J. of Plant Production, Mansoura Univ., Vol. 11 (11):1083-1096, 2020

Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Response of Snap Bean Plants to some Treatments under Temperature Stress Conditions

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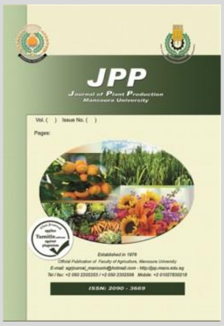

ABSTRACT

This work was carried out at the Experimental Farm of El-Baramoon Research Station, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt, during the early winter season of 2017/2018 and 2018/2019 and late summer seasons of 2018 and 2019 to study the effect of soil applications, i.e., seaweed (5 gm/100 L) (feldspar 75 kg/fed.), foliar applications, i.e., chitosan (175 ppm), yeast extract (20 ml/l), proline (50 ppm), salysilic acid (150 ppm), ascorbic acid (200 ppm), potassium silicate (100 ppm), ATP (0.03 gm/l), Royal jelly (0.1 g/l), fulvic acid (0.25 g/l) and citric acid (0.3 g/l). on growth, yield and chemical composition on snap bean cv. Giza 6. The obtained results revealed that, summer season data gave higher value of growth, yield and chemical composition of plants compared with the winter seasons date. Soil addition with seaweed at 5gm/l and spraying chitosan at 175 ppm gave the highest growth, yield and chemical components of bean plants, followed by yeast extract at 20 ml/l, and proline at 50 ppm. Sowing snap bean cv. Giza 6 in 20th May with adding seaweed as a soil at 5 gm/l and spraying with chitosan at 175 ppm introduced the best interaction with respect to growth, yield and chemical composition of plant. From the obtained results it could be recommended that sowing snap bean cv. Giza 6 in 20th May with seaweed extract addition at 5g/100 L. and spraying with chitosan at 175 ppm and/or yeast extract at 20 ml/l, and/or proline at 50 ppm improved growth, yield and chemical composition of snap bean growing at summer season.

Keywords: Snap beans, sowing date, seaweed extract, feldspar, antioxidant.

INTRODUCTION

Snap bean (*Phaseolus vulgaris L.*) is one of the most important leguminous crops, which is one of the basic sources of protein and energy. It plays an important role in human nutrition and also improves soil fertility. In addition, its agriculture preserve soil fertility through biological nitrogen fixation in organization with symbiotic rhizobium prevailing in its root nodules. Snap beans are a warm-season crop with very little tolerance to frost. The best temperature range for growth is (21 – 27 º C). Average temperatures below 10 º C greatly decreased plant growth and maturity, while temperatures above 32 º C during holding flowers may cause a high percentage of flowers drop, thereby decrease crop production and quality (Moghazy, 2014). Likewise, seaweed extract has increased protein contact in root and shoot system, total soluble sugar and chlorophyll contact in leaves (Khan *et al.*, 2009). feldspar which is a source of k for plants growing under natural conditions comes from the weathering of k minerals and organic k-sources (Seddik *et al.*, 2015). Chitosan is a natural carbohydrate polymer from chitin derived from crustaceous shells such as crabs and shrimps (Kim, 2005). Chitosan is an anti-transpirant compound that had proved to be effective in many crops used to protect plants against oxidative stress (Karimi *et al.*, 2012). yeast is a natural source of cytokines and improving flowers formation and their set and stress mitigation due to its high cytokinins content (Amer, 2004). Proline, an amino acid, play a beneficial role in plants exposed to various stress conditions (Hayat *et al.*, 2012). Moreover, salicylic acid classified under the group of plant hormones, assigned regulatory roles in the metabolism of plant, natural product of phenyl metabolism, has direct involvement in plant growth thermogenesis, (Abdel Ati *et al.*, 2000). Ascorbic acid is an important antioxidant in plants which accumulates as an adaptive mechanism to environmental stresses, (Khan *et al.*, 2011). Also, silicon induces the resistance to distinct stress, pathogens, diseases and improves the condition of soil which contain toxic levels of heavy metals (Mahbod *et al.*, 2014). Royal jelly is secreted from the head of queen bees, it is synthesized from water, pollens and honey mixed with saliva, vitamins and hormones. (Heyl, 1951 and Nation and Robinson, 1971). ATP (adenosine triphosphate) is a ubiquitous energy source, acts extracellularly as a neurotransmitter. ATP and nucleoside triphosphates it can drive energy- dependent reactions inside cells, and work also outside the cell, where they function as agonists that can induce physiological responses without being hydrolyzed (Roux and Steinebrunner, 2007). Fulvic acid is an organic fertilizer with a non-toxic mineral chelating additive and water binder that maximizes its uptake through leaves and stimulates plant productivity (Malan, 2015). Finally, citric acid plays an important action in plant metabolism, act as protecting plant from injury and non-enzymatic antioxidant in chelating free radicals and. (Sadak, O., and Abdel hamid, 2015). Therefore, this study was designed to investigate the role of some exogenous applications, i.e., soil additions and foliar antioxidants (chitosan, yeast, proline, salicylic acid, ascorbic acid, silicon, Royal jelly, ATP, fulvic acid and citric acid) in alleviating the adverse effect of low and high temperature on vegetative growth, yield and its components of snap bean plants.

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DOI: 10.21608/jpp.2020.130921

MATERIALS AND METHODS

Two field experiments were carried out at El-Baramon Research Farm, El-Mansoura Horticulture Research Station, Horticulture Research Institute (H.R.I), Agricultural Research Center (ARC), Egypt during summer of 2018 and 2019 and winter seasons of 2017/2018 and 2018/2019. to investigate the effect of feldspar and seaweed soil additions and foliar application with different antioxidant compounds, *i.e.*, chitosan, yeast, proline, salicylic acid, ascorbic acid, silicon, Royal jelly, ATP, fulvic acid and citric acid and their interactions on vegetative growth, pod yield, chemical constituents of leaves and pods of snap bean (*Phaseolus vulgaris* L.) cv. Giza 6 grown in clay soil.

Experimental soil analysis:

The initial of some soil physical and chemical properties of investigated soil profile of cultivated area (0.0 to 50 cm depth) are given in table (1).

Table 1. Mechanical and chemical analysis of the experimental soil.

Soil characters		2017	2018
Mechanical analysis (%)	Coarse sand	2.55	2.58
	Fine sand	12.95	12.97
	Silt	17.68	17.71
	Clay	66.82	66.74
	Texture class	Clay	Clay
EC ds / m (1:5)		1.47	1.52
PH		7.79	7.84
o.m.%		2.52	2.49
$CaCo_3$		1.84	1.86
Micro nutrients (ppm)	Fe	12.06	12.11
	Mn	7.03	7.06
	Zn	3.04	3.01
	Cu	0.96	0.94
Available (ppm)	N	32.50	33.01
	P	6.02	6.08
	K	340	348

Table 2. Monthly air temperature (c^o) and relative humidity (%) in Mansoura Distract during 2017/2018 and 2019 seasons.

Month	2017			2018			2019		
	Temperature (c^o)		Relative	Temperature (c^o)		Relative	Temperature (c^o)		Relative
	Max	Min	Humidity%	Max	Min	Humidity%	Max	Min	Humidity%
Jan.	19	9.9	59	18.9	9.7	59	19.9	10.1	70
Feb.	21	11.9	55	20.4	11.6	54	21.2	12.3	55
May	31.9	19.9	45	32	20.1	46	33.1	21.6	53
Jun	33.5	22	50	33.9	22	49	33.9	22.55	55
July	35.1	22.2	59	34.9	22.1	58	35.1	22.55	56
Aug	35.6	20.9	63	34.2	20.5	61	35.2	21.3	63
Nov	25	10.4	60	24.8	10.4	61	24.1	11.2	62
Dec.	20	15.6	62	20.3	15.7	61	20.1	15.66	63

Data of physical and chemical analysis of experimental soil were conducted at Mansoura Center of Soil Improvement, Mansoura.

1- Experimental design and Cultivation practices of bean plants:

The design used was a spilt-plot with three replications. Each of the three of soil applications (control, seaweed and feldspar) were randomized within each replication as a main plot and the eleven foliar applications of antioxidants (control, chitosan, yeast, proline, salicylic acid, ascorbic acid, potassium silicate, Royal jelly, ATP, fulvic acid and citric acid) were randomized within each soil applications as sub-plot in both winter and summer seasons.

The experimental plot:

Contained (12-ridges, each 3 m length and 0.75 m width). Thus, making an area of 27 m^2 with 15 cm spacing between plants on one side of ridges at a rate of 3-5 seeds. Were planted in hills by hand at the depth of 2-3 cm and then covered with wet and dry soil. The plants were thinned to a 2or1seedlind per hill two weeks after sowing on (20th May) of summer 2018 and 2019 and (25th November) of winter 2017 and 2018 seasons, respectively.

During experimental field preparation, were performed. 20m^3 of Cattle manure (20m^3/fed) and 100 Kg/fed. of superphosphate (15.5%, P_2O_5) before planting during service operations and another 100 Kg were added during the growing season/Fed. The mineral fertilization was added at rate of 200 Kg of nitrogen in the form of ammonium sulphate, and 48 Kg potassium sulfate (K_2O). fertilizers with ammonium sulphate were divided in two doses, the first one was added before the first irrigation and the second added before the flowering time according to the recommendations of Egyptian Ministry of Agriculture, the normal agricultural practices of snap bean production were followed. Pods harvesting was done according to the standard characteristics for exportation.

