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Effect of Irrigation, some Plant Nutrients with Mulching on Growth and Productivity of Cucumber

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ABSTRACT

This work was carried out during the two consecutive summers of 2016 and 2017 in the Experimental Station Farm, Faculty of Agriculture and Natural Resources, Aswan University, Egypt on a soil sandy textured soil. This work aimed to study the effect of number of drip irrigation periods/week, foliar spray with some plant nutrients "micronutrients and Biostimulant" and with or without mulching on growth, yield and quality of cucumber. Certain physiological and chemical characters plant height, number of leaves per plant, number of branches per plant, plant dry weight (g), chlorophyll, reducing sugars, acidity, vitamin C, soluble solids (TSS), No. of day to harvest, early yield (ton/fed.), average fruit weight (g), total yield (ton/fed.), and chemical analyses of plants (N, P and K %). The experimental design was a split-split plots system arranged in a randomized complete block design with three replications. Number of drip irrigation periods/week (2 and 3), foliar spray with some plant nutrients i.e. (control "distilled water", Zinc chelated (Zn 14 % EDTA) at 100 mg/l and Iron chelated (Fe 13.0 % EDTA) at 500 mg/l and seaweed extract 1000 mg/l) and polyethylene mulching treatments i.e. without mulching, clear polyethylene mulch + sugar cane straw mulch and black polyethylene mulch + sugar cane straw mulch. The obtained results revealed that 2 drip irrigation periods/week + black polyethylene mulch + sugar cane straw mulch + 1000 mg/l seaweed extract gave the significant effects in most studied characters under study during both seasons.

Keywords: Cucumber, Mulching, Straw mulch, Micronutrients, Seaweed, irrigation periods, growth, yield and quality.

INTRODUCTION

Cucumber *(Cucumis sativus* L.) is one of the most important cucurbit crops in the world (FAO, 2010) and favorite commodity exports for markets and local consumption. In Egypt, cucumber is represents one of the most important and economic vegetables, the total cultivated area was about 66640 fed. (6664 hectares) in 2005 according to the statistics of FAO and grown in the open field from March to November and under plastic houses from September to May. It is an annual herbaceous plant and can grow in various types of soil, but surpass light and humus-rich soils. Cucumber is a heat and moisture loving plant. Cucumber is an important summer crop grown that requires irrigation to achieve optimal yield and quality (Aybak and Kaygisiz, 2004). Water is a major input for agricultural production. In the current scenario, it is also a scarce resource, and there exists a large gap in terms of water available and its requirement for irrigation. Adoption of modern irrigation techniques which are simple, easy to operate and increase the efficiency of water usage. Drip irrigation is the most effective way to supply water and nutrients to the plant, which not only saves water but also increases yield of fruits and vegetable crops (Iqbal *et al*., 2014). This water saving is because maximum amount of water is stored in the root zone and deep percolation losses are minimized (Bhogi *et al*., 2011). The major deficiencies of microelements were found to be Fe and Zn. Lindsay and Schwab (1982) reported that the low solubility of these microelements in high pH soil, especially in the presence of $CaCo_3$. Micronutrients play a vital and effective role in some plant processes such as chlorophyll formation in the plant, which is a major activator of biochemical processes such as photosynthesis, respiration, and the symbiotic fixation of nitrogen. Bidwell (1979) illustrated that higher levels of iron nutrition are required for cell division. In addition, the main function of Zn is in plant enzyme systems and directly involved in the synthesis of the (IAA). Kaya and Higgs (2002) have decided that zinc plays an important role in pollen function and fertilization. Micronutrients are necessary for plant activities such as energy and protein system, development of the meristematic as reported by Taiz *et al.* (2003) on tomato and Helaly *et al.*(2018) reported that application Zn chelated (Zn15% EDTA) at 100 mg/l and Fe chelated (Fe13% EDTA) at 500 mg/l on tomato plants significantly increase all growth and yield characters as well as photosynthetic pigments, ions percentage, and fruit quality.

