Effect of inoculation with Azotobacter and organic fertilizer on growth and root nodule of Pea (*Pisum sativum* L.).

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Abstract

The study was conducted during the growing season 2018-2019, fall growing season in the college of Agricultural Engineering Science, University of Dohuk, Kurdistan region, Iraq, to evaluate the effects of inoculation of soil with Azotobacter ,and using seaweeds extract (Alga 600) on two pea cultivars (*Pisum sativum L*.) which were Ambrosia and Ezolda (B.) were grown in plastic pots in the field. Results of vegetative growth and quality parameters showed cultivar shows significantly difference as compared with cultivar (A) The results of number of nodules.plant^{-1}, length of nodules and width of nodules (mm),showed cultivar (B) gave high value which were(19.00, 4.444 and 4.132mm) respectively which significantly differ from cultivar triple interaction between Ezolda cultivar , 6m.L^{-1} seaweeds extract and inoculation the soil with Azotobacter record high value of (20.333 noduls.plant^{-1})compared with untreated plants that gave lower value (16. 333 noduls.plant^{-1}).

Keywords: Azotobacter, Seaweeds extracts, pea cultivar.

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Introduction

Pea (*Pisum sativum* L.) is considered one of the most important crop of Fabaceae family grown in Iraq and many countries all over the world. The origin of pea is Afghanistan and India. Pea has many nutritional values such as high content of protein, carbohydrates, phosphorus, iron, calcium and rich with A and B vitamins (10). The planted area of with this crop approximately 12-15% of the total area of earth and world (25).The planted areas in Iraq was 900 Acre that produce 15584.4 kg. and the total yield was 1500 ton (6).There is a great need for further studies under Iraq condition for the purpose of improving the quality and quantity of the crop as well as the reduction of environmental pollution which caused by chemical fertilizers.

Biofertilizers are some non-symbiotic and symbiotic microbes like *Azospirillum*, *Bacillus polymyxa*, *Pseudomanas* striata and. *Azotobacter*,in the soil (20) that stimulate plant growth and contribute to the improvement of ecosystem. They also play an active action in biologic control of plant pathogens(24).*Azotobacter* and *Azospirillum* also release growth regulators like giberellin, biotin and Auxin. These substances are effective in promotion of plant growth as biofertilizers(26). Azotobacter, for example, produces antifungal compounds and increases speed of seed germination, and seeding establishment(24). It also enhances root growth, water and nutrients uptake and facilitate atmospheric nitrogen fixation (20 and 21).

Seaweed extracts mostly used as natural promoters to increase vegetative growth and increase yield of most crop, these natural products and organic fertilizers are very cheap and safe for ecology and humans as compared with chemical products and plant growth regulators, such products are recommended as they are economical and safe for environment plant growth regulators(15). Seaweed do as a source of nutrients and as a growth promoting substance has also been recognized by Datta, *et.al*.(8) and Saravanan *et.al*.(19). Seaweeds provide an excellent source of bioactive compounds such as essential fatty acids, vitamins, amino acids as well as minerals, and growth promoting substances, antioxidants (5 and 17),The chemical analysis of seaweeds and their extracts has revealed the presence of a wide variety of plant growth-promoting substances such as auxins, cytokinins,

The purpose of this search is to show the effect of inoculation with Azotobacter, and organic fertilizer on growth and root nodule of pea (*pisum sativum* L.).

Material and Methods

The research was conducted in 10 October to March 2019 at research farm, college of Agricultural Engineering Science , University of Duhok. Seeds were grown in plastic bags (21.5 cm diameter). Soil and animal manure were used (1:2). used as mixture added after that As temperature degrees raised, the soil was put around the plastic bags to lowering the effect of high temperature on roots. The treatments were arranged in a factorial experiment in a Randomized Complete Block Design (R.C.B.D) with three factors. First one was the cultivars (Ambrosia (A) and Ezolda (B)). Second factor was inoculation with two concentration of Azotobacter (0 and 10ml.L^{-1}). Third factor was three concentrations of seaweeds (Al-gamix) (0, 4 and 6ml.L^{-1}) and Corbac G were used as fix for all treatment and added to mixture of soil for all treatment and so the experiment consist (2*2*3), it means we will have 12 treatments. SAS program were used to analysing all data(2). Experimental characters were as shown as follow:

A. Vegetative growth parameters, that include:

Leaf area, Chlorophyll content (SPAD) and Dry matter percentage.