All foliar application (control, chitosan, yeast, proline, salicylic acid, ascorbic acid, potassium silicate, Royal jelly, ATP, fulvic acid and citric acid). Were applied three times at 25, 35 and 45 days after sowing.

Data of temperature degree and relative humidity throughout of experiment period (two seasons) were obtained from Department of Agriculture Extension According to United Nations Climate Charts for mean, yearly temperatures and relative humidity.

2- Used treatment:

The experiment consent of the three soil application and eleven foliar application as follow:

a.Soil applications:

1.Control. (without addition)
2.Seaweed at (5 gm/100 L)*.
3.Feldspar ($KALSI_3O$) at 75 kg/fed.*

1- **Foliar applications of antioxidant:**

1. Control (sprayed with tap water).
2. Chitosan at 175 ppm.*
3. Yeast extract at 20 ml/l.
4. Proline (L-PROLINE, $C_5H_9NO_2$) at 50 ppm.**
5. Salicylic acid ($C7H_6O_3$) at 150 ppm.**
6. Ascorbic acid ($C_6H_8O_6$) at 200 ppm.**
7. Potassium silicate (K_2SiO_3) at 100 ppm.**
8. Royal jelly at 0.1 gm/l.***
9. ATP (Adenosine-5-triphosphate disodium salt) at 0.03 gm/l.
10. Fulvic acid at 0.25 gm/l.
11. Citric acid ($C_6H_8O_7$) at 0.3 gm/l.**

The soil amendments were added after two weeks from sowing. The plants were sprayed at three times with foliar applications at 25 days from sowing and repeated 10 days.

Yeast extract that contains Amino acids (Alanine 1.69, Arginine 1.49, Aspartic Acid 2.32, Phenylalanine 1.18, Proline 1.29, Tryptophan 0.25, Pyridoxine 22.09, vitamins: Vit.B1 23.33, Vit.B6 20.67, Folic acid 26.22 Adenine 31, Betaines 56 ppm) Minerals: Phosphorus 0.66%, Calcium 0.17%, Iron 107 ppm, Zinc 77 ppm. Crude Protein 43.00%, Carbohydrates 33.21% , Crude Fiber 7.20% and Ash 3.80). (Ahmed, 2013).

Data and measurements:

A sample of snap bean plants were randomly taken from each plant at 55 days after sowing and the following date were recorded

Fresh weight of plant (gm/plant):

It was determined from each sub-plot as average fresh weight including shoots and roots.

Dry weight of plant (gm/plant):

Average dry weight of all plant parts which dried at 70 C° in an oven with driven hot air for a constant weight and then it was calculated.

Green pods yield:

Total pods yield (ton/feddan)

It was calculated from all pods which harvested per plot and then calculated as ton per feddan.

Chemical composition of leaves

Total Chlorophyll: described by Lichtenthaler and Wellburn (1983) in fresh leaves.

Proline: It was determined according to the described by (Bates *et al.*, 1973).

Peroxidas: It was determined according to the described by Loukili *et al*., (1999).

Pod quality:

Crude fiber: Crude fiber according to A.O.A.C. (1984) were determined as percentage**.**

Total sugars (%): It was determined according to the method demonstrated to Sadasivam and Manickam (1996).

Protein (%): was calculated by multiplying the total nitrogen by the factor 6.25 according to A.O.A.C. (2000).

Total phenol: Content in pods was determined as gallic acid equivalent (mg Gallic acid /g dried extract). According to Slinkard and Singleton (1977).

Statistical Analysis:

All statistical analyses were performed using analysis of variance technique split plot design, the analysis of variance (ANOVA) and the least significant difference (L.S.D.) made by COSTAT computer software. Using the differences between individual pairs of treatment means were compared using LSD at 5% level according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

1. Vegetative growth parameters:

Effect of soil application

Winter season experiment

Data in Table 3 show the effect of soil application on vegetative growth parameters, *i.e.*, fresh and dry weight and leaf area/plant of snap bean during winter seasons of 2017/2018 and 2018/2019. It is clear from the previous Tables that seaweed extract and feldspar soil additions improved leaf area/plant, fresh weight and dry weight of bean plants during both season of the study compared with control (without addition) except fresh weight/plant in 1st seasons. The highest values of the aforementioned parameters were obtained with seaweed extract during both seasons followed by feldspar.

Summer season experiment

The effect of soil application on vegetative growth parameters, *i.e.*, fresh and dry weight and leaf area/plant of snap bean during summer seasons of 2018 and 2019 are presented in Table 4. The results showed that soil addition of seaweed extract and feldspar improved leaf area/plant, fresh weight and dry weight of bean plants during both season of the study compared with control (without addition). The highest values of the aforementioned parameters were obtained with seaweed extract during both seasons followed by feldspar.

These results are accordance with those obtained by Ahmed *et al.* (2013) on feldspar of bean plant and Stirk *et al.* (2014) on seaweed. Of bean plant.

Seaweed extract being rich in growth regulators such as gibberellins, auxins and cytokinins which has an effective role in cell division and enlargement and induce the photosynthesis and this in turn reflected on a great shoot growth (Khan *et al*., 2009). Concerning the positive effect of feldspar on snap bean growth, it can be solubilized or weathered under the influence of physical and biological agents was made by microorganisms which produce organic acids, phenolic compounds (Duponnois *et al*., 2005).

Effect of foliar application

Winter season experiment

It is obvious from Table 3 that all foliar applications had positive effects on all studied growth traits of snap bean, i.e., leaf area per plant and fresh and dry weight per plant in two seasons. Spraying snap bean plants with chitosan (100 ppm) had the highest effect followed by yeast (20 ml/l) and proline (50 ppm) in both seasons.

Summer season experiment

Data in Table 4 showed that spraying snap bean plans with all studied treatments improved the vegetative growth compared with untreated plants. spraying with chitosan (100 ppm) registered the highest effect followed by yeast (20 ml/l) and proline (50 ppm) in both seasons.

Similar results were obtained by Abu-Muriefah (2013) for chitosan on common bean, Khattab *et al.* (2015) for yeast extract on faba bean, El-Saadony *et al*. (2017) for proline on pea plant , Abdel azem *et al.* (2015) for salicylic acid on snap bean, Barakat *et al.* (2015) for ascorbic acid on common bean, El-Sherbini (2015) for potassium silicate on sugar pea, El-Seifi *et al.* (2009) for ATP on snap bean, Abdel-Baky *et al.*, (2019) for fulvic acid on faba bean, El-Shaikh (2010) for royal jelly on cucumber and Farouk and Ramadan (2012) for citric acid on cowpea.

The significant effect of chitosan on plant growth under stress conditions may be attributed to reducing the accumulation of harmful free radicals by increasing antioxidants and availability and uptake of water and essential nutrients through adjusting cell osmotic pressure, also enhancing growth by some signaling pathways related to auxin biosynthesis via a tryptophan-independent pathway (Guan *et al.*, 2009). Concerning the beneficial effect of yeast, it could be due to its essential bio-constituents contents; i.e., carbohydrate, protein, gas, IAA, cytokinins and vitamins as well as mineral content. In addition, the physiological roles of vitamins and amino acids in the yeast extract which increase the metabolic processes role and levels of endogenous hormones that may promote the vegetative growth parameters Abido and Seadh (2014). Also, proline has a key role in stabilizing cellular proteins and membranes in high concentrations of osmoticum. In the same orientation, Vendruscolo *et al.* (2007) reported that proline accumulation in stressed plants is a tolerance mechanism against oxidative stress and it is the main strategy of plants to avoid harmful effects of drought stress. Concerning the beneficial effects of salicylic acid (SA). it has a beneficial effect for catching the abundant reactive oxygen species (ROS) that cause senescence and loss of plasma membrane permeability and death of cells within plant tissues under different temperature conditions which partiand cipates in the regulation of physiological processes in plants as a growth regulator (Umebese *et al.*, 2009).

Table 3. Effect of soil application and foliar application on vegetative growth of snap bean plants during winter seasons of 2017/2018 and 2018/2019.

Treatments	Winter (2017/2018) Fresh Weight (g)	Winter (2017/2018) Dry Weight(g)	Winter (2018/2019) Fresh Weight (g)	Winter (2018/2019) Dry Weight(g)
A-soil application				
Control	50.16	7.84	55.38	8.29
Seaweed at (5gm/100 L)	52.48	8.13	57.29	8.59
Feldspar at 75kg/fed	51.98	7.97	56.11	8.40
LSD at 5%	2.50	0.07	0.89	0.08
B-foliar application				
Control	40.22	6.19	43.96	6.58
ATP at 0.03 gm/l	49.03	7.6a7	53.68	8.07
Chitosan at 175 ppm	65.54	9.59	68.22	10.21
Royal jelly at 0.1 gm/l.	46.65	7.27	51.33	7.66
Salicylic acid at 150 ppm	51.08	7.98	56.08	8.41
Fulvic acid at 0.25 gm/l	53.09	8.35	58.66	8.79
Proline at 50 ppm	57.97	9.08	63.75	9.55
Ascorbic acid at 200 ppm.	55.46	8.68	61.41	9.20
Potassium silicate at 100 ppm	44.82	6.96	48.92	7.35
Yeast at 20 ml/l.	60.63	9.47	66.44	9.97
Citric acid at 0.3 gm/l	42.47	6.55	46.43	6.95
LSD at 5%	1.69	0.06	0.51	0.06

Table 4. Effect of soil application and foliar application on vegetative growth of snap bean plants during summer seasons of 2018 and 2019.

