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RESEARCH ARTICLE

Effect of Some Natural Extracts on Growth and Productivity of Cucumber under Sandy Soil Conditions

El Sagan, M. A. M.
Plant Production Department, Desert Research Center, Cairo, Egypt .

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Corresponding Author

El Sagan, M. A. M.
Drm_elsagan@yahoo.com

Abstract

Two field experiments were carried out during the two consecutive winter seasons of 2013 and 2014 under low tunnels at the Baloza Experimental Station of (Desert Research Center) at North Sinai Governorate. The aim of the study was to investigate the effect of some natural extracts *i.e.* sea algae at rate of 0.5, 1 and 1.5 g/l; compost tea at rate of 50, 100 and 150 g/l; licorice at rate of 2.5, 5 and 7.5 g/l and yeast at rate of 2.5, 5 and 7.5g/l on growth, yield and its components and chemical constituents of cucumber (*Cucumis sativus* L.). Obtained results revealed that all foliar treatments improved growth, yield parameters and chlorophyll content compared with control treatment. The highest significant increments in plant length, plant weight, average of leaf area, fruit weight, No. of fruit/plant, yield and chemical content were recorded with foliar sprays using yeast extract at the rate of 7.5gm/l, algae extract at the rate of 1.5gm/l and compost tea extract at the rate of 150 gm/l, respectively, in both growing seasons.

Linear correlation and regression of cucumber traits on each other were carried out. It may be worth to mention that for each increased of one square centimeter of leaves area/plant, fresh weight of areal part and total yield correspondingly increased by (5.195 and 3.64 gm/plant) and (0.050 and 0.055 ton/fed.) in the first and second season, respectively.

INTRODUCTION

Cucumber (*Cucumis sativus*) is a widely cultivated plant which belongs to *Cucurbitaceae* family. It is considered one of the most popular vegetable, cash and exportable vegetable crops in Egypt. Natural resources or ecologically friendly agriculture is increasingly being adopted around the world. Therefore, using natural production such as extracts of seaweed, compost tea, licorice and yeast considered one of the safe and economic systems for improving plant production in reclaimed soils.

Application of seaweed extract, as foliar spray increased, total soluble solid and vitamin C of two strawberry cultivars (**Masny *et al.* 2004**), yield of two potato cultivars (**Blunden and Paul, 2006**), fruit size of pepper (**Eris *et al.*, 2008**), sex expression and total yield of cucumber (**Al-Jebbouri, 2009**) and all growth parameters, total yield, fruit dry weight and its T.S.S of pepper (**Mohammed, 2013**)

Compost has been applied at one time before planting and this led to release nutrients slowly which became available for crop requirements. In modern terminology, compost tea is considered a compost extract which produced from the fermented compost in water (**Litterick *et al.*, 2004)**. Compost tea has been utilized in agriculture as a good source of organic matter and soil amendment that provide plants with mineral nutrients (**Abbasi *et al.*, 2002**). In addition, compost tea is very rich in phytohormones and growth regulators. It stimulates the

microorganisms that have a direct or indirect beneficial effect on plant rhizosphere, improves soil physical and chemical properties and suppress some plant diseases pathogen (**Biocycle, 2004**). Moreover, **Bayoumi and Hafez (2006)** showed that compost tea and seaweed extracts (Algae) significantly increased all growth parameters of cucumber plants and chlorophyll content especially at the earlier growth stage as compared to the control plants. In the same line in organic production, results obtained by **Abou-El-Hassan *et al.*, (2014)** revealed that compost tea improved cucumber yield and its quality in sandy soil as compared with recommended dose of nitrogen.

Recent studies pointed out the possibility of using some plant extracts such as licorice extract (one of the perennial weeds) which belongs to the legume family (*Fabaceae*) to enhance growth and yield of plants (**Aldroush, 1976**). This plant contains many of chemical compounds such as gleserezin, glycyrrhejel and licorice acid and vlavonideh. Licorice extract had improving effect similar to that of growth regulators on vegetative and flowering characteristics of various plants (**Alajaili, 2005**). Moreover, **Moses *et al*, (2002)** added that it contain a wide range of elements and nutrients. In another study, **Zuhair (2010**) investigated the effect of licorice root extract at rates of 0, 2 and 4g/L. applied as a foliar spray on vegetative and flowering parameters of two strawberry varieties. He found that 2g/ L. gave a significant increase of leaf area and foliage dry weight, while 4g/ L. caused a significant increase in total chlorophyll content.