Seaweed contains phytohormones (Farouk, 2015), certain micro-and macro-nutrients (Zhang and Schmidt, 2002), and secondary metabolites (MacKinnon *et al.,* 2010). Swe has been used as a foliar application to accelerate nutrient uptake, photosynthetic pigments (Farouk, 2015). On the other hand, the extreme seaweed extract that is a new generation of natural organic fertilizers is highly nutritious, promotes faster germination of seeds (Dhargalkar and Pereira, 2005). Extracts of brown seaweeds are widely used in horticultural crops largely for their plant growth-promoting effects and for their ameliorating effect on crops that are tolerant to abiotic stresses such as salinity, extreme temperatures, nutrient deficiency and drought. The chemical constituents of seaweed extract include complex polysaccharide, fatty acids, vitamins, phytohormones and mineral nutrients (Battacharyya *et al*., 2015). El-Sagan (2015) reported that the using foliar application of algae extract at a level of 1.5 mg/L caused significant increments in cucumber plant length, plant weight, average of leaf area, fruit weights No. of fruit/plant, yield and chemical content (leaves N, P and K content) and Helaly *et al.*(2018) on tomato. Mulching is used to cover soil surface around the plants to create congenial condition for the plant growth. These responses have been attributed to enhanced soil warming (Taber, 1983), Mulch materials improve conservation of soil moisture during dry period (Gilsha Bai *et al*., 1998) and minimize soil erosion, weed problems and nutrient loss (Clough *et al*., 1990). Black plastic mulch was reported that there was 15 % moisture conservation in brinjal (Manjari Gota) and 20 % saving in a Mahyco variety (NCPAH, 1991). More efficient and consistent use of water and fertilizers Bhella (1988). Mulch is any material (organic or inorganic) maintain favorable soil temperatures around plant roots, that results in better plant growth and development (Abdul-Baki *et al.* 1997). Halil Kirnak and Naim Demirtas (2006) confirm that limiting soil evaporation with mulches is a key action to take to save irrigation water and to improve water use efficiency and irrigation water-use efficiency. Because use of drip irrigation with mulching can increase water use efficiency, this strategy might be used for vegetable production in semi-arid regions where irrigation water is limited. It also exerts decisive effects on earliness, yield and quality of the crop (Bharadwaj, 2013). Mulch reduces production costs and it is highly effective in controlling weeds, various diseases and pests and reduced soil erosion, leaching of fertilizers (Mu, *et al.,* 2014).

Therefore, these investigations are an attempt to evaluate the effect of number of drip irrigation periods/week, foliar spray with "some microelements and seaweed" and mulching on growth, yield and quality of cucumber plants grown in sandy soil under Aswan Governorate conditions, Egypt.

Materials and methods

Field experiments were conducted for two consecutive early summer seasons of 2016 and2017 at the Experimental Station Farm, Faculty of Agriculture and Natural Resources, Aswan University, Aswan Governorate-Egypt. Some analytical data of experimental soil before cultivation are presented in Table (1). The experimental field was ploughed, pulverized and ridged into 4 meters long and 1.50 meter wide rows; 50 cm apart within the row between plants and the row surface was carefully leveled. In each hole one plant encouraged it to grow. Each experimental plot consisted of three rows, 18 m^2. Three weeks old cucumber transplanting nearly. Gynoecious cucumber hybrid "Hala" were planted in an open field on 1st March in both seasons, after placing the mulches types by hand.

Table 1. Means of the mechanical and chemical analysis of the soil before cultivation of two seasons.

Soil property *	Season 2016	Season 2017
Physical properties		
Clay (%)	3.00	3.50
Silt (%)	0.00	0.00
Sandy (%)	97.00	95.50
Textural class	Sandy	Sandy
Chemical properties		
Soluble cations in (1:1) soil to water extract mmol/L)		
Ca^{++}	3.06	3.10
Mg^{++}	1.02	1.05
K+	0.83	0.85
Na+	0.76	0.80
Soluble anions in (1:1) soil to water extract(mmol/L)		
CO_3^{--}	0.00	0.00
HCO_3^-	7.10	7.06
Cl^-	3.60	3.57
SO_4^{--}	0.40	0.44
pH (1:1 soil suspension)	7.64	7.70
EC (dS/cm) at 25°C	0.33	0.32
Available N (mg/kg soil)	128.31	130.00
Available P (mg/kg soil)	8.00	10.00
Available K (mg/kg soil)	177.00	180.00

***The analyses were carried out at Soil Fertility Department, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt.**

The plowed soil was fertilized with 20 percent of nitrogen as ammonium nitrate (33.5% N), potassium as a potassium sulfate (48% K_2O) and 50 percent of the phosphorus as calcium superphosphate (15.5% P_2O_5) from the recommended fertilizer requirements as a recommended dose; (200 kg N, 75 kg P_2O_5 and 150 kg K_2O, /fed.) by Agricultural Research Center of Egyptian (ARCE). The drip irrigation network consisted of lateral's GR of 16 mm in diameter, with emitters at 50 cm distance.

The emitters had a discharge rate 4.l h^{-1}. All missing transplants were replaced by another mother one, one week later after transplanting.

a. Plant nutrients

Plants were sprayed with each micronutrient and Biostimulant as a foliar application with aqueous solution three times after 15, 30 and 45 days from transplanting. Plant nutrients were foliar sprayed as (control "distilled water", zinc chelated (Zn 14 % EDTA) at 100 mg/l and iron chelated (Fe 13.0 % EDTA) at 500 mg/l and seaweed extract 1000 mg/l) under bare soil and/ or mulching types.

b. Laying out the mulching

The soil was ridged into rows one and half meter width then the drip irrigation network were designed on top of the rows. The rows were covered with a layer of sugar cane straw with a thickness of 5 cm that was covered with a layer of clear polyethylene or black polyethylene sheets (1.1meter wide 40 μm thick) and performed with round perforations of 2 cm diameter in staggered rows spaced 50 cm apart on the northern side. The polyethylene mulches were kept to the end growing seasons. Mulching treatments were: without mulching "control", clear polyethylene mulch + sugar cane straw mulch and black polyethylene mulch + sugar cane straw mulch.