Treatments	Summer (2018) Fresh Weight (g)	Summer (2018) Dry Weight (g)	Summer (2019) Fresh Weight (g)	Summer (2019) Dry Weight (g)
A-soil application				
Control	58.56	8.75	61.76	10.09
Seaweed at (5gm/100 L)	60.54	8.99	64.02	10.38
Feldspar at 75kg/fed	59.39	8.84	62.75	10.22
LSD at 5%	0.75	0.16	1.11	2.07
B-foliar application				
Control	44.95	7.17	46.59	7.55
ATP at 0.03 gm/l	56.91	8.49	60.46	9.81
Chitosan at 175 ppm	72.86	10.69	76.39	12.47
Royal jelly at 0.1 gm/l.	54.57	7.89	57.46	9.43
Salicylic acid at 150 ppm	59.24	8.84	63.11	10.23
Fulvic acid at 0.25 gm/l	62.14	9.21	65.87	10.72
Proline at 50 ppm	67.13	10.02	71.23	11.61
Ascorbic acid at 200 ppm.	65.17	9.69	69.11	11.27
Potassium silicate at 100 ppm	51.65	7.72	53.98	8.86
Yeast at 20 ml/l.	70.49	10.49	74.74	12.18
Citric acid at 0.3 gm/l	49.37	7.28	52.29	8.44
LSD at 5%	0.60	0.16	0.51	0.44

Regarding ascorbic acid effect of snap bean growth, it can be discussed on the ground that ascorbic acid seems to enhance biosynthesis of carbohydrate and soluble sugars which are vital steps in stepping up plant tissues (Rady, 2006). The stimulative effect of silicon on vegetative growth might be due to that silicon improves protection against pathogens and enhances the growth (Greger *et al.*, 2011). Likewise, the improvement of the vegetative growth of snap bean in response to Royal jelly due to its content of nutrients, vitamins and hormones (El-Shaikh, 2010). Concerning ATP treatment, its hydrolysis readily and currently participated releasing the required energy for different process in plant Also, it links to alteration of gene expression to clod tolerance during stress via its role in signal transduction system (McClure *et al.*, 1989). Fulvic acids (FAs) are humic acids with a higher oxygen content and lower molecular weight ranging and can pass through micropores of biological or artificial membrane systems (Bulgari *et al.*, 2015). Regarding to citric acid, In addition, (Sun and Hong 2011) indicated that exogenous citric acid improving stress tolerance of L. chinensis plants during saline stress conditions.

3. Effect of the interaction

Winter season experiment

The effect of interaction between soil application and foliar applications on vegetative growth parameters of snap bean is presented in Table 5. All interaction treatments had positive significant effect on leaf area, fresh and dry weight/plant compared with control in both seasons.

Results in Table 5 indicated that plants treated with seaweed extract as soil addition and chitosan as foliar application gave the highest values of vegetative growth parameters in both seasons followed by yeast extract, while the plants untreated with soil addition and sprayed with tap water recorded the lowest values in both seasons.

Summer season experiment

Data in Table 6 showed that the interaction between soil and foliar applications had positive significant effect on leaf area, fresh and dry weight/plant of snap bean compared with control, in both seasons. The same results indicated that plants treated with seaweed extract as soil addition and sprayed with chitosan gave the highest values of vegetative growth parameters in both seasons followed by yeast extract, whereas the untreated plants (without soil and foliar additions) recorded the lowest values in both seasons.

2. Green Pods yield.

Effect of soil addition

Winter season experiment

Data in Table 7 showed the effect of soil application on pod yield, total green pod yield/feddan of snap bean plants during winter seasons of 2017/2018 and 2018/2019.

It is clear from the previous Tables that seaweed extract and feldspar soil additions improved total yield/fed during both season of the study compared with control (without addition). The highest values of the aforementioned parameters were obtained with seaweed extract during both seasons followed by feldspar.

Summer season experiment

The effect soil addition on pod yield and its components total pod yield/feddan of snap bean plants in Table 7. It is obvious that, using seaweed had the highest effect compared with feldspar and control treatments during summer seasons of 2018 and 2019.

The similar results were obtained by Ezzat *et al.* (2005) on feldspar on common bean and Abou El-Yazied *et al.* (2012) on seaweed of bean plant.

Seaweed extract contained components such as amino acids, cytokinins, macro- and micro element nutrients, vitamins and auxins which affect cellular metabolism in treated plants leading to enhanced growth and crop yield on common bean (Zewail, 2014). Also, feldspar had a great effect on The growth responsibility and yield quantity were improved as a result of the interaction between bio and natural fertilizers that had significant effect on soil characters and this may be due to the reaction of these microorganisms Stirk *et al.* (2014) on seaweed. Of bean plant.

Table 5. Effect of the interaction between soil application and foliar application on vegetative growth of snap bean plants during winter seasons of 2017/2018- 2018/2019.

Treatments		Winter (2017/2018)		Winter (2018/2019)	
A-soil application	B- Foliar application	Fresh Weight(g)	Dry Weight(g)	Fresh Weight(g)	Dry Weight(g)
Control	Control	40.22	6.19	43.96	6.58
	ATP(0.03gm/l)	48.13	7.54	52.97	7.92
	Chitosan (175ppm	60.82	9.21	67.47	10.08
	Royal jelly(0.01gm/l)	45.75	7.17	50.25	7.55
	Salicylic acid(150ppm)	49.53	7.79	54.59	8.20
	Fulvic acid(0.25gm/l)	51.59	8.24	57.66	8.64
	Proline(50pm)	56.71	8.96	62.72	9.42
	Ascorbic acid(200pm)	54.27	8.54	60.19	9.02
	Potassium silicate(100ppm)	44.44	6.84	48.40	7.19
	Yeast(20ml/l)	59.09	9.33	65.38	9.86
	Citric acid(0.03gm/l)	41.23	6.38	45.52	6.82
Seaweed (5gm/100 L)	Control	40.22	6.19	43.96	6.58
	ATP(0.03gm/l)	50.22	7.78	54.62	8.26
	Chitosan (175ppm	71.49	9.94	69.65	10.43
	Royal jelly(0.01gm/l)	47.64	7.42	52.39	7.82
	Salicylic acid(150ppm)	52.48	8.15	57.32	8.58
	Fulvic acid(0.25gm/l)	54.52	8.53	59.91	8.96
	Proline(50pm)	59.14	9.22	64.87	9.74
	Ascorbic acid(200pm)	57.04	8.79	62.55	9.41
	Potassium silicate(100ppm)	45.43	7.08	49.80	7.49
	Yeast(20ml/l)	62.99	9.63	67.62	10.15
	Citric acid(0.03gm/l)	43.92	6.75	47.47	7.13
Feldspar (75kg/fed)	Control	40.22	6.19	43.96	6.58
	ATP(0.03gm/l)	48.74	7.69	53.43	8.04
	Chitosan (175ppm	63.73	9.62	67.54	10.11
	Royal jelly(0.01gm/l)	46.55	7.22	51.43	7.62
	Salicylic acid(150ppm)	51.22	8.02	56.33	8.46
	Fulvic acid(0.25gm/l)	53.18	8.27	58.42	8.76
	Proline(50pm)	58.08	9.05	63.64	9.52
	Ascorbic acid(200pm)	55.06	8.72	61.49	9.18
	Potassium silicate(100ppm)	44.59	6.98	48.55	7.36
	Yeast(20ml/l)	59.79	9.44	66.32	9.91
	Citric acid(0.03gm/l)	42.25	6.52	46.29	6.89
	$LSD_{at5\%}$	5.90	0.22	1.84	0.20

Table 6. Effect of the interaction between soil application and foliar application on vegetative growth of snap bean plants during summer seasons of 2018- 2019.