Many studies indicated that yeast is one of the richest sources of high quality protein, especially the essential amino acids like lysine and tryptophan, essential minerals as calcium and trace elements as cobalt and iron. Yeast is the best source of the B-complex vitamins and a valuable source of bio-constituents especially cytokinins (**Amer 2004**). Also **Mahmoud *et al*. (2013)** found that yeast extracts improved pea vegetative growth, green pods yield and pod quality with using the highest level of yeast extract (2%). Foliar application of yeast increased growth, yield and quality of lettuce (**Fawzy 2007**), eggplant (**El-Tohamy *et al.*, 2008**) and cucumber (**Shehata *et al.*, 2012**).

The objective of this work was to investigate the effect of some natural extracts *i.e.* sea algae, compost tea, licorice and yeast on cucumber growth, production and chemical constituents grown in sandy soil at Baloza location, North Sinai governorate.

Materials and methods

The field experiments were carried out during the two successive winter seasons of 2013 and 2014 under low tunnels at the Baloza Experimental Station of the Desert Research Center, North Sinai Governorate. The physical and chemical analysis of the experimental soil was carried out according to **Page *et al.* (1982)** as presented in Table (A). Irrigation water analysis was determined according to **Richards (1954)** and presented in Table (B).

Table (A): Physical and chemical properties of the experimental soil.

Particle size distribution (%)			Texture soil	EC dsm^{-1}	pH	Available nutrients (Cations)					Available nutrients (Anions)			
Sand	Silt	Clay				P%	Na^{+}%	K^{+}%	Ca^{++} Meg/l	Mg^{++} Meg/l	$CO_3^{=}$	HCO_3^{-} Meg/l	$SO_4^{=}$	Cl^{-}
90	5	5	Sand	1.37	8.20	0.42	4.78	0.54	3.65	4.40	-	3.85	6.5	3.3

Table (B): Chemical analysis of irrigation water.

Samples	pH	E.C. (ppm)	S.A.R	Soluble cations (me/l)				Soluble anions (me/l)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	$SO_4^{=}$	Cl^{-}
1 st. season	7.45	1456	3.80	2.90	3.20	8.60	0.60	0.10	5.60	2.10	7.50
2 nd. season	7.10	1512	3.52	3.25	3.05	9.50	0.40	0.50	3.81	3.69	8.20

pH: Acidity, E.C.: Electrical conductivity, dSm^{-1}: dec sieme per meter,
S.A.R: Sodium adsorption ratio, me/l: mille equivalent per liter

The present study included 13 foliar spray treatments which were as follows: control treatment (water spray), three sea algae extracts at rates of 0.5, 1 and 1.5 gm/l, three compost tea extracts at rates of 50, 100 and 150 gm/l, three licorice root extracts at rates of 2.5, 5 and 7.5gm/l and three yeast extracts at rates of 2.5, 5 and 7.5 gm/l. Plants were sprayed monthly at 30, 60 and 90 days after planting.

1- Algae extract (oligo-x) was obtained from Union for Agricultural Development Company having the following composition: oligosaccharides 3%, algnic acid 5%, phytin 0.003% menthol 0.001%, natural growth regulators (Cytokinin0.001%, indol acetic acid0.0002%), pepsin 0.02 % and minerals (potassium oxide12%, phosphorus oxide 0.5%, N1%, Zn 0.3%, Fe 0.2% and Mn 0.1%).
2- Compost tea extract was prepared following by **Al-Fartusy (2003)** dissolving a certain weight of the compost in distilled water (weight/volume) and left in plastic containers for 24 hours, then concussed well and was filtered through the filter paper type 12 whatman.
3- Yeast extract was prepared from brewer's yeast (*Saccharomyces cerevisiae*) by dissolving it in water followed by adding sugar at a ratio of 1: 1 and kept 24 hours in a warm place for reproduction according to the methods of **Morsi *et al.* (2008).**
4- Licorice extract was prepared from dry root of (*giycyrrhiza glabra* L.), which was soaked in distilled water and kept 24 hours, then filtered through the filter paper type 12 whatman.