Data were recorded for the following parameters

1. Vegetative growth

Four plants from each treatment were selected and randomly pulled up with roots for each treatment at full blooming stage after 60 days from transplanting to measure and record the plant height (cm) was recorded from the base of the plant to the terminal growing point of tagged plants using a meter, number of leaves/plant were counted, number of main branches/plant were counted and plant dry weight (g) estimated as follows "the plants were washed thoroughly with distilled water and an electrical oven dried at 70° C until constant weight. The dry tissues were weighted and used for chemical analysis.

2. Plant chemical constituents

At 60 day from transplanting, a random sample of five plants was taken from each experimental unit to estimate leaf color degrees or leaf chlorophyll indication (SPAD) for determination chlorophyll readings , at harvest leaf greenness (chlorophyll content) according to (Marquard and Tipton, 1987) and leaves plant contents (%) of nitrogen and phosphorus colorimetrically according to A.O.A.C (1992). Potassium content was measured in plants using flam photometer according to the method by (Jackson, 1973).

3. Yield and its components characters

The number of days to harvested (earliness) was measured as average number of days from transplanting to harvest, early yield (ton/fed.) was collected from the sum of the yield of the first four pickings, average fruit weight (gm) as “Total yield per plant (kg)/ No. of fruit per plant” X1000 and total yield (ton/fed.) was calculated as the total weight of full ripe fruits per plot.

4. Fruits quality

To estimate some composition of fruit characters, 5 fully ripened fruit were used to extract their juice to estimate " reducing sugars were measured according to the method described by Malik and Singh (1980), total titratable acidity (%) was determined as citric acid percent (mg/100 cm^3 juice), by titration with 0.1 (NaOH) after adding a few drops of phenolphthalein as an indicator depending on the method A.O.A.C. (1992), vitamin C (ascorbic acid) was estimated by way of Ranganna (1986) using titration with iodede potassium and calculated as mg vitamin C/100 cm3 juice, total soluble solids (TSS) measure this character by using the refractometer according to the method of A.O.A.C. (1992),

Statistical analysis

Data were subjected to analysis of variance procedures and means were compared using L. S. D. test (according to Snedecor and Cochroni, 1973).

RESULTS AND DISCUSSION

1. Vegetative growth characters and plant chemical constituents

Results presented in Tables (2 & 3) show that vegetative growth represented as a plant height, number of leaves per plant, number of branches per plant, plant dry weight and plant chemical constituents as (chlorophyll, N, P and K content) were no significantly increased with number of drip irrigation periods/week on plant height and plant dry weight but it was significantly increase on chlorophyll % and P % where this treatment was significantly increase in first season on N % and K %. These results are quite similar with those obtained on cucumber by Halil Kirnak and Naim Demirtas (2006).

The data in the same table assesse that all vegetative growth parameters and plant chemical constituents are significantly increased due to the application of micronutrients and seaweed. When spraying plants with seaweed extract exceeded the spraying with micronutrients during both seasons. Increasing plant height and plant chemical constituents with micronutrients agree with those obtained Mohsen Kazemi (2013) on cucumber seaweed extract increased chlorophyll content and plant height El-Sagan (2015) on cucumber and on tomato by Helaly *et al.* (2018).

Also, clear polyethylene mulch + sugar cane straw mulch and black polyethylene mulch + sugar cane straw mulch as compare to without mulching during both experimental seasons. The highest values in vegetative growth during both seasons are obtain due to the application of black polyethylene mulch + sugar cane straw mulch when compare to with without mulching. These results are in harmony with those found on vegetative growth characters with application black polyethylene mulch by Cai *et al.,* (1993), Ruppel and Maskswitat (1996) and Alaa El-Deen (2000) on cucumber, Halil Kirnak and Naim Demirtas (2006) who used black polyethylene mulch + wheat straw mulch on cucumber and Helaly *et al.* (2018) on tomato.

Table 2. Effect of irrigation, foliar spray plant nutrients, mulching on vegetative growth and plant chemical constituents of cucumber plants during 2016 and 2017