Treatments		Summer (2018)		Summer (2019)	
A-soil application	B- Foliar application	Fresh Weight(g)	Dry Weight(g)	Fresh Weight(g)	Dry Weight(g)
Control	Control	44.95	6.83	46.59	7.55
	ATP(0.03gm/l)	56.09	8.33	59.37	9.75
	Chitosan (175ppm	71.49	10.50	75.51	12.33
	Royal jelly(0.01gm/l)	53.58	7.47	56.51	9.25
	Salicylic acid(150ppm)	57.56	8.63	61.65	9.93
	Fulvic acid(0.25gm/l)	61.31	9.14	64.50	10.55
	Proline(50pm)	66.39	9.87	70.26	11.56
	Ascorbic acid(200pm)	63.71	9.46	67.35	11.04
	Potassium silicate(100ppm)	50.98	7.58	53.37	8.79
	Yeast(20ml/l)	69.56	10.34	73.01	12.05
	Citric acid(0.03gm/l)	48.54	7.16	51.22	8.25
Seaweed (5gm/100 L)	Control	44.95	6.83	46.59	7.55
	ATP(0.03gm/l)	57.68	8.64	61.84	9.94
	Chitosan (175ppm	75.61	10.93	78.08	12.72
	Royal jelly(0.01gm/l)	55.54	8.20	58.44	9.64
	Salicylic acid(150ppm)	59.99	9.03	64.61	10.44
	Fulvic acid(0.25gm/l)	63.45	9.32	67.42	10.97
	Proline(50pm)	67.53	10.15	71.74	11.64
	Ascorbic acid(200pm)	66.59	9.83	70.50	11.47
	Potassium silicate(100ppm)	52.52	7.87	54.85	8.95
	Yeast(20ml/l)	71.61	10.69	76.51	12.35
	Citric acid(0.03gm/l)	50.44	7.45	53.59	8.55
Feldspar (75kg/fed)	Control	44.95	6.83	46.59	7.55
	ATP(0.03gm/l)	56.96	8.49	60.16	9.75
	Chitosan (175ppm	72.09	10.67	75.58	12.37
	Royal jelly(0.01gm/l)	54.59	8.02	57.43	9.42
	Salicylic acid(150ppm)	60.17	8.86	63.08	10.33
	Fulvic acid(0.25gm/l)	61.65	9.16	65.68	10.63
	Proline(50pm)	67.47	10.05	71.70	11.63
	Ascorbic acid(200pm)	65.22	9.78	69.48	11.31
	Potassium silicate(100ppm)	51.45	7.72	53.74	8.85
	Yeast(20ml/l)	70.29	10.43	74.69	12.15
	Citric acid(0.03gm/l)	49.14	7.24	52.06	8.52
	$LSD_{at\ 5\%}$	2.04	0.54	1.97	2.49

Effect of foliar application:

Winter season experiment

As for the effect of foliar application on yield and its components, data presented in Table 7 indicated that foliar application of chitosan, yeast, proline, salicylic acid, ascorbic acid, fulvic acid, ATP, Royal jelly, citric acid and potassium silicate it exerted significant increases in total yield compared with control.

It is a great benefit to give insight on the case of un treated plants (control) which show the absolutely lowest values for all growth parameters during two seasons. This indicated that these plants are dramatically and adversely by the prevailing low temperature during their growing seasons Table (2).

Summer season experiment

Data in Table 7 resulted the effect of foliar application on yield and its components. It is clear that foliar application of chitosan had the highest values followed by proline and yeast compared with control in both summer seasons of 2018 and 2019.

Herein, it could be suggested that the result improvement in yield and its components of snap bean by the application of the mentioned treatments under temperature stress conditions were logically true and expected, since the same treatments have several important functions in alteration the plants to be in an internal active protective case against cold and heat stress adverse effect.

Table 7. Effect of soil application and foliar application on yield of snap bean plants during winter seasons of 2017/2018- 2018/2019 and Summer 2018-2019.

Treatments	Winter (2017/2018)-(2018/2019)		Summer 2018-2019	
	Total yeild/ fed (ton)	Total yeild/ fed (ton)	Total yeild/ fed (ton)	Total yeild/ fed (ton)
A-soil application				
Control	4.36	4.49	4.88	5.17
Seaweed at (5gm/100 L)	4.51	4.61	5.09	5.37
Feldspar at 75kg/fed	4.43	4.55	4.99	5.27
LSD $_{at\ 5\%}$	0.02	0.02	0.05	0.05
B-foliar application				
Control	3.59	3.69	4.01	4.33
ATP at 0.03 gm/l	4.35	4.42	4.97	5.27
Chitosan at 175 ppm	5.20	5.33	5.88	6.14
Royal jelly at 0.1 gm/l.	4.12	4.25	4.67	4.96
Salicylic acid at 150 ppm	4.47	4.60	5.01	5.27
Fulvic acid at 0.25 gm/l	4.54	4.66	5.14	5.39
Proline at 50 ppm	4.90	5.03	5.45	5.73
Ascorbic acid at 200 ppm.	4.75	4.88	5.31	5.58
Potassium silicate at 100 ppm	3.98	4.10	4.48	4.79
Yeast at 20 ml/l.	5.05	5.18	5.69	5.97
Citric acid at 0.3 gm/l	3.82	3.94	4.26	4.55
LSD $_{at\ 5\%}$	0.02	0.02	0.04	0.03

The significant effect of chitosan on yield and its components might be due to its simulative effect on physiological processes and improved the transportation of nitrogen in the functional leaves which improved growth and development (Gornik *et al*., 2008). Regarding yeast extract, it participates beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants due to its high auxins and cytokinin contents in addition to its beneficial effect on carbohydrate accumulation (Barnett *et al.*,1990). This indicated that proline accumulation in faba bean plants Increase the plant's ability to withstand various stress conditions However, other authors noted that proline content showed significant positive correlation with yield of bean plants under water deficit conditions and different temperature conditions (Ghiabi *et al*., 2013). The stimulatory influence of spraying salicylic acid on yield may be due to its bioregulator effect on cell division, ion uptake, cell elongation, cell differentiations and sink and source regulation, photosynthetic activity and protein synthesis a (El-Tayeb, 2005). Likewise, Royal jelly improves snap bean on total yield because of its contents of nutrition elements and hormones (El-Shaikh, 2010). Which, stimulate vegetative growth and subsequently increase yield of plant and yield per fedden. Fulvic acid, enhanced photosynthetic activity, increased vegetative growth, dry matter accumulation, and consequently increased translocation and accumulation of certain metabolites in plant organs, which affected their yield and yield components (Abdel-Baky, 2019).

3. Effect of the interaction

Winter season experiment

Regarding the interaction between natural soil addition and foliar application on snap bean yield, data in Table 8 showed positive effects in both seasons. on total yield/fed. Generally, most studied parameters of yield and its components had the highest values with seaweed soil addition plant foliar application of chitosan compared with control.

Summer season experiment

The interaction between soil addition and foliar application on snap bean yield and its components, showed significant effects in both studied summer seasons (Tabel 8). The highest values of total yield as a result of the interaction between seaweed extract soil addition and foliar application of chitosan. Were recorded compared with control.

3. Total chlorophyll, peroxidase and proline in leaves

Effect of soil application

Winter season experiment

Data in Table 9 showed the effect of soil application on chemical composition of leaves, *i.e.,* total chlorophyll, peroxidase and proline of bean plants.

Presented data in Table 9 showed that peroxidase and proline and Total chlorophyll in leaves significantly increased by seaweed extract flowed by feldspar compared with control in both seasons. Concerning leaves content of peroxidase and proline as indicator of snap bean tolerant to low temperature stress, it can be said that seaweed and feldspar soil additions increased the previous contents compared with control (without addition). The highest content was recorded in leaves of seaweed extract addition then feldspar and the lowest was recorded in control leaves.

Summer season experiment

The effect of soil addition on chemical composition of leaves and total chlorophyll of bean plants showed in Table 10. Seaweed extract recorded the highest values followed by feldspar compared control in both summer seasons. In this respect, peroxidase and proline can be expressed as evidence of plant resistance to heat stress and they were higher in the summer seasons by using seaweed extract followed by feldspar.

In general, the contents of peroxidase and proline were higher value in plants grown in summer season than winter season. These results suggesting that the antioxidative response can vary with the stress type, intensity and duration, combined effects of other environmental factors.

Table 8. Effect of the interaction between soil application and foliar application interaction on yield of snap bean plants during winter seasons of 2017/2018 and summer 2018/2019.

Treatments		Winter (2017/2018)-(2018/2019)		Summer 2018-2019	
A-soil application	B- Foliar application	Total yeild/fed (ton)	Total yeild/fed (ton)	Total yeild/fed (ton)	Total yeild/fed (ton)
Control	Control	3.59	3.69	4.01	4.33
	ATP(0.03gm/l)	4.26	4.37	4.79	5.04
	Chitosan (175ppm	5.12	5.26	5.81	6.09
	Royal jelly(0.01gm/l)	4.05	4.19	4.59	4.90
	Salicylic acid(150ppm)	4.40	4.53	4.93	5.19
	Fulvic acid(0.25gm/l)	4.39	4.55	4.98	5.24
	Proline(50pm)	4.85	4.97	5.29	5.56
	Ascorbic acid(200pm)	4.69	4.81	5.16	5.46
	Potassium silicate(100ppm)	3.92	4.04	4.39	4.70
	Yeast(20ml/l)	4.97	5.11	5.61	5.87
	Citric acid(0.03gm/l)	3.78	3.88	4.16	4.49
Seaweed (5gm/100 L)	Control	3.59	3.69	4.01	4.33
	ATP(0.03gm/l)	4.53	4.46	5.25	5.55
	Chitosan (175ppm	5.27	5.39	5.97	6.21
	Royal jelly(0.01gm/l)	4.19	4.31	4.74	5.03
	Salicylic acid(150ppm)	4.55	4.67	5.08	5.34
	Fulvic acid(0.25gm/l)	4.63	4.75	5.27	5.49
	Proline(50pm)	4.98	5.10	5.57	5.84
	Ascorbic acid(200pm)	4.82	4.95	5.45	5.69
	Potassium silicate(100ppm)	4.04	4.16	4.59	4.88
	Yeast(20ml/l)	5.11	5.23	5.76	6.04
	Citric acid(0.03gm/l)	3.87	4.01	4.35	4.64
Feldspar (75kg/fed)	Control	3.59	3.69	4.01	4.33
	ATP(0.03gm/l)	4.28	4.42	4.87	5.21
	Chitosan (175ppm	5.23	5.33	5.86	6.13
	Royal jelly(0.01gm/l)	4.13	4.24	4.67	4.95
	Salicylic acid(150ppm)	4.48	4.59	5.03	5.28
	Fulvic acid(0.25gm/l)	4.59	4.69	5.19	5.43
	Proline(50pm)	4.89	5.02	5.49	5.79
	Ascorbic acid(200pm)	4.76	4.88	5.32	5.58
	Potassium silicate(100ppm)	3.97	4.09	4.48	4.79
	Yeast(20ml/l)	5.05	5.18	5.69	5.99
	Citric acid(0.03gm/l)	3.82	3.93	4.27	4.53
	at 5% LSD	0.08	0.09	0.14	0.12