B. The quality parameters of pea, that include:

Root length (cm,) Length and width of nodules, Stomata number in lower and upper part of leaf and length and width of stomata.

Table (1and2) show the effect of 1 cultivars, seaweeds ,Azotobacter and their interaction on leaf area and chlorophyll content (SPAD). It showed that there are significant differences in the leaves area in cultivar (B)that gave(7.744 cm2) compared with cultivar (A),treating plant with Azotobacter gave highest leaf area (7.917 cm2) as compared with untreated plant compared. The interaction between the Azotobacter and cultivar (B) had a significant effect on the average of leaf area(7.607 cm) the highest value for the mean leaf area was observed in the cultivate (B) in the plant treated with 2m.L of plant received seaweeds which gave highest value of leaves area (8.431cm2) compared with compared with other treatment. Triple interaction between seaweeds, Azotobacte and cultivar (B) gave high leaves area .(8.696cm) compared with other treatment

Regarding chlorophyll (SPAD) results in Table (2)shows the effect of cultivars Azotobacter and seaweed extracts on total chlorophyll (SPAD), it showed that the total chlorophyll percentage in the leaves was not different significantly between the cultivars. Chlorophyll content in the leaves of plant treated with seaweed extract significantly surpassed the percentage of the total chlorophyll compared the untreated plant, The treated plant with seaweed extract with cultivar showed significant difference as compared with untreated plant. The interaction between seaweed extract Azotobacter and cultivar (A) recorded significant difference as compared with untreated plant. 1

Results:

Table (1and2) show the effect of cultivars, seaweeds ,Azotobacter and their interaction on leaf area and chlorophyll content (SPAD). It showed that there are significant differences in the leaves area in cultivar (B)that gave(7.744 cm2) compared with cultivar (A),treating plant with Azotobacter gave highest leaf area (7.917 cm2) as compared with untreated plant compared. The interaction between the Azotobacter and cultivar (B) had a significant effect on the average of leaf area(7.607 cm) the highest value for the mean leaf area was observed in the cultivate (B) in the plant treated with 2m.L of plant received seaweeds which gave highest value of leaves area (8.431cm2) compared with compared with other treatment. Triple interaction between seaweeds, Azotobacte and cultivar (B) gave high leaves area .(8.696cm) compared with other treatment

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Table-1: Effect of Cultivars ,Azotobacter, seaweeds extract , and their interactions on leaf area (cm^2) of Pea

Cultivars	**Azotobacter ($ml.L^{-1}$)**	**Seaweeds extract ($ml.L^{-1}$)**			**Mean of Azotobacter*cultivar**	**Mean of cultivars**
A	0	5.919 f	4.400 g	7.125 a-c	5.814c	6.556b
	10	7.190 c-e	6.400 e-f	8.301 ab	7.297b	
B	0	6.943 de	8.167 ab	7.605 b-d	7.572ab	7.744a
	10	7.221 c-e	7.833 a-d	8.696 a	7.917a	
Mean of seaweeds		6.818 b	6.916 b	7.716 a		
Mean t of Cultivar*seaweed	A	6.554 c	5.400 d	7.713 b	**Mean of Azotobacter**	
	B	7.082 bc	8.431 a	7.719 b		
Mean of Azotobacter *seaweed	0	6.431 c	6.283 b	7.365 b	6.693b	
	10	7.205 b	7.548 ab	8.067 a	7.607a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05 level.