Cucumber seeds (Elmanar cultivar) were sown on the 1st of November of both seasons under low tunnels in sandy soil and irrigated with drip-irrigation system. The area of each experimental plot was 21 m², (one line 21m long and 1m wide). All experimental plots received the recommended dose of organic and mineral fertilizers. Farmyard manure was applied at the rate of 20m³/fed. before planting, phosphorus fertilizer as calcium superphosphate (15.5% P2O5) was added at rate of 60 kg P2O5 /fed. potassium sulphate fertilizer (48% K2O) was used at rate of 75 kg K2O /fed. and ammonium sulphate fertilizer (20.5% N) was applied at the rates of 60 kg N/fed. Both of nitrogen and potassium fertilizers were divided into small quantities and applied at intervals through drip-irrigation system starting 30 days from seed sowing and continued all over the season. The other common agricultural practices for growing cucumber plants were applied according to the recommendation of the Egyptian Ministry of Agriculture and land reclamation.

Experimental Measurements

a) Growth parameters:-

Foliage plant sample were taken after 75 days from planting date to record plant length and weight, leaves area, shoot dry matter percentage. Percentage of dry matter was estimated by the method of **A.O.A.C. (1975).** Total chlorophyll in plant laves was measured as SPAD units using Minolta chlorophyll meter (model SPAD 502). Chlorophyll measurements were made using the recently fully expanded leaf and 10 readings were averaged per experimental unit according to **A.O.A.C. (1990)**.

b) Yield and its components:

Average fruit weight (gm), fruit dry matter percentage, fruit No./plant, total yield/ plant and total yield (ton/fed.).

c) Chemical composition

Mineral content of leaves was estimated using the wet ash procedure for the dry powdered samples according to **Johnson and Ulrich, (1959).**

1- Total nitrogen was determined using the modified micro Kjeldahl method.
2- Phosphorus was determined using the colorimetric method following the procedure described by **Cottenie *et al.*(1982),**
3- Potassium was determined using a flame photometer according to methods of **Brown and Lilliland (1964).**
4- Total carbohydrate content was determined according to the method described by **A.O.A.C. (1990).**

Experiment design and statistical analysis:

Complete randomized design with three replicates was used. Obtained data were subjected to the statistical analysis according to **Thomas and Hills (1975).**

Results and Discussion

Vegetative growth and chlorophyll content:

Data presented in Table (1) showed the effect of foliar spray with some natural extracts (sea algae, compost tea, licorice, yeast extract and control treatment, spray with tap water) on cucumber growth parameters, *i.e.*, plant length and weight, leaves area, shoot dry matter percentage and total chlorophyll content. Obtained results revealed that all foliar treatments enhanced growth parameters and chlorophyll content compared with control treatment. The highest significant values of plant length and weight and leaves area were, generally, recorded with either the highest concentrations of yeast extract (7.5gm/l), algae extract (1.5gm/l) or compost tea extract (150 gm/l) in both growing seasons.

Results of yeast extract in Table (1) were in agreement with those obtained by **Fawzy, (2007**) on lettuce **El-Tohamy *et al.* (2008)** on eggplant and **Shehata *et al.* (2012)** on cucumber. They found that foliar application of active dry yeast extract had favorable effect on vegetative growth characters of cucumber plants.

The positive effect of yeast extract may be interpreted in the light of its high content of high quality protein, amino acids like lysine and tryptophan, essential minerals, trace elements, B-complex vitamins and bio-constituents especially, cytokinins. **Amer (2004).**

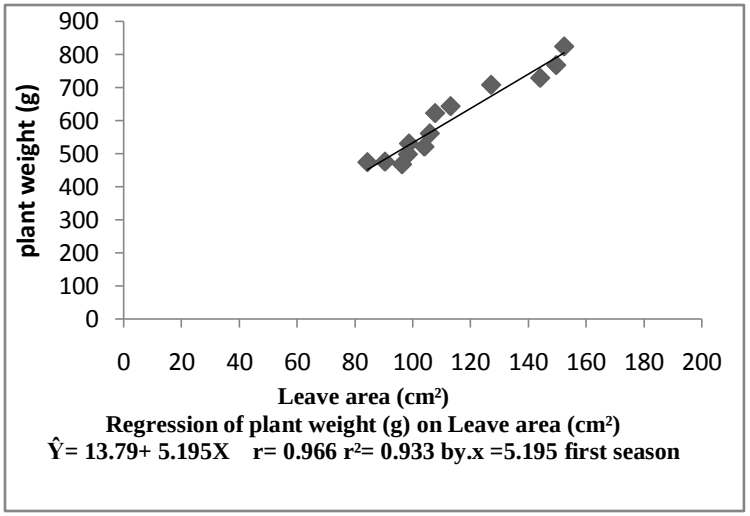
Algae extract results are in confirmation with those obtained by **Mohammed (2013)** who found that foliar spray with Seamino led to positive significant difference in all growth parameters as compared to untreated pepper plants. The positive effect of algae extract may be due to its constituents of N, P, K, Ca, Mg, S, Zn, Fe, Mn, Cu, Mo, and Co, some growth regulators, polyamines and vitamins which improve nutritional status and vegetative growth. (**Hegab *et al.* 2005**).