Treatments	Vegetative growth								Plant chemical constituents							
	Plant height		No. of leaves		No. of branches /plant		plant dry weight (g)		Chlorophyll (SPAD)		N %		P %		K %	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
A) No. of irrigation /week																
A_1) 2 irrigations	135.7	134.6	44.96	42.55	14.06	13.16	43.47	41.75	33.36	32.89	4.076	3.253	0.385	0.360	3.633	3.364
A_2) 3 irrigations	134.7	134.1	44.64	43.15	13.86	12.90	43.49	42.04	34.93	34.46	4.198	3.345	0.390	0.364	3.682	3.437
L.S.D (0.05)	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	**	**	**	N.S	**	**	**	N.S
B) Plant nutrients																
B_1) Without plant nutrients	121.3	120.6	40.42	38.07	12.41	10.98	39.28	37.72	30.06	29.58	3.260	2.483	0.234	0.209	2.433	2.161
B_2) Zn	137.6	138.1	45.05	43.76	13.76	13.09	44.07	42.98	35.57	35.09	4.138	3.278	0.377	0.352	3.728	3.486
B_3) Fe	130.0	129.7	43.33	41.07	13.01	11.91	42.11	40.41	32.22	31.75	3.917	3.023	0.285	0.260	3.296	3.054
B_4) Seaweed extract	151.8	149.1	50.40	48.49	16.66	16.13	48.44	46.47	38.75	38.27	5.232	4.412	0.653	0.627	5.172	4.902
L.S.D (0.05)	1.254	3.282	0.47	0.58	0.33	0.33	0.328	0.801	0.308	0.310	0.0001	0.129	0.0001	0.001	0.0001	0.061
C) Mulching																
C_1) Without mulching	93.4	97.9	31.14	32.14	10.80	9.07	30.27	29.76	30.28	29.81	3.759	2.946	0.327	0.302	3.200	2.909
C_2) Clear polyethylene mulch + sugar cane straw mulch	144.3	144.8	47.88	45.74	14.28	13.57	46.93	44.89	33.54	33.07	4.234	3.421	0.368	0.343	3.709	3.401
C_3) Black polyethylene mulch + sugar cane straw mulch	167.9	160.4	55.38	50.66	16.81	16.44	53.22	51.03	38.62	38.14	4.417	3.530	0.466	0.441	4.062	3.892
L.S.D (0.05)	1.960	2.110	0.32	1.01	0.23	0.28	0.993	0.674	0.096	0.288	0.174	0.093	0.0001	0.001	0.0001	0.118
A x B	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
A x C	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
B x C	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***

Table 3. Effect of three interaction between irrigation, foliar spray plant nutrients with mulching on vegetative growth and plant chemical constituents of cucumber plants during 2016 and 2017

Treatments	Vegetative growth								Plant chemical constituents							
	Plant height		No. of leaves/plant		No. of branches/plant		plant dry weight (g)		Chlorophyll (SPAD)		N %		P %		K %	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
$A_1B_1C_1$	82.20	85.80	27.40	26.90	9.64	7.880	26.63	26.03	22.59	22.12	2.973	2.279	0.1970	0.1720	2.169	1.878
$A_1B_1C_2$	135.2	136.1	45.07	43.03	13.15	12.11	43.80	41.54	31.42	30.95	3.129	2.402	0.2340	0.2090	2.338	2.030
$A_1B_1C_3$	145.0	139.9	48.29	44.17	13.93	12.58	46.93	44.43	33.80	33.33	3.259	2.465	0.2710	0.2460	2.732	2.424
$A_1B_2C_1$	93.10	97.70	31.02	30.12	10.69	8.900	30.15	29.75	32.58	32.11	3.686	2.759	0.3140	0.2890	3.108	2.817
$A_1B_2C_2$	143.0	143.2	47.66	45.25	13.77	12.65	46.31	44.49	32.60	32.12	4.173	3.459	0.3410	0.3160	3.540	3.232
$A_1B_2C_3$	175.2	173.0	56.49	54.68	17.53	17.74	54.09	54.94	40.19	39.71	4.407	3.493	0.4510	0.4260	4.359	4.232
$A_1B_3C_1$	91.00	96.90	30.32	29.18	10.27	8.950	29.47	27.67	25.27	24.80	3.433	2.639	0.2240	0.1990	2.720	2.429
$A_1B_3C_2$	138.1	137.0	46.03	43.32	13.36	12.18	44.73	42.56	31.53	31.05	4.066	3.139	0.2480	0.2230	3.160	2.852
$A_1B_3C_3$	161.8	159.0	53.94	50.19	15.37	15.71	52.42	50.47	34.77	34.30	4.217	3.290	0.3660	0.3410	3.960	3.833
$A_1B_4C_1$	102.9	106.5	34.30	36.36	11.90	9.880	33.33	32.17	33.61	33.13	4.469	3.669	0.5000	0.4750	4.279	3.988
$A_1B_4C_2$	154.9	150.2	51.64	47.42	15.55	16.22	50.18	46.66	36.79	36.32	5.179	4.352	0.5640	0.5390	5.112	4.804
$A_1B_4C_3$	205.4	189.9	67.37	59.96	23.60	23.17	63.53	60.30	45.20	44.73	5.918	5.091	0.9040	0.8790	6.110	5.850
$A_2B_1C_1$	85.20	89.80	28.41	28.50	9.890	8.580	27.61	28.11	29.24	28.77	2.993	2.299	0.2180	0.1930	2.337	2.046
$A_2B_1C_2$	136.9	138.8	45.62	43.79	14.03	12.66	44.34	43.16	29.59	29.11	3.603	2.776	0.2630	0.2380	2.498	2.190
$A_2B_1C_3$	143.2	133.3	47.74	42.01	13.79	12.09	46.40	43.02	33.70	33.22	3.603	2.676	0.2190	0.1940	2.523	2.396
$A_2B_2C_1$	98.20	102.8	32.73	34.02	11.05	9.520	31.81	30.77	32.15	31.68	3.953	3.026	0.3540	0.3290	3.470	3.179
$A_2B_2C_2$	148.3	149.6	47.77	47.23	14.38	13.14	49.67	46.45	36.03	35.56	4.279	3.519	0.3840	0.3590	3.798	3.490
$A_2B_2C_3$	168.0	162.2	54.62	51.26	15.14	16.59	52.37	51.48	39.86	39.39	4.330	3.413	0.4140	0.3890	4.092	3.965
$A_2B_3C_1$	89.00	91.60	29.66	31.00	10.31	8.610	28.83	29.50	31.14	30.67	3.737	2.877	0.2610	0.2360	2.934	2.643
$A_2B_3C_2$	140.0	141.5	46.67	44.70	13.52	12.53	45.36	43.95	31.85	31.37	3.973	3.046	0.2890	0.2640	3.808	3.500
$A_2B_3C_3$	160.1	152.2	53.36	48.01	15.22	13.50	51.86	48.31	38.77	38.30	4.071	3.144	0.3220	0.2970	3.192	3.065
$A_2B_4C_1$	106.0	111.9	35.32	41.04	12.61	10.27	34.33	34.11	35.70	35.22	4.829	4.017	0.5480	0.5230	4.584	4.293
$A_2B_4C_2$	157.7	161.9	52.56	51.16	16.45	17.11	51.08	50.32	38.54	38.06	5.469	4.679	0.6200	0.5950	5.414	5.106
$A_2B_4C_3$	184.0	174.1	61.22	55.03	19.87	20.15	58.20	55.27	42.64	42.16	5.527	4.663	0.7810	0.7520	5.528	5.368
L.S.D (0.05)	2.807	5.968	0.91	n.s	0.65	0.80	0.691	1.906	0.815	0.815	0.0001	0.262	0.0001	0.002	0.0001	0.335