Effect of foliar application

Winter season experiment

Presented data in Table 9 showed that all foliar applications significantly increased peroxidase and proline and Total chlorophyll compared with untreated plants (control) in both seasons. Same data showed that chitosan treatment gave the highest values for mineral composition and Total chlorophyll followed by yeast and proline in both seasons.

Concerning leaves content of peroxides and proline, chitosan treatment gave the highest values followed by yeast and proline, respectively in both seasons.

Summer season experiment

All foliar applications in Table 10 showed significant effect in peroxidase and proline and Total chlorophyll compared with untreated plants (control). Data showed that chitosan treatment gave the highest values for peroxidase and proline and Total chlorophyll followed by yeast and proline compared with control. Also, leaves content of peroxides and proline were higher in plants treated with chitosan followed by yeast and proline, sequentially in both summer seasons.

The significant effect of foliar spray of chitosan might be due to that chitosan is a new plant growth promoter such as GA_3 that may be have effect on photosynthetic pigments content of leaves El-Bassiony *et al*. (2014). The positive effects of applying active dry yeast was attributed to its contents of different nutrients, high percentage of protein, large amounts of vitamin B and natural plant growth regulators. Also, yeast affects cell division and enlargement, protein and nucleic acid synthesis, and chlorophyll formation on tomato plant (Wanas 2006). In addition, proline was shown to affect leaf size and pigments and tissue formation as well, (Mattioli *et al.* 2008).

The effect of salicylic acid on chemical composition of leaves may be due to its influence on biochemical and physiological process including, ion uptake, membrane permeability, photosynthesis, enzyme activity, and growth and development of plants (Arberg, 1981). The positive effect of ascorbic acid on leaf content of total chlorophylls may be attributed to its major role regulating and protecting photosynthetic process (Farago and Brunhold, 1994) and in turn probably led to more synthesis of pigment including total chlorophylls and carotenoids content and elements in leaves. Silicon improved the photosynthetic performance of plants under stress conditions (Ananieva *et al*., 2004), Also, SA treatment diminished changes in phytohormones levels in soybean seedlings under salinity , it prevented any decrease in IAA and cytokinin content and thus reduced stress-induced inhibition of plant growth (Shakirova *et al*., 2003). silicon led to increase production of carbon skeleton and increased the demand for N for the synthesis of amino acids and other N compounds and photosynthetic activity (Lima Filho and Abdalla, 2008). Additionally, applied ATP might active H+-ATP-ase membrane pumps (Remond *et al.*, 1992) thereby increasing cations absorption (K, Ca and Mg) and turn those activated such pumps in dynamic process inducing cold tolerance case (Palta, 1990). Beside, (ATP) via it's cytokinin function might increases water and nutrients uptake and photo metabolites translocation by controlling sink source (Jameson, 1994). According to, foliar application of fulvic acid it acts as natural chelators in the mobilization and transport of Fe and other micronutrients (Bocanegra *et al.*, 2006), there by increased chllorophylls andcaroteids and nutrients uptake. Citric acid seems to be a substance contributing to osmotic adjustment during drought stress and helps minimizing the injury caused by dehydration to plant tissues, which is indicated by higher chlorophyll content in leaves (Burkhard *et al*., 2012).

Table 9. Effect of soil application, foliar application on peroxidase and proline and Total chlorophyll of leaves of snap bean plants during winter seasons of 2017/2018 and 2018/2019.

Treatments	Winter (2017/2018)			Winter (2018/2019)		
	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g
A-soil application						
Control	1.106	17.07	0.671	1.062	17.87	0. 812
Seaweed at (5gm/100 L)	1.132	16.62	0.689	1.086	17.46	0.827
Feldspar at 75kg/fed	1.108	16.85	0.653	1.074	17.64	0.796
LSD at 5%	0.01	0.03	0.06	0.02	0.06	0.05
B-foliar application						
Control	0.907	20.42	0.334	0.871	21.08	0.524
ATP at 0.03 gm/l	1.051	17.61	0.614	1.032	18.46	0.759
Chitosan at 175 ppm	1.327	13.21	0.973	1.281	13.99	1.082
Royal jelly at 0.1 gm/l.	1.007	18.33	0.556	0.989	19.15	0.706
Salicylic acid at 150 ppm	1.085	16.86	0.676	1.071	17.72	0.816
Fulvic acid at 0.25 gm/l	1.176	16.12	0.738	1.117	16.97	0.864
Proline at 50 ppm	1.271	14.65	0.855	1.200	15.40	0.976
Ascorbic acid at 200 ppm.	1.223	15.38	0.795	1.158	16.22	0.922
Potassium silicate at 100 ppm	0.968	19.08	0.495	0.948	19.21	0.652
Yeast at 20 ml/l.	1.318	13.93	0.914	1.243	14.94	1.029
Citric acid at 0.3 gm/l	0.937	19.77	0.432	0.906	20.63	0.598
LSD at 5%	0.01	0.05	0.06	0.03	0.06	0.03

Table 10. Effect of soil application, foliar application on peroxidase and proline and Total chlorophyll of leaves of snap bean plants during summer seasons of 2018 and 2019.

Treatments	Summer (2018)			Summer (2019)		
	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g
A-soil application						
Control	0.596	16.21	0.560	0.618	17.02	0.580
Seaweed at (5gm/100 L)	0.613	15.65	0.609	0.635	16.46	0.633
Feldspar at 75kg/fed	0.604	15.81	0.579	0.625	16.80	0.615
LSD at 5%	0.03	0.08	0.02	0.03	0.06	0.02
B-foliar application						
Control	0.487	19.41	0.252	0.500	21.05	0.253
ATP at 0.03 gm/l	0.570	16.70	0.524	0.592	17.47	0.548
Chitosan at 175 ppm	0.731	12.58	0.872	0.757	13.18	0.907
Royal jelly at 0.1 gm/l.	0.545	17.34	0.464	0.565	18.22	0.524
Salicylic acid at 150 ppm	0.587	15.92	0.586	0.608	16.75	0.608
Fulvic acid at 0.25 gm/l	0.636	14.14	0.642	0.659	15.34	0.712
Proline at 50 ppm	0.688	13.93	0.755	0.713	14.58	0.785
Ascorbic acid at 200 ppm.	0.661	14.62	0.698	0.685	15.29	0.725
Potassium silicate at 100 ppm	0.524	18.13	0.413	0.542	18.99	0.427
Yeast at 20 ml/l.	0.712	13.23	0.812	0.738	13.84	0.844
Citric acid at 0.3 gm/l	0.508	18.77	0.395	0.527	19.65	0.370
LSD at 5%	0.01	0.05	0.02	0.02	0.04	0.02

3. Effect of the interaction

Winter season experiment

Concerning the interaction between soil addition and foliar applications on leaves, data in Table 11 showed increases in total chlorophyll content as aresult of adding seaweed extract and sprayed with chitosan (175 ppm) compared with control. The interaction between soil additions and foliar application presented in Table 11 showed that increased peroxidase and proline by adding seaweed extract and sprayed with chitosan (175 ppm) in both seasons.

Summer season experiment

Data in Table 12 showed the effect of the interaction between soil addition and foliar application on leaves, peroxidase and proline and Total chlorophyll content of plants treated by seaweed extract soil addition and sprayed with chitosan (175 ppm) were higher compared with other interaction in the summer season. The resulted showed that increased peroxides and proline in response to adding seaweed extract and sprayed with chitosan (175 ppm) in both seasons.

4. Green pod quality:

Effect of soil additions:

Winter season experiment

Concerning pod characteristic (total sugars, fiber, protein and total phenol), it is evident from Table 13 that soil additions had a significant enhancement on all pod quality characteristics aspect of snap bean than control in both seasons. The highest values of the green pods parameters were obtained with seaweed extract during both seasons followed by feldspar.

