي. من خلال النتائج السابقة يمكن التوصية برش البسلة السكرية صنف سنو ويند أو شوجر سناب بحمض الفولفيك بمعدل ٢٠ مل/ لتر أو مستخلص الكائنات الدقيقة (إى إم) بمعدل ٥ مل / لتر ثلاث مرات الأولى بعد ١٥ يوم من الزراعة ثم تكرر كل ١٥ يوم وذلك للحصول على أعلى محصول وأفضل جودة تحت ظروف الأرض الرملية.