Regarding the interactions between A x B, significant increase in vegetative growth characters and plant chemical constituents in both seasons. The highest values were observed from the application of 3 of drip irrigation periods/week x 1000 mg/l seaweed extract, in the first and second seasons, respectively.

Meanwhile the interactions between A x C resulted in significant increase in this characters, in both seasons.

Application of 2 of drip irrigation periods/week x black polyethylene mulch + sugar cane straw mulch. These results are quite similar with those obtained on cucumber by Halil Kirnak and Naim Demirtas (2006) who reported that using mulch improved vegetative growth characters of plants under water stress treatments when used wheat straw mulch plus black polyethylene mulch + water stress.

Also, significant increase was gained from the interaction between B x C, in both seasons. Vegetative growth characters and plant chemical constituents from the interaction of 1000 mg/l seaweed extract x black polyethylene mulch + sugar cane straw mulch gave the highest values in both seasons. These results are in line with those obtained on tomato by Helaly *et al.* (2018) who used seaweed extract + black polyethylene mulch. It should be mentioned that the values obtained from each interaction surpassed those obtained from single treatment.

Concerning the interactions of the three factors, significant effect was obtained, in both seasons. Among these interactions, the highest values of vegetative growth characters and plant chemical constituents were obtained from 2 of drip irrigation periods/week x 1000 mg/l seaweed extract x black polyethylene mulch + sugar cane straw mulch for the first and second seasons. Again, the triple interactions were more effective in this character than that obtained from one or two sorts of fertilizers.

The effects number of drip irrigation periods/week that reduced vegetative growth characters may by duo to leaf wilting as reported by Halil Kirnak and Naim Demirtas (2006) on cucumber. Dhindsa *et al.* (1981) and Chen *et al.* (1991) have linked increased electrolyte leakage to reductions in chlorophyll concentrations (due to leaf senescence), while Premachandra *et al.* (1992) and McDonald and Archbold (1998) have shown that reductions in water use affect electrolyte leakage.

The promote effect of micronutrients on plant growth was confirmed by Seadh *et al.* (2009) and Farouk *et al.* (2010). The specific effect of each micronutrients may be summarized as a fellow. Foliar spraying with zinc improving the vegetative growth and including the plant capacity for building metabolites. Such response may be due to that zinc is known to play an activator of over 300 enzymes in plants Fox and Guerimot (1998) and is directly involved in the biosynthesis of auxin, indole acetic acid in particular (Maischner, 2002) which inducing more dry matter. Application of Fe improved plant growth, in special, fresh and dry weight through its role in activating of chlorophyll biosynthesis and photosynthesis (Rao *et al.*, 2001). Along with the iron requirement in some hemi enzymes and its involvement in the manufacture of the hemi group in general, iron has a function in Fe-S proteins, which have a strong involvement with the light-dependent reactions of photosynthesis. As well as being the electron donor for the synthesis of NADPH in photosystem I, it can reduce nitrate in the reaction catalyzed by nitrite reductase and it is an electron donor for sulfite reductase. All these parameters might have contributed to optimum growth. Apart from this increased concentration of active Fe in the plants with these treatments enhanced the concentration of nitrogen in the plants. As physiologically active Fe play many roles in the metabolism of nitrogen within the plants by affecting the activities of nitrate reductase, which are directly involved in the assimilation of N and finally improving plant growth (Hewitt and Notton, 1980).