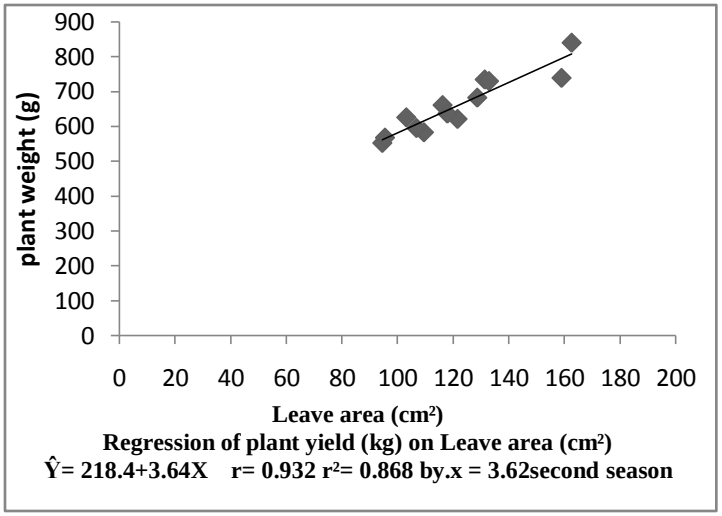
As for, the improvement of shoot dry mater (%) as a result of licorice extract foliar applied may be due to licorice plant contains many of chemical compounds such as a substance of gleserezin and glycyrrhejel and licorice acid compounds of vlavonideh including glabridin and glaring (**Alajaili, 2005)**. Obtained results were in the same line with those obtained by **Zuhair, (2010)** who found that licorice extract at the rate of 2 g/ L. gave a significant increase in foliage dry weight.

A liner correlation showed that there was close positive correlation between weight of areal part of cucumber (gm/plant) and leaves area (cm^2/plan) (Fig.,1). Linear correlation coefficient (r) were 0.966 and 0.932 in the first and the second season, respectively. The corresponding coefficient of determination (r^2) were 0.933 and 0.868 which indicated that 93.3 and 86.8% of the variation in weight of areal parts were related to leaves area. On the other hand, the regression coefficient (by.x) were 5.195 and 3.64 in the first and second seasons, respectively. This indicated that for each increased of one square centimeter of leaves area/plant, fresh weight of areal part correspondingly increased by 5.195 and 3.64 gm/plant in the first and second season, respectively.

Table (1): Effect of some natural extracts (gm/L) on plant length, plant weight, dry matter of shoot, leaves area and total chlorophyll of cucumber plants during two successive seasons of 2013 and 2014.

Characters / Treat.	Plant length (Cm)		Plant weight (gm/plant)		Dry matter of shoot (%)		Leave area (Cm² /plant)		Total chlorophyll (SPAD)	
Seasons	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Control	69.5	84.1	474.9	552.8	12.75	12.47	84.3	94.6	39.4	40.0
Algae extract 0.5	88.8	98.9	530.8	582.8	14.24	13.87	98.8	109.5	41.7	42.3
Algae extract 1	118.7	118.1	643.8	621.1	14.46	13.86	113.1	121.6	44.7	42.4
Algae extract 1.5	**123.7**	**131.3**	**768.3**	**738.8**	**15.25**	**15.46**	**149.6**	**158.9**	45.0	45.4
Compost tea 50	98.0	95.6	499.6	625.0	13.84	14.40	98.3	103.1	41.9	41.4
Compost tea 100	116.3	120.3	623.0	660.4	14.55	14.66	107.8	116.2	45.1	44.3
Compost tea 150	**122.3**	**129.9**	**729.0**	**734.5**	14.62	15.17	**144.2**	131.4	**45.5**	**45.6**
Licorice extract 2.5	72.7	92.6	477.0	567.1	14.49	15.05	90.5	95.5	42.2	44.3
Licorice extract 5	74.8	104.7	467.5	594.5	**15.91**	**15.81**	96.3	106.8	42.6	44.5
Licorice extract 7.5	93.2	106.2	561.2	682.4	**15.49**	**15.68**	105.9	128.7	43.4	43.5
yeast extract 2.5	88.0	99.9	521.1	636.0	15.07	15.24	104.1	118.0	44.9	45.1
yeast extract 5	90.3	128.8	707.6	729.7	14.99	14.92	127.0	**132.9**	**46.6**	**46.2**
yeast extract 7.5	**124.0**	**139.2**	**824.9**	**839.8**	14.75	14.73	**152.3**	**162.5**	**46.0**	**45.6**
L. S. D. at 5%	**7.09**	**10.30**	**70.10**	**47.87**	**0.88**	**0.93**	**6.40**	**5.89**	**1.33**	**1.19**