Note: A , mean Ambrosia cultivar. B , mean Ezolda cultivars

Table (2): Effect of of Cultivar Azotobacter, Seaweeds extract, and their interactions on chlorophyll content (SPAD) of pea

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1}) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	0	41.967b	43.127b	46.607ab	42.567b	44.506a
	10	47.000a	44.400b	44.967ab	45.456ab	
B	0	42.00c	43.650b	44.093ab	43.557ab	44.354a
	10	45.867ab	46.027a	46.533a	46.142a	
Mean of seaweeds		40.440b	44.301a	44.550a		
Mean of cultivar*seaweed	A	44.963ab	44.025a	44.530a	**Mean of Azotobacter**	
	B	43.917b	44.577a	44.570a		
Mean of Azotobacter *seaweed	0	42.447b	46.388a	43.350a	43.062b	
	10	42.4.433b	45.213a	45.750a	45.799a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05 level

Table (3and 4,) showed that there are significant influence on (plant length cm and dry matter of vegetative growth, the effect of, Azotobacter seaweed extract recorded significant increase in plant length compared with untreated plant that gave lower value , cultivar (B) recorded higher length compared cultivar (A) (75.123cm 71.494cm). Plant treated with Azotobacter gave higher length (74.654cm) as compared with no injection with Azotobacter that gave (71.963cm),plant treated with (6m.Lof seaweeds recorded significant increase compared with untreated plant that gave lower length of plant (75.43cm, 70.085cm)respectively. Regarding interaction between seaweed extract at (4m.L^{-1}) and soil inoculation with Azotobacter gave a significant difference as compared with untreated plant that gave lower value (68.740cm). Concerning the triple interaction between seaweeds extract , cultivars and Azotobater showed significant difference among them higher length of plant were recorded in plant treated with (6m.L) seaweeds extracts *soil inoculation with Azotobacter and cultivar (B) (88.200cm)compared interaction between cultivar (A)*untreated plant with seaweeds and Azotobacter that gave lower value (67.600cm).

Concerning dry matter percentage results in table (4) shown that their an effect of cultivars, seaweed extracts and Azotobacter on dry matter percentage, it recorded significantly a different between the cultivars. Dry matter percentage of plant treated with seaweed extract significantly surpassed compared the untreated plant, The double interaction between plant treated with seaweed extract and cultivar showed significant difference compared with untreated plant. The interaction between seaweed extract Azotobacter and cultivar (A) recorded significant difference compared with untreated plant.

Table (3): Effect of Cultivar Azotobacter, Seaweeds extract, and their interactions on plant length (cm) of Pea

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1}) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	0	67.600d	72.440b	78.860ab	72.96b7	71.494
	10	71.200bc	75.200b	63.667e	70.022c	
B	0	69.880c	72.000b	71.000b-c	70.960c	75.123ab
	10	71.660bc	78.00ab	88.200a	79.28a	
Mean of seaweeds		70.085c	74.410b	75.432a		
Mean of cultivar*seaweed	A	69.400c	74.400ab	78.600ab	**Mean of Azotobacter**	
	B	70.770b	75.000ab	79.600a		
Mean of Azotobacter *seaweed	0	68.740	72.220	74.930b	71.963b	
	10	71.430c	76.600a	75.93bb	74.654a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05 level

Table (4): Effect of Cultivar, Azotobacter, Seaweeds extract, and their interactions on dry matter percentage of vegetative growth of Pea

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1}) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	**0**	7.000b	4.397c	7.574b	6.324b	7.476b
	1	9.240a	8.413a	8.232a	8.628a	
B	**0**	7.655b	7.481b	8.736a	7.957a	8.339a
	1	8.167a	9.194a	8.800a	8.720a	
Mean of seaweeds		5.790c	7.371b	8.335a		
Mean of cultivar * seaweed	**A**	8.120a	6.405b	7.903ab	**Mean of Azotobacter**	
	B	7.911ab	8.337a	8.768a		
Mean of Azotobacter*seaweed	**0**	7.328b	5.939b	8.155a	7.140b	
	1	8.703a	8.803a	8.516a	8.674a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05level