The promote effects of biostimulants on plant growth are not yet explained, although there are some theories which probably work together, and can be summarised: 1) Biostimulants like seaweed accelerate physiological processes in plants like macro-and micronutrient uptake, cell elongation, enzymatic activity and protein synthesis and finally inducing biomass production (Rady and Mohamed, 2015). Accordingly, it was found that application of biostimulants increased phosphorous percentage that plays an important role in the biosynthesis and translocation of carbohydrates and stimulation cell division as well as formation of DNA and RNA (Taiz, 2003). 2) Activate root cells and stimulate the biosynthesis of endogenous cytokinins (Schmidt, 2005). Cytokinins known to promote cell division, inhibit leaf senescence by blocking the export of photosynthetic to new tissue and stimulating translocation of resources to treated leaves (Taiz, 2003), 3) Stimulation the biosynthesis of antioxidants solutes, as in chloroplasts which protect chloroplast and stimulation of chlorophyll biosynthesis (Zhang and Schmidt, 2002). 4) The enriched content of Swe in crude protein and growth promoting hormones, in special, auxin and cytokinins (Abdalla, 2015). Proteins are essential for the formation of protoplasm, while growth substances favored rapid cell division and cell multiplication as well as elongation. The role of seaweed in increasing chlorophyll concentration may be due to containing considerable amounts of macro-and micro-nutrients, amino acids, vitamins and hormonal like activities (Kurepin *et al.,* 2014), and/or the high content of betains (Blunden, 1997), which possibly increased chlorophyll concentration leading to higher rates of photosynthesis. These results were confirmed in tomato plant (Zodape, 2011).

The promote effect of seaweed in N, P and K % is not fully understood. It may be resulted from improving root system growth, increasing proliferation of root hairs, production of smaller and more ramified lateral roots (Canellas *et al.,* 2002) and to stabilizing membrane permeability, additionally improving nitrogen use efficiency by retarded nitrification processes or inhibited urease activity (Adani *et al.,* 1998).

This enhancement of the plant growth may be due to suitable changes in the wavelength composition of light reflected from various colors of polyethylene surface, exposure to red (R) and far-red (FR) light implicating phytochrome as the sensing mechanism, the mulch surface color could induce changes in the plant microclimate that could act through natural regulating systems with plant growth, might be brought about by warming of the stem by air escaping from the planting hole in the mulch and a consequence of enhanced root growth and nutrient uptake Adams (1997). The beneficial effect of mulch covers in reducing water stress is probably due to its minimizing water loss from the soil surface as well as its regulation of soil temperature in the root zone (Carter *et al.,* 1992).

2. Yield and its components and fruit quality characters

Data in Tables (4 & 5) indicated that this characters significantly responded positively to the foliar spray with some plant nutrients "micronutrients and Biostimulant" and with mulching on yield and its components (No. of days to harvest, early yield (ton/fed.), average fruit weight(g), total yield (ton/fed.) and fruit quality characters (reducing sugars, acidity, vitamin C and TSS %) on cucumber but number of drip irrigation periods/week, was significantly increased reducing sugars % whereas, insignificant increase in early yield (ton/fed.), average fruit weight(g) and total yield (ton/fed.) while it was significantly in first season only on No. of days to harvest, in both seasons.

Spraying cucumber plants with plant nutrients resulted in a significant increase in yield and its components and decreased reducing sugars, acidity but increasing vitamin C and TSS % compared to control. When seaweed extract surpassed on micronutrients in this character. Whereas black polyethylene mulch + sugar cane straw mulch surpassed clear polyethylene mulch + sugar cane straw mulch on yield and its components and fruit quality characters for the first and second seasons, respectively.

The same results were reported by Gajc-Wolska *et al*. (2005) on sweet pepper found that sweet pepper fruits cultivated on mulch with straw contained significantly more vitamin C compared to those cultivated on polypropylene fiber mulch, Halil Kirnak and Naim Demirtas (2006) on cucmber, Majkowska-Gadomska *et al.* (2012) and Helaly *et al.* (2018) on tomato, Increasing yield and its components and fruit quality duo to foliar spray plant nutrients "micronutrients and Biostimulant "and mulching and the results obtained from treatment of plants by irrigation were quite similar results as obtained with micronutrients like Fe or Zn are important in fruit development Mohsen Kazemi (2013) on cucumber plants, on tomato by Helaly *et al.* (2018). The results obtained by application seaweed on yield and fruit quality agreed with that obtained on tomato by Helaly *et al.* (2018).