Fig(1): Linear regression (b), correlation coefficients (r), coefficients of determination (r^2) and regression coefficient of plant yield (kg) on plant weight (g) and leave area (cm) and plant weight (g) on leave area (cm).

Yield and its components:

Data concerning the effect of some natural extract on cucumber yield and its components *i.e.*, fruit weight, No. of fruit/plant, fruit dry matter (%) and total yield per plant and per fed. were presented in Table (2). Obtained results indicated that there were no significant differences between control treatment and foliar spray with low concentration of algae extract (0.5 g/l), compost tea (50g/l) and licorice (5g/l) while other treatments had significant positive effect on the investigated yield parameters. The highest values were obtained with plants treated with high concentration of yeast extract (7.5g/l), algae extract (1.5g/l) and compost tea. Results were true in both investigated seasons.

Results of yeast extract shown in Table (2) were in agreement with those obtained by **Fawzy (2007), El-Tohamy *et al.* (2008)** and **Shehata *et al.* (2012)**. The positive effect of yeast extract may be due to yeast is one of the richest sources of high quality protein, essential minerals and trace elements. In addition, yeast is good source of the B-complex vitamins **(Amer 2004**). Also, the increase in fruits weight of plants sprayed with algae extracts may refer to its role in enhancing the growth and consequently the physiological activities as photosynthesis and plant nutrition provision and these could be the reasons of increasing fruit weight and yield **(Al-Saaberi, 2005**). Moreover, results concerned with compost extract shown in Table (2) were in the same line with those obtained by **Abou-El-Hassan *et al.*, (2014) who** stated that enhancing organic production in sandy soil can be performed successfully using compost tea to produce good yield and quality of cucumber.

A liner correlation showed that there was positive correlation between total yield of cucumber (ton/fed.) and either plant weight (gm/plant) or leaves area (cm^2/plan) (Fig.,1). Linear correlation coefficient (r) were 0.937 and 0.920 in the first season and 0.864 or 0.902 in the second season, respectively. The corresponding coefficient of determination (r^2) were 0.878 or 0.846 in the first season and 0.747 or 0.814 in the second season which indicated that 87.8 or 84.6% and 74.7% or 81.4 of the variation in total yield (ton/fed.) were related to plant weight (gm/plant) and leaves area (cm^2/plan) respectively. Moreover, there was positive correlation between fruit weight (gm) and leaves area (cm^2/plan) the regression coefficient (by.x) were 0.212 and 0.337 in the first and second seasons, respectively. This indicated that for each increased of one square centimeter of leaves area/plant, fruit weight correspondingly increased by 0.212 and 0.337 gm/fruit in the first and second season, respectively.

Chemical composition

Data recorded in Table (3) indicated that the highest values of N% were recorded with foliar spray yeast at the rate of 7.5 gm/l and compost tea extract at the rate of 150 gm/l in both seasons. Moreover, the highest significant increments in P content were, generally, obtained with plants foliar sprayed with algae extract at rate of 1.5g/l, compost tea at the rate of 150 g/l and yeast extract at the rate of 7.5g/l in both seasons. As for K content, the highest values were obtained with plants sprayed with the highest concentration of compost tea (150 g/l), algae extract (1.5 g/l) and yeast extract (7.5 g/l).While the effect of the used of natural extract on carbohydrate content was more, generally, pronounced with licorice extract with concentration of 7.5 g/l in both seasons.