Table 11. Effect of the interaction between soil applicationand foliar application treatments peroxidase and proline and Total chlorophyll of leaves of snap bean plants during winter seasons of 2017/2018 and 2018/2019.

Treatments		Winter (2017/2018)			Winter (2018/2019)		
A-soil application	B- Foliar application	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g
Control	Control	0.907	20.42	0.334	0.871	21.08	0.524
	ATP(0.03gm/l)	1.041	17.85	0.614	1.021	18.69	0.759
	Chitosan (175ppm	1.279	13.44	0.972	1.272	14.24	1.084
	Royal jelly(0.01gm/l)	0.986	18.58	0.557	0.975	19.42	0.706
	Salicylic acid(150ppm)	1.081	17.11	0.675	1.060	17.97	0.812
	Fulvic acid(0.25gm/l)	1.160	16.38	0.738	1.103	17.23	0.866
	Proline(50pm)	1.260	14.89	0.856	1.187	15.60	0.975
	Ascorbic acid(200pm)	1.209	15.62	0.793	1.146	16.47	0.922
	Potassium silicate(100ppm)	0.960	19.32	0.496	0.932	20.11	0.653
	Yeast(20ml/l)	1.300	14.17	0.915	1.229	14.98	1.029
	Citric acid(0.03gm/l)	0.930	20.03	0.433	0.892	20.83	0.598
Seaweed (5gm/100 L)	Control	0.907	20.42	0.334	0.871	21.08	0.524
	ATP(0.03gm/l)	1.061	17.35	0.634	1.044	18.22	0.778
	Chitosan (175ppm	1.364	12.97	0.995	1.288	13.75	1.095
	Royal jelly(0.01gm/l)	1.024	18.08	0.576	1.001	18.93	0.724
	Salicylic acid(150ppm)	1.145	16.62	0.697	1.086	17.46	0.832
	Fulvic acid(0.25gm/l)	1.191	15.87	0.757	1.133	16.72	0.876
	Proline(50pm)	1.282	14.42	0.873	1.216	15.22	0.994
	Ascorbic acid(200pm)	1.240	15.14	0.816	1.172	15.96	0.941
	Potassium silicate(100ppm)	0.977	18.84	0.514	0.965	19.73	0.671
	Yeast(20ml/l)	1.323	13.68	0.935	1.257	14.49	1.047
	Citric acid(0.03gm/l)	0.945	19.48	0.448	0.920	20.45	0.615
Feldspar (75kg/fed)	Control	0.907	20.42	0.334	0.871	21.08	0.524
	ATP(0.03gm/l)	1.052	17.62	0.595	1.031	18.46	0.741
	Chitosan (175ppm	1.340	13.21	0.955	1.285	14.01	1.066
	Royal jelly(0.01gm/l)	1.012	18.33	0.536	0.992	19.09	0.688
	Salicylic acid(150ppm)	1.031	16.86	0.656	1.067	17.72	0.804
	Fulvic acid(0.25gm/l)	1.178	16.11	0.718	1.117	16.97	0.850
	Proline(50pm)	1.273	14.63	0.834	1.198	15.39	0.958
	Ascorbic acid(200pm)	1.221	15.39	0.775	1.157	16.22	0.905
	Potassium silicate(100ppm)	0.967	19.08	0.475	0.948	19.85	0.634
	Yeast(20ml/l)	1.331	13.95	0.892	1.244	14.74	1.012
	Citric acid(0.03gm/l)	0.935	19.80	0.416	0.906	20.61	0.580
	at 5% LSD	0.05	0.06	0.19	0.03	0.09	0.16

Table 12. Effect of the interaction between soil application and foliar application treatments on peroxidase and proline and Total chlorophyll of leaves of bean plants during summer seasons of 2018 and 2019.

Treatments		Summer (2018)			Summer (2019)		
A-soil application	B- Foliar application	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g	Total cholo (mg/g.fw)	Proline mg/g	POX mg/g
Control	Control	0.487	19.41	0.252	0.500	21.05	0.253
	ATP(0.03gm/l)	0.561	16.94	0.527	0.587	17.75	0.546
	Chitosan (175ppm	0.725	12.75	0.867	0.751	13.35	0.904
	Royal jelly(0.01gm/l)	0.533	17.65	0.466	0.552	18.46	0.608
	Salicylic acid(150ppm)	0.558	16.23	0.586	0.577	16.96	0.608
	Fulvic acid(0.25gm/l)	0.628	15.55	0.643	0.650	16.23	0.699
	Proline(50pm)	0.681	14.15	0.755	0.706	14.83	0.785
	Ascorbic acid(200pm)	0.654	14.86	0.695	0.678	15.54	0.725
	Potassium silicate(100ppm)	0.520	18.33	0.415	0.538	19.18	0.434
	Yeast(20ml/l)	0.702	13.44	0.813	0.727	14.04	0.845
	Citric acid(0.03gm/l)	0.504	18.94	0.350	0.523	19.85	0.364
Seaweed (5gm/100 L)	Control	0.487	19.41	0.252	0.500	21.05	0.253
	ATP(0.03gm/l)	0.579	16.44	0.540	0.601	17.23	0.573
	Chitosan (175ppm	0.738	12.41	0.906	0.764	13.03	0.942
	Royal jelly(0.01gm/l)	0.555	17.16	0.486	0.575	17.96	0.506
	Salicylic acid(150ppm)	0.619	15.76	0.605	0.642	16.47	0.631
	Fulvic acid(0.25gm/l)	0.644	13.44	0.665	0.668	14.05	0.793
	Proline(50pm)	0.693	13.74	0.776	0.718	14.35	0.808
	Ascorbic acid(200pm)	0.671	14.34	0.718	0.695	15.02	0.746
	Potassium silicate(100ppm)	0.527	17.94	0.433	0.546	18.86	0.452
	Yeast(20ml/l)	0.720	13.01	0.830	0.747	13.63	0.864
	Citric acid(0.03gm/l)	0.512	18.53	0.491	0.532	19.37	0.393
Feldspar (75kg/fed)	Control	0.487	19.41	0.252	0.500	21.05	0.253
	ATP(0.03gm/l)	0.568	16.72	0.506	0.588	17.45	0.526
	Chitosan (175ppm	0.730	12.59	0.844	0.756	13.16	0.875
	Royal jelly(0.01gm/l)	0.548	17.22	0.439	0.568	18.22	0.458
	Salicylic acid(150ppm)	0.583	15.76	0.566	0.605	16.82	0.586
	Fulvic acid(0.25gm/l)	0.637	13.44	0.618	0.660	15.74	0.643
	Proline(50pm)	0.689	13.92	0.734	0.714	14.54	0.763
	Ascorbic acid(200pm)	0.660	14.64	0.679	0.683	15.32	0.704
	Potassium silicate(100ppm)	0.524	18.13	0.391	0.542	18.95	0.397
	Yeast(20ml/l)	0.714	13.23	0.792	0.740	13.84	0.825
	Citric acid(0.03gm/l)	0.507	18.85	0.343	0.526	19.73	0.352
	at 5% LSD	0.02	0.09	0.13	0.05	0.28	0.25

Summer season experiment

It is evident from Table 14 that soil addition had a significant enhancement on all pod quality characteristics of snap bean (total sugars, fiber, protein and total phenol). seaweed extract recorded the highest values compared with feldspar and control in both summer season.

The similar results were obtained by Abd El-Rahman *et al.* (2015) on feldspar on snab pean and Belal *et al.* (2017) on seaweed on commen bean.

Effect of foliar application:

Winter season experiment

It is evident from Table 13 that all foliar application had a significant enhancement on all pod quality characteristics aspect of snap bean (total sugars, fiber, protein and total phenol) than control. They mostly differed considerably in both seasons. It is a great benefit to give insight on the case of non treated (control) plants which show the absolutely lowest values for parameters during the two seasons. It is clear from the same data that chitosan at a concentration of (175 ppm) gave the highest values for all studied characteristics followed by yeast and proline during the two seasons.

Summer season experiment

Data in Table 14 presented that all foliar application of pod quality characteristics of snap bean (total sugars, fiber, protein and total phenol) showed that chitosan (175 ppm) followed by yeast and proline had a significant effect compared with control during both summer seasons.

Table 13. Effect of soil applicaation, foliar application on pod quality of snap bean plants during winter seasons of 2017/2018 and 2018/2019.