Regarding the interactions between A x B, significant increase in yield and its components and fruit quality were obtained, in both seasons. The highest values were observed from the application 3 of drip irrigation periods/week x 1000 mg/l seaweed extract in the first and second seasons, respectively

Table 4. Effect of single and double interactions between irrigation, foliar spray plant nutrients with mulching on yield and fruit quality of cucumber plants during 2016 and 2017

Treatments	Yield characters								Fruit quality							
	No. of days to harvest		Early yield (ton/fed.)		Average fruit weight (g)		Total yield (ton/fed.)		Reducing sugars		TSS %		Acidity %		vitamin c %	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
A) No. of irrigation /week																
A_1) 2 irrigations	44.92	45.58	1.109	1.108	85.73	84.09	15.51	14.97	2.156	2.119	4.445	4.614	0.205	0.206	5.885	5.784
A_2) 3 irrigations	44.25	44.92	1.087	1.087	85.45	83.79	15.22	14.71	2.246	2.175	4.403	4.572	0.212	0.213	5.960	5.965
L.S.D (0.05)	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S	**	**	N.S	N.S	**	*	N.S	*
B) Plant nutrients																
B_1) Without plant nutrients	47.44	48.11	0.769	0.768	79.14	77.52	10.76	10.31	2.494	2.594	3.476	3.645	0.243	0.244	5.863	5.727
B_2) Zn	43.67	44.33	1.177	1.177	86.81	85.15	16.48	15.98	2.102	2.000	4.829	4.998	0.197	0.198	5.730	5.726
B_3) Fe	45.06	45.72	1.099	1.099	85.49	83.82	15.39	14.84	2.305	2.203	4.176	4.345	0.212	0.213	5.686	5.487
B_4) Seaweed extract	42.17	42.83	1.347	1.347	90.92	89.27	18.83	18.23	1.903	1.792	5.216	5.384	0.183	0.184	6.410	6.559
L.S.D (0.05)	0.542	0.542	0.02	0.02	1.00	0.98	0.254	0.211	0.038	0.059	0.136	0.136	0.00	0.01	0.12	0.16
C) Mulching																
C_1) Without mulching	50.92	51.58	0.793	0.882	80.70	78.99	11.11	10.64	2.523	2.549	3.857	4.025	0.243	0.244	5.401	5.297
C_2) Clear polyethylene mulch + sugar cane straw mulch	42.29	42.96	1.107	1.061	84.74	83.05	15.49	14.94	2.223	2.093	4.323	4.491	0.210	0.211	6.034	6.026
C_3) Black polyethylene mulch + sugar cane straw mulch	40.54	41.21	1.395	1.349	91.33	89.77	19.50	18.95	1.857	1.799	5.093	5.262	0.173	0.174	6.332	6.300
L.S.D (0.05)	0.061	0.530	0.01	0.03	0.80	0.82	0.221	0.214	0.244	0.062	0.022	0.096	0.00	0.00	0.12	0.18
A x B	***	***	***	***	***	***	***	***	N.S	N.S	***	***	***	***	***	***
A x C	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
B x C	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***

*** = significant

Table 5. Effect of interaction between irrigation, foliar spray plant nutrients with mulching on yield and fruit quality characters of cucumber plants during 2016and 2017