Results of yeast extract were in agreement with those obtained by **Fawzy, (2007**) and **El-Tohamy *et al.*, (2008)**. Also, the positive effect of algae extract may be due to its contents of N, P, K, Ca, Mg, and S as well as Zn, Fe, Mn, Cu, Mo, and Co. **Hegab et. al (2005**). The positive effect of compost tea due to its high contents of phytohormones and growth regulators which stimulates the microorganisms that have a direct or indirect favorable effect on the plant rhizosphere, besides improving soil physical and chemical properties as well as suppress some plant diseases pathogens (**Biocycle, 2004**). Also, the favorable effect of licorice on carbohydrate may be due to its role in increasing plant photosynthesis which agreed with those obtained by **Zuhair, (2010**) who found that treatments with 2g licorice/liter gave a significant increase in foliage dry weight.

Conclusion

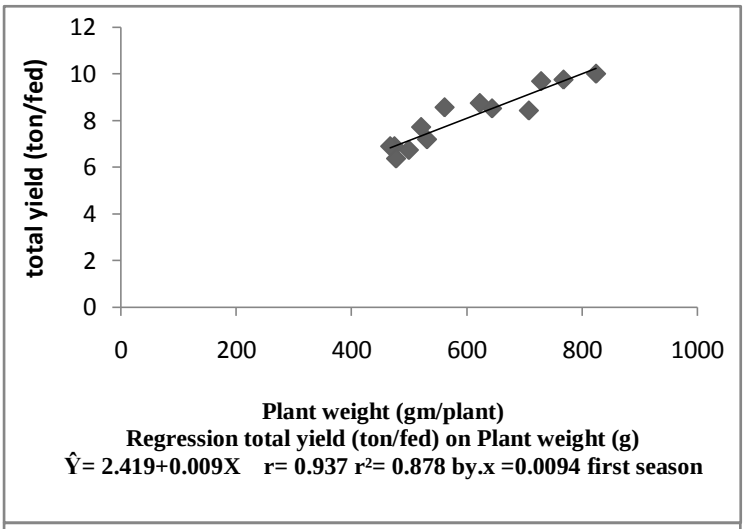
The present study led to demonstrate that foliar spray with 7.5g yeast extract/L or 1.5 g algae extract/L or 150 g compost tea extract had the highest significant positive effect on growth, yield and chemical composition of cucumber grown in sandy soil. Generally, it can be concluded that natural extracts could be replace many commercial growth inhibitors or pesticide. Concentration of 7.5 g yeast /L, 1.5g algae /L and 150 g compost/L were ideal for cucumber, as a source of nutrients.

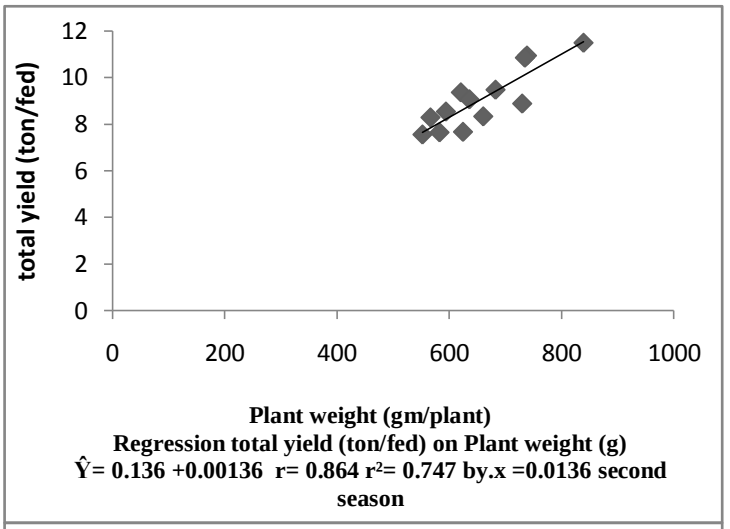
Table (2): Effect of some natural extracts on fruit weight, No. of fruit /plant, dry matter of fruit and total yield/ fed. of cucumber plants during two successive seasons of 2013 and 2014.