Table (5) revealed that the effect of seaweeds extracts ,Azotobacter, cultivar and their interaction among with the root length (cm) the data showed that there were significant differences in length of root according to the cultivar, in cultivar B significantly increased which reaches(36.57cm.plant^{-1}) as compared with (34.089cm.plant^{-1}) in the cultivar B, it was showed significant increase in cultivars B, plant treated with bacteria that gave higher length of roots per plant (39.452cm) as compared with plant treated with seaweeds extracts about interaction between the treatment it was indicted that there was significant difference in the interaction between plant treated with(6ml.L^{-1}) cultivar (B) which gave high length of roots which was (38.495cm.plant^{-1}) as compared with untreated plants. Concerning plant treated with Azotobacter it was showed significant increase in plant treated with bacteria that gave the highest length with recorded (37.404cm)compared with untreated plant that gave (33.163cm).

Regarding the table (6,7 and 8) there was significant difference regard to the number, length and width of nodules, It also indicates that interaction among treatments showed significant increase in the number of nodules. plant^{-1} as compared with control. Concerning the length of nodules, there significant increscent among cultivar., cultivar B gave the best length of nodules (4.44 mm) as compared with (4.40 mm) of cultivar A, in the other hand treated plant with Azotobacter showed significant difference as recorded (4.656mm) nodules with plants compared with untreated plant treated with 6ml.L^{-1} seaweeds gave higher length of nodules(4.517 mm)compared with control that gave lower value (4.367 mm).

It was showed there are significant increases in width of nodules among cultivar, cultivar B, gave high width which was (4.132mm) as compared with cultivar A, Concerning the data were shown in the interaction between plant treating with Azotobacter and with cultivars B that gave highest width of nodules compared with other treatment treating plant with 4ml.L^{-1} of seaweeds extract and cultivar B, as compared with other interaction. The triple interaction among treatments showed significant difference.

Table (5): Effect of cultivar Azotobacter, Seaweeds extract , and their interactions on root length (cm) of Pea

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1})			Mean of Azotobacter*cultivar	Mean of cultivars
		0	4	6		
A	0	30.467b	34.067ab	33.333b	32.622b	34.089B
	10	34.667ab	36.667a	35.333a	35.556ab	
B	0	32.667ab	34.000c	34.443ab	33.703b	36.578a
	10	36.997a	38.813bc	42.547ab	39.452a	
Mean of seaweed extracts		36.997a	35.887a	36.414a		

Mean of cultivar*seaweeds extract	A	32.567b	35.367ab	34.333ab	**Mean of Azotobacter**
	B	34.832ab	36.407ab	38.495a	
Mean of Azptpbacter*seaweed	0	31.567b	34.033ab	33.888b	33.163b
	10	35.832a	37.740ab	38.940a	37.504a

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05 level

Table (6): Effect of cultivar Azotobacter ,seaweeds extract , and their interactions on Number of nodule of Pea

Cultivars	Azotobacter ($ml.L^{-1}$)	Seaweeds extract ($ml.L^{-1}$) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	**0**	16.333b	19.000a	18.887ab	18.073b	18.515b
	10	18.703	19.165a	19.000a	18.956ab	
B	**0**	19.000a	19.000a	19.333a	19.111a	19.000a
	10	18.333ab	18.000ab	20.333a	18.889ab	
Mean of seaweeds extract		18.093b	18.791ab	19.388a		
Mean of cultivar*seaweeds extract	**A**	17.518c	19.083a	18.943ab	**Mean of Azotobacter**	
	B	18.667ab	18.500b	19.833a		
Mean of Azotobacter*seaweed	**0**	17.667c	19.000a	19.110a	18.592b	
	10	18.518zb	18.583zb	19.667a	18.923a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05 level