Treatments	Winter (2017/2018)				Winter (2018/2019)			
	Fiber (%)	Total phenol mg/100g	Protein %	Total Sugar%	Fiber (%)	Total phenol mg/100g	Protein %	Total Sugar%
A-soil application								
Control	14.35	97.00	11.46	6.70	14.12	102.04	13.47	6.79
Seaweed at (5gm/100 L)	14.19	98.64	11.79	6.82	13.95	103.74	13.81	6.94
Feldspar at 75kg/fed	14.27	97.86	11.58	6.77	14.02	102.86	13.64	6.87
LSD at 5%	0.02	0.36	0.27	0.02	0.06	0.40	0.04	0.02
B-foliar application								
Control	15.55	84.41	9.15	5.77	15.12	89.36	11.02	5.98
ATP at 0.03 gm/l	14.48	95.32	11.13	6.55	14.27	100.19	13.10	6.59
Chitosan at 175 ppm	13.15	110.50	13.91	7.81	12.84	116.07	16.31	7.96
Royal jelly at 0.1 gm/l	14.78	92.51	10.66	6.34	14.51	97.47	12.53	6.38
Salicylic acid at 150 ppm	14.18	97.92	11.69	6.78	14.03	102.91	13.72	6.84
Fulvic acid at 0.25 gm/l	13.94	100.61	12.17	6.98	13.78	105.58	14.24	7.06
Proline at 50 ppm	13.49	106.01	13.03	7.39	13.31	111.03	15.22	7.47
Ascorbic acid at 200 ppm.	13.71	103.32	12.59	7.16	13.54	108.29	14.78	7.26
Potassium silicate at 100 ppm	15.05	89.79	10.22	6.13	14.10	94.79	11.98	6.22
Yeast at 20 ml/l.	13.31	105.68	13.42	7.61	13.18	113.90	15.76	7.69
Citric acid at 0.3 gm/l	15.32	87.17 j	9.79	5.92	14.99	92.10	11.43	6.08
LSD at 5%	0.02	0.30	0.08	0.01	0.04	0.25	0.03	0.01

Table 14. Effect of soil aplication, foliar application on pod quality of snap bean plants during summer seasons of 2018 and 2019.

Treatments	Summer (2018)				Summer (2019)			
	Fiber (%)	Total phenol mg/100g	Protein %	Total Sugar %	fiber (%)	Totalphenol mg/100g	Protein %	Total Suga r%
A-soil application								
Control	13.94	89.26	13.96	7.03	13.94	93.39	14.41	7.32
Seaweed at (5gm/100 L)	13.76	90.79	14.29	7.29	13.76	94.97	14.82	7.56
Feldspar at 75kg/fed	13.84	90.07	14.15	7.21	13.84	94.22	14.62	7.49
LSD at 5%	0.04	0.74	0.04	0.05	0.05	0.76	0.14	0.07
B-foliar application								
Control	15.07	77.55	11.77	6.21	15.75	81.40	12.07	6.34
ATP at 0.03 gm/l	14.05	87.51	13.58	6.94	14.75	91.47	14.13	7.23
Chitosan at 175 ppm	12.77	102.44	16.72	8.37	13.39	107.34	17.26	8.71
Royal jelly at 0.1 gm/l.	14.34	85.17	13.07	6.71	15.06	89.25	13.50	6.96
Salicylic acid at 150 ppm	13.75	89.99	14.06	7.19	14.43	93.79	14.43	7.45
Fulvic acid at 0.25 gm/l	13.54	92.26	14.59	7.40	14.22	96.48	15.35	7.71
Proline at 50 ppm	13.08	97.58	15.65	7.84	13.76	102.12	16.18	8.17
Ascorbic acid at 200 ppm.	13.29	95.03	15.09	7.63	13.96	99.23	15.58	7.93
Potassium silicate at 100 ppm	14.61	82.51	12.61	6.19	14.75	86.49	13.05	6.44
Yeast at 20 ml/l.	12.92	100.04	16.19	8.08	13.54	104.27	16.72	8.43
Citric acid at 0.3 gm/l	14.84	80.40	12.15	6.39	15.52	84.27	12.55	6.68
LSD at 5%	0.03	0.54	0.04	0.03	0.04	0.55	0.07	0.06

The role of chitosan chemical component of pods may be due to its effects on stabilizing cellular membranes through increasing antioxidants substances, saving cell membranes from oxidative stress and hence improving plant cell permeability. (Farouk,S. and Abd EL Mohsen, A.R. 2011). Concerning, yeast extract it might be has an effect on carbohydrates accumulation (Winkler *et al*., 1962). And has organic substances that play effective roles in improving pods.

In addition, proline plays a regulatory role in activity and function of the enzymes catalase, peroxidase and polyphenol oxidase in plant cells and in their participation in development of metabolic responses to environmental factors (Ozturk and Demir 2002). Also, salicylic acid improved the photosynthetic performance of plants under stress conditions (Ananieva *et al*., 2004), and diminished changes in phytohormones levels under stress conditions, (IAA and cytokinin content) and, thus reduced stress-induced inhibition of plant growth (Shakirova *et al*., 2003). Moreover, the enhancing effect of ascorbic acid on pod quality probably related to its major role in multifarious metabolic process such as photosynthesis and regulating co-enzymatic reactions by which carbohydrate and proteins are metabolized (Barakat *et al.*, 2015). The possible mechanisms of silicon-improvement of crop quality may be due to, improvement of micro-nutrient supply, coordination of nutrition supply and enhancement of resistance to stressful conditions (Jia-wean *et al*., 2013). Moreover, silicon increased photosynthetic activity and increased the demand for N for the synthesis of amino acids and other N compounds (Lima Filho and Abdalla, 2008).

Concerning fulvic acid, it has reported that fulvic acid increased the total carbohydrates percentage, crude protein percentage, minerals (nitrogen, phosphorus, and potassium) percentage, arginine, lysine, phenylalanine, tryptophan, and consequently total detected free amino acids in the dry seeds of faba bean cultivars. Concerning that ATP Biostimulants improve the primary metabolism of plants, increasing the levels of carbohydrates, proteins biosynthesis, free amino acids, pigments, and various enzymes (Yakhin *et al.*, 2017).

4.3. Effect of the interaction:

Winter season experiment

Concerning the interaction between soil addition and foliar application on pods quality of snap bean, data in Table 15 show increases in pods quality characteristics (total sugars, fiber, protein and total phenol) in the plants which treated with seaweed extract and sprayed with chitosan (175 ppm) in both season.

Summer season experiment

Concerning the interaction effect of soil and foliar applications on pod quality of snap bean, data in Table 16 showed increases in pod quality ((total sugars, fiber, protein and total phenol) with adding seaweed extract as soil application and spraying with chitosan in summer season compared with control.

Table 15. Effect of the interaction between soil application and foliar application on pod quality of snap bean plants during winter seasons of 2017/2018 and 2018/2019.

Treatments		Winter (2017/2018)				Winter (2018/2019)			
A-soil application	B- Foliar application	fiber (%)	Totalphenol mg/100g	Protein %	Total Sugar%	Fiber (%)	Totalphenol mg/100g	Protein %	Total Sugar%
Control	Control	15.55	83.50	9.14	5.77	**15.12**	88.50	11.02	5.98
	ATP(0.03gm/l)	14.59	94.30	10.89	6.48	14.35	99.20	12.89	6.52
	Chitosan (175ppm	13.22	109.50	13.82	7.74	12.93	115.02	16.12	7.82
	Royal jelly(0.01gm/l)	14.88	91.63	10.46	6.26	14.58	96.50	12.34	6.32
	Salicylic acid(150ppm)	14.27	97.13	11.52	6.68	14.11	101.97	13.55	6.76
	Fulvic acid(0.25gm/l)	14.03	99.67	11.96	6.91	13.87	104.70	14.06	6.99
	Proline(50pm)	13.56	105.10	12.81	7.32	13.39	110.10	15.04	7.39
	Ascorbic acid(200pm)	13.79	102.37	12.42	7.10	13.62	107.37	14.61	7.17
	Potassium silicate(100ppm)	15.14	88.93	10.12	6.06	14.84	93.93	11.79	6.15
	Yeast(20ml/l)	13.34	107.77	13.29	7.54	13.41	112.90	15.57	7.59
	Citric acid(0.03gm/l	15.41	86.20	9.65	5.83	15.09	91.03	11.25	6.01
Seaweed (5gm/100 L)	Control	15.55	85.27	9.14	5.77	15.12	90.27	11.02	5.98
	ATP(0.03gm/l)	14.39	96.13	11.39	6.63	14.19	101.13	13.34	6.68
	Chitosan (175ppm	13.10	110.50	14.02	7.88	12.79	116.07	16.49	8.10
	Royal jelly(0.01gm/l)	14.69	93.43	10.86	6.42	14.44	98.37	12.72	6.44
	Salicylic acid(150ppm)	14.08	98.83	11.94	6.86	13.96	103.83	13.87	6.94
	Fulvic acid(0.25gm/l)	13.84	101.60	12.36	7.06	13.70	106.50	14.42	7.12
	Proline(50pm)	13.42	106.86	13.39	7.46	13.23	111.90	15.40	7.52
	Ascorbic acid(200pp	13.63	104.16	12.79	7.21	13.46	109.23	14.95	7.32
	Potassium silicate(100ppm)	14.94	9.063	10.38	6.21	14.66	95.67	12.16	6.27
	Yeast(20ml/l)	13.22	109.53	13.58	7.67	13.01	115.10	15.95	7.80
	Citric acid(0.03gm/l	15.22	88.10	9.92	5.99	14.90	93.03	11.61	6.16
Feldspar (75kg/fed)	Control	15.55	84.47	9.14	5.77	15.12	89.30	11.02	5.98
	ATP(0.03gm/l)	14.46	95.53	11.09	6.53	14.26	100.23	13.07	6.59
	Chitosan (175ppm	13.15	110.00	13.88	7.82	12.81	116.00	16.30	7.97
	Royal jelly(0.01gm/l)	14.76	92.47	10.67	6.33	14.50	97.53	12.52	6.38
	Salicylic acid(150ppm)	14.19	97.80	11.61	6.79	14.03	102.93	13.73	6.83
	Fulvic acid(0.25gm/l)	13.94	100.57	12.19	6.98	13.77	105.53	14.24	7.07
	Proline(50pm)	13.49	106.07	12.89	7.39	13.31	111.10	15.22	7.49
	Ascorbic acid(200pp	13.71	103.43	12.56	7.17	13.55	108.27	14.78	7.28
	Potassium silicate(100ppm)	15.07	89.80	10.17	6.12	14.74	94.77	11.98	6.24
	Yeast(20ml/l)	13.36	108.73	13.39	7.61	13.12	113.70	15.77	7.69
	Citric acid(0.03gm/l	15.32	87.20	9.81	5.92	14.98	92.07	11.44	6.08
	at 5% LSD	0.14	0.41	0.07	0.08	0.15	0.76	0.07	0.09

Table 16. Effect of the interaction between soil application and foliar application on pod quality of snap bean plants during summer seasons of 2018 and 2019.