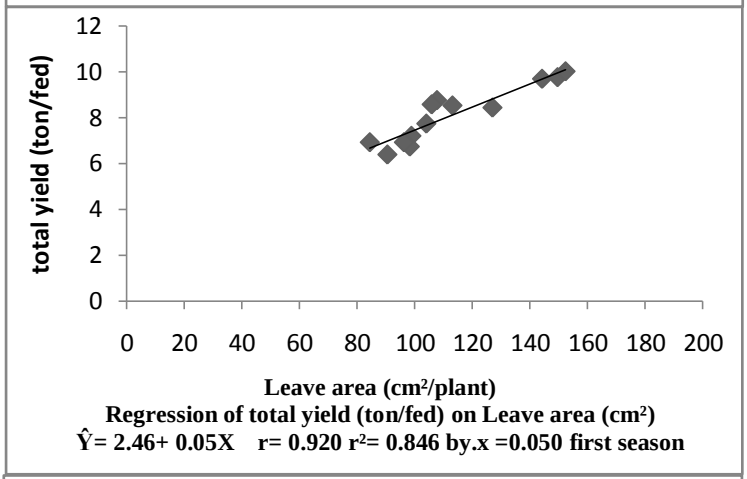
Characters / Treat.	Fruit weight (gm/fruit)		No. of fruit /plant		Dry matter of fruit (%)		Plant yield (Kg/plant)		Total yield (ton/ fed.)	
Seasons	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Control	51.17	51.13	14.0	13.5	4.37	4.86	0.71	0.69	6.92	7.56
Algae extract 0.5	52.12	53.78	14.6	14.8	4.28	4.66	0.76	0.79	7.21	7.65
Algae extract 1	58.25	61.43	16.6	16.1	3.88	4.07	0.97	0.99	8.52	9.36
Algae extract 1.5	**64.93**	**74.97**	**16.7**	**17.2**	3.82	4.30	**1.08**	**1.29**	**9.76**	**10.93**
Compost tea 50	54.46	58.37	12.7	14.1	4.31	4.50	0.69	0.83	6.74	7.68
Compost tea 100	62.11	64.43	14.6	14.1	4.45	4.64	0.91	0.91	8.76	8.34
Compost tea 150	**63.13**	**68.70**	**16.6**	**16.3**	4.31	4.50	**1.05**	**1.12**	**9.70**	**10.85**
Licorice extract 2.5	51.55	54.43	12.6	14.3	**4.90**	**5.09**	0.65	0.78	6.38	8.29
Licorice extract 5	52.78	59.13	13.5	15.0	4.41	4.60	0.71	0.89	6.92	8.53
Licorice extract 7.5	59.57	62.17	14.9	15.4	4.19	4.05	0.89	0.96	8.57	9.47
yeast extract 2.5	59.55	65.63	14.6	14.9	**4.70**	**4.89**	0.87	0.98	7.74	9.07
yeast extract 5	62.40	65.57	16.3	15.9	4.33	4.52	**1.02**	**1.05**	8.44	8.87
yeast extract 7.5	**66.47**	**76.37**	**17.6**	**17.3**	4.11	4.81	**1.17**	**1.32**	**10.01**	**11.50**
L. S. D. at 5%	3.87	3.76	1.12	1.15	0.47	0.49	0.08	0.10	0.72	0.80

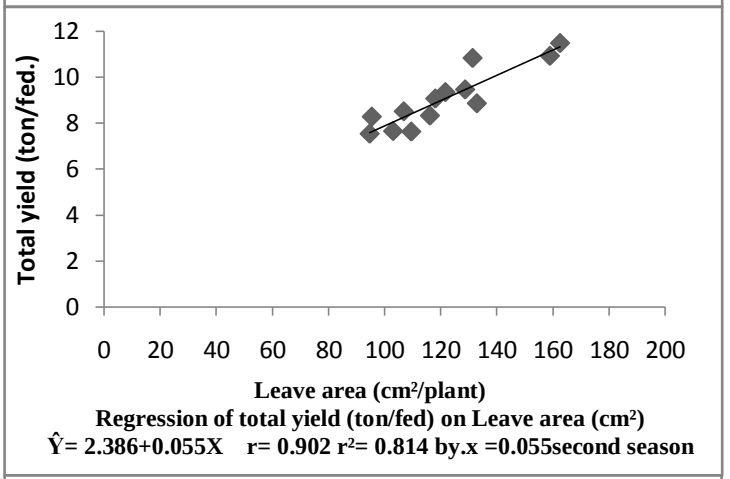
Table (3): effect of some natural extracts on chemical composition of cucumber plants during two successive seasons of 2013 and 2014.