Table (7) Effect of cultivar Azotobacter, Seaweeds extract , and their interactions on length of nodule (mm)

Cultivars	Azotobacter ($ml.L^{-1}$) 0	Seaweeds extract ($ml.L^{-1}$) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	**10**	4.067a	4.150a	4.233a	4.150a	4.404a
	0	4.567a	4.740a	4.667a	4.658a	
B	**10**	4.000a	4.103a	4.600a	4.234a	4.444ab
		4.833a	4.560a	4.567a	4.653a	
Mean of seaweed extracts		4.367b	4.388ab	4.517a		
Mean of cultivar*seaweeds extract	**A**	4.317a	4.445a	4.450a	**Mean of Azotobacter**	
	B	4.417a	4.332a	4.583a		
Mean of Azotopbacter*seaweed	**0**	4.033a	4.127a	4.417a	4.192ab	
	10	4.700a	4.650a	4.617a	4.656a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05level.

Table (8) Effect of Cultivar, Azotobacter, Seaweeds extract , and their interactions on width of nodules (mm)

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1})			Mean of Azotobacter*cultivar	Mean of cultivars
	0	0	4	6		
A	0	3.467bc	4.067ab	3.467bc	3.667b	3.845b
	10	3.960bc	4.167ab	3.943bc	4.023ab	
B	0	4.067ab	4.160ab	3.367c	3.864b	4.132a
	10	4.500a	4.400a	4.300ab	4.400a	
Mean of seaweed extracts		3.998a	4.198a	3.769b		
Mean of cultivar*seaweeds extract	A	3.713b	4.117a	3.705ab	**Mean of Azotobacter**	
	B	4.283a	4.280a	3.833ab		
Mean of Azotobacter*seaweed	0	3.767ab	4.113a	3.417ab	3.766b	
	10	4.230a	4.283a	4.122a	4.212a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05 level.

Regarding the table (9,10and 11) there was significant difference regard with the number of stomata , cultivar A recorded high number of stomata than B cultivar, the plant treated with Azotobacter significantly differ compared with untreated plant that gave lowered number of stomata (67.932and 63.851mm) respectively plant treated with 4m.L^{-1}seaweeds extract had high number of upper stomata (70.33), It also indicates that interaction among treatments showed significant increase in the number of lowered stomata [1]as compared with control. the interaction between cultivars A and treated plant with Azotobacter gave huge number of stomata (71.33)compared with other treatments, the triple interaction among treatments was shown in cultivar A*(4ml.L) seaweeds and treating plant with Azotobacter that gave higher number of stomata as compared with other treatments.

At the same time, it was showed there are no significant increases in width of stomata among cultivars, cultivar there are no significant deference among treatment when using seaweeds and Azotobacter.(4ml.Lseaweeds*plant treating with Azotobacter and cultivar B that gave higher width of lowered stomata

(0.366mm).compared with untreated plant that gave lowered width (0.183mm).

Table (11and 12) shows that there was significant differed from with the number of upper stomata between cultivars, the plant treated with Azotobacter significant differ compared with untreated plant that gave upper number of stomata (51.71)and 42.89 stomata) respectively plant treated with 4m.L^{-1} seaweeds extract had high number of upper stomata(53.67), It also indicates that interaction treatments showed significant increase in the number of upper stomata [1]as compared with control. Treating plant Aztobacter and cultivars A gave higher number of stomata as compared with untreated plant with Azotobacter in cultivars A(41.506). Concerning the interaction between treatment the interaction between 4ml.L^{-1} seaweeds extracts and treating plant with Azotobacter gave high number of upper stomata(61.423)compared with other treatments. The triple interaction among treatments was shown in cultivar A*(4ml.L) seaweeds and treating plant with Azotobacter that gave higher number of stomata as compared with other treatment (71.847).