Treatments		Summer (2018)				Summer (2019)			
A-soil application	**B- Foliar application**	**Fiber (%)**	**Totalphenol mg/100g**	**Protein%**	**Total Sugar%**	**fiber (%)**	**Totalphenol mg/100g**	**Protein %**	**Total Sugar%**
Control	Control	15.07	76.61	11.77	6.21	15.75	80.54	12.07	6.34
	ATP(0.03gm/l)	14.15	86.45	13.42	6.86	14.85	90.63	13.95	7.12
	Chitosan (175ppm	12.84	101.44	16.52	8.22	13.49	106.34	17.06	8.56
	Royal jelly(0.01gm/l)	14.48	84.43	12.93	6.64	15.16	88.52	13.34	6.89
	Salicylic acid(150pp	13.86	89.59	13.85	7.11	14.48	93.62	13.98	7.35
	Fulvic acid(0.25gm/	13.68	90.63	14.43	7.31	14.37	94.71	14.93	7.64
	Proline(50pm)	13.19	96.53	15.49	7.73	13.89	100.69	16.02	8.08
	Ascorbic acid(200pp	13.41	94.31	14.84	7.55	14.05	98.43	15.35	7.85
	Potassium silicate(100ppm)	14.73	81.75	12.43	5.44	15.36	85.65	12.92	5.68
	Yeast(20ml/l)	12.94	99.61	16.02	7.98	13.65	103.60	16.54	8.32
	Citric acid(0.03gm/l	14.98	79.28	11.96	6.31	15.62	83.54	12.36	6.73
Seaweed (5gm/100 L)	Control	15.07	78.54	11.77	6.21	15.75	82.12	12.07	6.34
	ATP(0.03gm/l)	13.92	88.53	13.76	7.04	14.65	92.36	14.32	7.32
	Chitosan (175ppm	12.67	102.44	16.97	8.52	13.29	107.34	17.53	8.85
	Royal jelly(0.01gm/l)	14.23	85.59	13.21	6.79	14.95	89.68	13.65	7.04
	Salicylic acid(150ppm)	13.67	90.66	14.26	7.29	14.39	94.05	14.73	7.57
	Fulvic acid(0.25gm/	13.45	93.69	14.75	7.44	14.09	98.34	15.94	7.76
	Proline(50pm)	12.99	98.55	15.83	7.92	13.66	104.69	16.36	8.26
	Ascorbic acid(200pp	13.19	95.54	15.26	7.73	13.91	99.72	15.75	7.98
	Potassium silicate(100ppm)	14.49	83.51	12.75	6.61	11.68	87.61	13.15	6.86
	Yeast(20ml/l)	12.88	100.26	16.32	8.18	13.39	104.50	16.86	8.56
	Citric acid(0.03gm/l	14.73	81.42	12.31	6.49	15.44	85.49	12.68	6.70
Feldspar (75kg/fed)	Control	15.07	77.48	11.77	6.21	15.75	81.54	12.07	6.34
	ATP(0.03gm/l)	14.09	87.53	13.58	6.93	14.75	89.53	14.11	7.24
	Chitosan (175ppm	12.80	102.40	16.66	8.38	13.38	107.30	17.20	8.72
	Royal jelly(0.01gm/l)	14.29	85.48	13.07	6..69	15.08	91.40	13.52	6.95
	Salicylic acid(150pp	13.72	89.72	14.08	7.16	14.43	93.72	14.56	7.45
	Fulvic acid(0.25gm/	13.50	92.47	14.62	7.46	14.20	96.39	15.16	7.75
	Proline(50pm)	13.07	97.65	15.64	7.88	13.73	102.22	16.16	8.16
	Ascorbic acid(200pp	13.29	95.24	15.15	7.61	13.95	99.54	15.65	7.95
	Potassium silicate(100ppm)	14.59	82.28	12.65	6.51	15.27	86.22	13.07	6.80
	Yeast(20ml/l)	12.94	100.24	16.23	8.09	13.58	104.50	16.76	8.42
	Citric acid(0.03gm/l	14.81	80.28	12.18	6.39	15.49	83.78	12.61	6.62
	at 5% LSD	0.14	0.40	0.51	0.18	0.38	0.95	0.09	0.12

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إستجابة نباتات الفاصوليا الخضراء لبعض المعاملات تحت ظروف الإجهاد الحراري

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تم تنفيذ هذا العمل فى المزرعة البحثية بالبرامون ، التابعة لمحطة بحوث البساتين بالمنصورة ، معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزة مصر ، خلال العروة الشتوية المبكرة والعروة الصيفية المتأخرة لموسمى 2018/2017 و 2019/2018 على نبات الفاصوليا الخضراء صنف جيزة 6 لدراسة تأثير استخدام بعض الإضافات الأرضية مثل مستخلص الطحالب البحرية بمعدل (5 جم/100 لتر) و الفلسبار بمعدل(75 كجم/فدان.) بالإضافة الى الرش ببعض مضادات الأكسدة شيتوزان 175 جزء فى المليون - خميرة 20مل/لتر - برولين 50 جزءفى الميلون- حمض السالسيلك 150 جزء فى المليون —— حمض الاسكوربيك 200 جزء فى المليون –سليكات البوتاسيوم 100 جزء فى الميلون —- غذاء ملكات النحل 0.1 جم/لتر - حمض فولفيك 0.25 جم/ لتر- حمض الستريك 0.3 جم/لتر – ادينوزين تراى فوسفات 0.03 جم/لتر.وكذلك التفاعل بينهم على النمو والمحصول وبعض الصفات الكيماوية للقرون الخضراء. أوضحت النتائج التي تم الحصول عليها أن الزراعة في 20 مايو حققت ارتفاع قيم النمو المتمثلة في (المساحة الورقية و الوزن الطازج والوزن الجاف للنبات) ، وزيادة المحصول (محصول القرون /الفدان) بالإضافة الى تحسين محتوي القرون الخضراء متمثلا فى زيادة النسبة المئوية لكل من الالياف ، الفينولات الكلية ، بعض الانزيمات مثل البرولين ، البيروكسيديز، السكريات الكلية والبروتين. تأثرت جميع الصفات المختبرة بشكل كبير بالاضافات الارضية و بمعاملات الرش الورقية في كلا الموسمين مقارنة بالكنترول. حققت الاضافة الارضية بمستخلص الطحالب البحرية بمعدل 5جم /100 لترافضل نمو واعلى محصول ومكوناته واحسن تركيب كيمياوي. ، يليه الفلسبار بمعدل 75كجم / فدان وحققت ايضا معامله الرش باستخدام شيتوزان بمعدل 175 جزء فى المليون اعلى نموو افضل محصول ومكوناته واحسن تركيب كيمياوى يليه خميرة 20مل/لتر ثم برولين 50 جزءفى الميلون. كانت معاملة التفاعل بين زراعة بذور الفاصوليا صنف جيزة 6 في 20 مايوو الاضافه الارضية بمستخلص الطحالب و الرش الورقي بالشيتوزان بتركيز 175 جزء فى المليون قدم أفضل المعاملات فيما يتعلق بالنمو ومكونات المحصول والتركيب الكيميائي . من النتائج التي تم الحصول عليها ، يمكن التوصية بزراعة الفاصوليا صنف جيزة 6 في 20 مايو والاضافة الارضية بمستخلص الطحالب بمعدل (5 جم/100 لتر) والرش الورقي باستخدام شيتوزان 175 جزء فى المليون لزيادة النمو والمحصول والتركيب الكيميائي للفاصوليا المنزرعة في والصيفيه المتأخرة .

***Feldspar, alumina silicate minerals. Seaweed in form of seaweed flake was obtained from Techno-Gene Company, Dokki,**

****Salicylic acid, ascorbic acid, citric acid and potassium silicate were obtained from El-Gomhorya Company, Egypt.**

***** Royal jelly was obtained from Bee Research Institute, Agriculture Research Center, Egypt.**

*** Chitosan (acetamido-2-deoxy-β-D-glucopyranose as well as 2-amino-2-deoxy-β-D-glucopyranose), proline were obtained from Techno-Gene Company, Dokki, Giza, Egypt.**