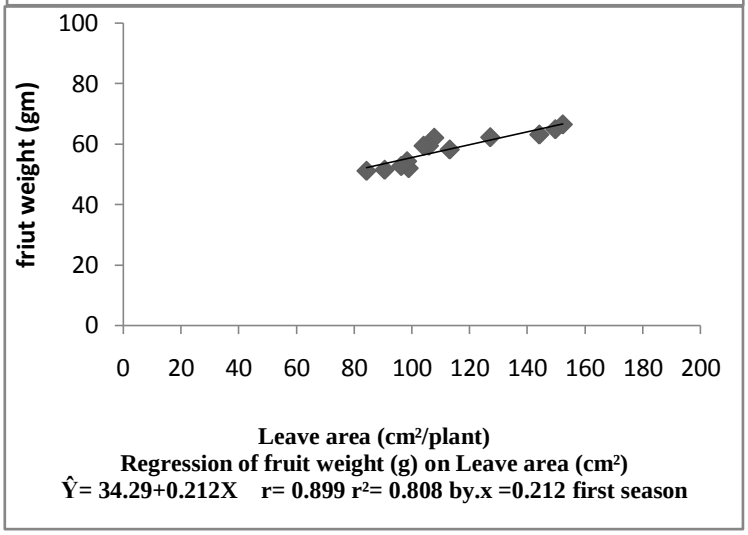
Characters / Treat.	N (%)		P (%)		K (%)		Total carbohydrate ppm	
Seasons	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Control	2.42	1.97	0.97	1.21	2.33	2.18	79.3	77.7
Algae extract 0.5	2.83	2.61	0.90	1.36	2.68	2.57	77.3	81.0
Algae extract 1	2.85	2.69	1.14	1.56	2.45	2.61	81.0	78.0
Algae extract 1.5	2.70	2.64	1.86	1.97	2.87	2.85	83.3	88.3
Compost tea 50	2.39	2.47	1.21	1.43	2.31	2.22	81.0	85.0
Compost tea 100	2.48	2.50	1.64	1.69	2.59	2.64	72.7	85.7
Compost tea 150	3.29	3.04	1.78	1.89	2.90	2.93	70.0	87.3
Licorice extract 2.5	2.36	1.92	0.94	1.21	2.40	2.20	79.3	88.7
Licorice extract 5	2.46	2.20	1.15	1.52	2.32	2.30	83.3	88.3
Licorice extract 7.5	2.44	2.25	1.21	1.35	2.39	2.38	94.7	91.7
yeast extract 2.5	2.70	2.64	1.65	1.67	2.67	2.73	78.7	84.7
yeast extract 5	2.90	2.85	1.68	1.63	2.69	2.64	84.7	88.0
yeast extract 7.5	3.36	3.19	1.73	1.85	2.79	2.75	86.7	88.7
L. S. D. at 5%	0.45	0.33	0.23	0.28	0.28	0.21	4.36	3.86

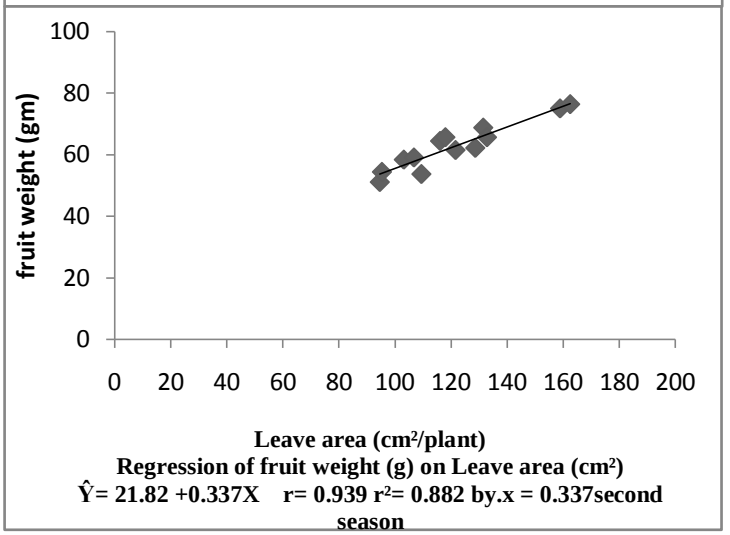












Fig(2): Linear regression (b), correlation coefficients (r), coefficients of determination (r^2) and regression coefficients of total yield (ton/fed) on either plant weight (gm/plant) or leave area (cm^2/plant) as well as regression of fruit weight (gm/fruit) on leave area(cm^2/plant).

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