It was showed there are no significant increases in width of stomata with regard cultivar, there are no significant difference between treatments when using seaweeds and Azotobacter. Treating plant with Azotobacter and seaweeds do not show any effect on width of upper stomata as untreated plant with seaweeds that gave high width of stomata (0.297mm) compared with other treating plant .

Table (9) Effect of Cultivar, Azotobacter, Seaweeds extract, and their interactions on number of stomata\2mm^2 in the upper leaf epidermis of pea.

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1})			Mean of Azotobacter*cultivar	Mean of cultivars
	0	0	4	6		
A	0	58.667c	74.667ab	59.480c	64.271a	67.80a
	10	77.667ab	82.333a	54.000c	71.333a	
B	0	64.627b	64.000	61.667bc	63.431b	63.981a
	10	68.590b	60.333b	64.667	64.530a	
Mean of seaweed extracts		67388b	70.333a	59.953b		
Mean of cultivar*seaweeds extract	A	68.167ab	78.500a	56.740b	**Mean of Azotobacter**	
	B	66.608b	62.167ab	63.167a		
Mean of Azotobacter*seaweed	0	61.647	69.333	60.573	63.851a	
	10	73.128	71.333	59.333	67.932a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05level.

Table (10) Effect of Cultivar, Azotobacter, Seaweeds extract , and their interactions on number of stomata\2mm^2 in the lower leaf epidermis of pea

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1}) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	0	40.167c	41.517bc	42.833bc	41.506b	47.325a
	10	44.273bc	71.847a	43.313bc	53.144a	
B	0	41.540bc	50.333ab	40.960ab	44.278ab	47.282b
	10	57.533ab	51.000ab	42.323ab	50.286a	
Mean of seaweeds		45.878ab	53.674a	42.358b		
Mean of seweed*cultivars	A	42.220b	56.682a	43.073b	Mean of Azotobacter	
	B	49.537ab	50.667a	41.642b		
Mean of azotobacter* seaweed	0	40.853b	45.925ab	41.897b	42.892b	
	10	50.903a	61.423a	42.818b	51.715a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05level.

Table (11) Effect of Cultivar, Azotobacter, Seaweeds extract , and their interactions on width of stomata lowered epidermis of leaf

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1}) 0	4	6	Mean of Azotobacter*cultivar	Mean of cultivars
A	0	0.183e	0.201d	0.216	0.200cb	0.250a
	10	0.254ab	0.304a	0.345a	0.301a	
B	0	0.240bc	0.259bc	0.221bc	0.240bc	0.255a
	10	0.366a	0.221bc	0.220ab	0.269	
Mean of seaweeds		0.261a	0.246a	0.250a		
Mean of seaweeds Mean of seweed*cultivars	A	0.218c	0.252a-c	0.280ab	Mean of Azotobacter	
	B	0.303a	0.240a-c	0.221b-c		
Mewan of Azotobacter *seaweeds	0	0.211bc	0.230bc	0.219c	0.220a	
	10	0.310a	0.262bc	0.282bc	0.285a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05;evel.

Table (12) Effect of Cultivar, Azotobacter, Seaweeds extract , and their interactions on width of stomata upper epidermis of leaf

Cultivars	Azotobacter (ml.L^{-1})	Seaweeds extract (ml.L^{-1})			Mean of Azotobacter*cultivar	Mean of cultivars
		0	4	6		
A	0	0.222d	0.274ab	0.216bc	0.237b	0.246b
	10	0.348a	0.216bc	0.199b-e	0.254ab	
B	0	0.279ab	0.215	0.289	0.261ab	0.280a
	10	0.341a	0.284bc	0.273bc	0.299b	
Mean effect of seaweeds		0.297a	0.247a	0.244a		
Cv	0	0.285c	0.245b	0.207bc	Mean of Azotobacter	
	1	0.310a	0.249b	0.281ab		
Mean of Azotobacter*seaweeds	0	0.250c	0.244bc	0.252b	0.249b	
	10	0.344a	0.250b	0.236b	0.277a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan's multiple range test at 0.05.

Discussion

Tables (1, 2 and 3) reveled that there are significant difference in vegetative growth parameters, increasing vegetative growth components by the effect of cultivar and Azotobacter and seaweeds extracts may be gose to the action of seaweeds on improving soil fertility and enhanced biological processes and consequently growth characteristics would be improved(12). Production of growth regulators by the Azotobacterin the root zone which gets absorbed by the plant roots has been reported by Rana and Chandel(18). Antipchuk *et al*. (3) who reported that inoculation of different *Azotobact erstrains* to soil resulted in higher vitamin C in tomato.

That enhance the plant to grow well, faster and early maturity leading to high plant productivity. Early maturity in pea plant is very important because it might avoid the crop from diseases, (12) which consider the main problem facing crop cultivation in the world(7 and 23).

The beneficial effect of seaweed extract application can be attributed to its many components working synergistically at different concentrations(9). This is enhanced growth effect is thought to be due to various organic compounds present in the seaweed extracts. It is noted from the above results that a significant increase occurred in length of nodules, width of nodules and number of nodules.plant^{-1} the improvement of stomata and root quality may be attributed to better growth of plant as results of different rate of seaweeds extracts and soil inoculation with Azotobacter.

The enhanced growth may be as a results of seaweed extracts may be due to its role in increasing the leaves numbers, leaf area and dry weight percentage so the physiological activities as photosynthesis and providing plant by nutrition (1). The effect of seaweed extracts lead to increase the percentage of the total soluble substances(11).

References.

1 - Al- Saaberi, M. R. S.2005. Effect of Some Agricultural Treatments on Growth, Yield of Lettuce *Lactuc sativa* L. M.Sc. Thesis. College of Agriculture and Forestry .University of Mosul. Iraq.

2 - Anonyme.2005.”Humic Acid”. Plant Meds(American Lawn Care Company). Washington. USA. File://G:.humicacid.htm.

3 - Antipchuk, A. F.; E. V. Tantsyurenko and Mantselyaruk, R. M. 1982. Effect of bacteria on tomato yield and quality. Teknologiya Pr-va-i-Effectivnost Primeneniya-Bakterialynkh-Udobreni 98-103. Fide Horticultural Abstracts 54:1768.

4 - Bambal, A. S.; R. M. Verma; D. M. Panchbhai; V. K. Mahorkar,; N. Bhaskar and Miyashita, K.2005.Lipid composition of Padinatetratomatica (*Dictyotales, Phaeophyta*), a brown seaweed of the west coast of India. Indian Journal of Fisheries,52:263-268.

5 - Bhaskar, N. and K. Miyashita.2005.Lipid composition of Padinatetratomatica (*Dictyotales Phaeophyta*) a brown seaweed of the west coast of India. Indian Journal of Fisheries,52:263-268.

6 - Central Statistical Organization-Iraqi. 2012. Ministry of planning mop. www.mop.gov.iq. For Agricultural Production.

7 - Colapietra, M. and A. Alexander.2006. Effect of foliar fertilization on yield and quality of table grapes. Acta Hort. (ISHS). 72: 213-218.

8 - Datta, A. S.; M. B. Das and Basu, T. K. 2003.Effect of krikelp powder (seaweed extract) and inorganic fertilizer on growth and productivity of pigeon pea under new alluvial zone of West Bengal. Environment and Ecology,21(4):823-826.

9 - Fornes F,; M. Sánchez-Perales and Guadiola, J. L.2002.Effect of a seaweed extract on the productivity of‘ de Nules ’Clementine mandarin and Navelina orange. Bot. Mar., 45:486–489.

10 - Hassan, A.A.1997.Vegetable Fruits. Al-Dar Al-Arabia Publications and Distribution. Cairo. Egypt. pp.241.

11 - Jensen, E. 2004 .Seaweed, Fact or Fancy.(In. Moses the Midwest Organic and Sustainable Education. From the Broad Caster.12(3):164-170.).

12 - Jianguo, Y.U.; Y. E. Shuiying; Z. Y. Ujuan and Yingchang, S.1998.Influence of humic acid on the physiological and biochemical indexes of apple trees. Forest Res.,11(6):623-628.

13 - Khan, W; U. P. Rayirath; S. Subramanian; K. B. Jithesh; A. K. Jager and Anstaden, J. V.1999. The effect of seaweed concentrate on the *Invitro* growth and acclimatization of the potato plants. Potato Res., 42(1):131-139.

14 - Khankhane, R. N.1998.Effect of biofertilizers and nitrogen levels on growth and yield of cauliflower (*Brassica oleracea* var . Botrytis). Orissa J. Hort., 26(2):14-17.

15 - Kowalski, B.; A. K. Jager and Anstaden, J. V.1999.The effect of seaweed concentrate on the invitro growth and acclimatization of the potato plants”. Potato Res.,42(1): 131-139.

16 - Little, H. A. and T. M. Spann.2011. Applications of a commercial extract of the brown seaweed Ascophyll and umnodosum increases drought tolerance in container-grown ‘Hamlin’ sweet orange nursery trees. Hort. Science,45:1-6.

12 - Potter, G., 2005.An Interview. www.kaizenbonsai.com.

18 - Rana, R. K. and J. S. Chandel.2003. Effect of biofertilizers and nitrogen on growth, yield and fruit quality of strawberry. Prog. Hort.,35(1):25-30.

19 – Saravanan, S.; S. V. Thamburaj; D. Eeraragavathatham and Subbiah, A.2003. Effect of seaweed extract and chlomequat on growth and fruit yield of tomato (Lycopersicon esculentum Mill). Indian J. Agric. Res.,37(2):79-87.

20 - Saxena, M.C., 1993. The challenge of developing biotic and a biotic stress resistance in cool-season food legumes. pp. 3- 14(In: Singh, K.B., Saxena, M.C. (Eds). Breeding for Stress Tolerance in Cool-Season Food Legumes. John Wiley and Sons, Chi Chester, U. K.

21 - Sinclair, T.R.; A.R. Zimet and Muchow, R. C.1998.Changes in soybean nodule number and dry weight in response to drought. Field Crops Research, 18: 197-202.

22 - Sivasankari, S. ; V. Venkatesalu ; M. Anantharaj and Chandrasekaran.2006. Effect of seaweed extracts on the growth and biological constituents of *Vigna sinensis*. Bioresource Technology, 97:1745-1751.

23 - Spann, T.M. and H. A. Little.2011. Applications of a commercial extract of the brown seaweed Ascophyll and umnodosum increases drought tolerance in container-grown ‘Hamlin’ sweet orange nursery trees. Hort. Science, 45:1-6.

24 - Tilk, K.V.B.R.; N. Ranganayaki; K. K. De; R. Pal; A. K. Saxena.; C. Shekhar Nautiyal.; S. Mittal.; A. K. Tripath and B. N. Johri, N. B.2005. Diversity of plant growth and soil health supporting bacteria. Cur. Sci.,98:136- 150.

25 - Vance, C.P.; P. H. Graham and Allen D. L.2000.Biological Nitrogen Fixation Phosphorus (In. A Critical Future Need, Pedrosa, M.; M. C. Hungria and Newton, W. E. eds., Nitrogen Fixation From Molecules to Crop Productivity. Kluwer Academic Publishers. Dordercht. The Netherlands, pp. 506-514.

26 - Vessey, J. K.2003. Plant growth promoting Rhizobacteria as biofertilizers. Plant and Soil, 255: 571-586.

27 - Yahalom, E., Y.O. Kapulnik. and Kon, Y.1984.Response of Setariato inoculation with *Azospirillum brasilenseas* compared to *Azotobacter*. Plant and Soil,82:77-85.