Treatments	Yield characters								Fruit quality							
	No. of days to harvest		Early yield (ton/fed.)		Average fruit weight(g)		Total yield (ton/fed.)		Reducing sugars		TSS %		Acidity %		vitamin c %	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
$A_1B_1C_1$	57.00	57.67	0.704	0.792	78.49	76.99	9.85	9.43	3.103	3.242	3.299	3.467	0.301	0.302	5.307	5.108
$A_1B_1C_2$	44.67	45.33	0.751	0.706	78.89	77.20	10.52	10.06	2.409	2.279	3.713	3.881	0.236	0.237	5.808	5.909
$A_1B_1C_3$	42.00	42.67	0.865	0.819	80.33	78.78	12.10	11.63	1.870	2.185	3.865	4.033	0.198	0.199	6.149	6.030
$A_1B_2C_1$	50.33	51.00	0.807	0.896	81.17	79.42	11.31	10.82	2.361	2.349	4.175	4.343	0.224	0.225	4.997	4.798
$A_1B_2C_2$	42.33	43.00	1.166	1.121	84.22	82.53	16.33	15.75	1.931	1.801	4.506	4.674	0.191	0.192	5.897	5.934
$A_1B_2C_3$	40.00	40.67	1.624	1.579	95.51	93.96	22.74	22.48	1.798	1.644	5.603	5.771	0.171	0.172	6.440	6.240
$A_1B_3C_1$	52.33	53.00	0.765	0.853	80.11	78.36	10.71	10.25	2.401	2.389	3.198	3.366	0.241	0.242	5.296	5.097
$A_1B_3C_2$	42.33	43.00	1.095	1.050	83.12	81.43	15.33	14.78	2.411	2.281	4.342	4.510	0.214	0.215	6.015	5.816
$A_1B_3C_3$	41.00	41.67	1.442	1.396	92.58	91.02	20.19	19.57	1.952	1.928	5.137	5.305	0.173	0.174	5.207	5.008
$A_1B_4C_1$	47.67	48.33	0.853	0.942	82.95	81.26	11.95	11.47	2.168	2.157	4.313	4.482	0.205	0.206	6.208	5.909
$A_1B_4C_2$	41.00	41.67	1.295	1.250	89.59	87.90	18.13	17.53	1.864	1.799	4.992	5.160	0.182	0.183	6.021	5.824
$A_1B_4C_3$	38.33	39.00	1.941	1.896	101.81	100.26	26.99	25.93	1.605	1.379	6.202	6.370	0.121	0.122	7.270	7.740
$A_2B_1C_1$	55.00	55.67	0.713	0.802	78.29	76.54	9.99	9.54	3.227	3.366	3.393	3.561	0.292	0.293	5.219	5.020
$A_2B_1C_2$	44.00	44.67	0.760	0.714	78.79	77.10	10.63	10.17	2.422	2.292	3.352	3.520	0.226	0.227	5.885	5.686
$A_2B_1C_3$	42.00	42.67	0.820	0.774	80.05	78.50	11.48	11.01	1.935	2.199	3.236	3.404	0.206	0.207	6.807	6.608
$A_2B_2C_1$	48.67	49.33	0.834	0.922	81.43	79.68	11.68	11.19	2.281	2.269	4.582	4.750	0.211	0.212	5.499	5.300
$A_2B_2C_2$	41.00	41.67	1.211	1.166	86.16	84.48	16.95	16.36	2.372	2.242	4.673	4.841	0.211	0.212	5.376	6.111
$A_2B_2C_3$	39.67	40.33	1.421	1.376	92.36	90.80	19.90	19.29	1.866	1.693	5.437	5.606	0.174	0.175	6.171	5.972
$A_2B_3C_1$	50.00	50.67	0.774	0.862	79.71	77.95	10.84	10.36	2.502	2.490	3.221	3.389	0.238	0.239	5.150	4.951
$A_2B_3C_2$	43.00	43.67	1.165	1.120	86.91	85.22	16.32	15.75	2.472	2.342	3.997	4.165	0.218	0.219	6.060	5.861
$A_2B_3C_3$	41.67	42.33	1.355	1.309	90.51	88.96	18.96	18.36	2.094	1.785	5.162	5.330	0.186	0.187	6.387	6.188
$A_2B_4C_1$	46.33	47.00	0.896	0.984	83.43	81.74	12.54	12.04	2.140	2.128	4.675	4.843	0.229	0.230	5.528	6.195
$A_2B_4C_2$	40.00	40.67	1.409	1.363	90.25	88.57	19.72	19.09	1.905	1.708	5.008	5.176	0.204	0.205	7.206	7.071
$A_2B_4C_3$	39.67	40.33	1.690	1.645	97.47	95.92	23.66	23.33	1.735	1.582	6.105	6.273	0.154	0.155	6.229	6.616
L.S.D (0.05)	1.500	1.500	0.04	N.S	N.S	N.S	0.493	0.607	0.061	0.174	N.S	N.S	0.01	0.01	0.33	0.51

Meanwhile the interactions between A x C resulted in significant increase in this character, in both seasons. Application of 2 of drip irrigation periods/week x black polyethylene mulch + sugar cane straw mulch showed the highest values for the first and second seasons, respectively. These results are quite similar with those obtained by Tiwari *et al.* (1998) reported that 100% irrigation requirement met through drip irrigation along with black plastic mulch gave the highest yield in okra with 72% increase in yield as compared to furrow irrigation, on cucumber by Halil Kirnak and Naim Demirtas (2006) who reported that using mulch improved yield and fruit quality characters of plants under water stress treatments when used wheat straw mulch plus black polyethylene mulch + water stress.

Also, significant increase was gained from the interaction between B x C, in both seasons. Yield and its components and fruit quality from the interaction of 1000 mg/l seaweed extract x black polyethylene mulch + sugar cane straw mulch gave the highest values in both seasons. These results are in line with those obtained on tomato by Helaly *et al.* (2018).

Concerning the interactions of the three factors, significant effect was obtained, in both seasons. Among these interactions, the highest values were obtained from 2 of drip irrigation periods/week x 1000 mg/l seaweed extract x black polyethylene mulch + sugar cane straw mulch for the first and second seasons. Again, the triple interactions were more effective in this character than that obtained from one or two sorts of fertilizers.

Additionally, Zn application have a great effect on pollen germination, tube elongation and increasing the number of ruptured pollen that results in best fertilization, higher fruit set and total yield Taiz *et al.* (2003). The enhancement effect of the applied micronutrients may be explained by their encouragement of Fe absorption and stimulation of some growth activators synthesis as reported by Abd-Alla, *et al.* (1984) on summer sweet pepper plant.

The stimulation effect of biostimulants on yield could be attributed to the presence of plant growth substances, in special, cytokinins in seaweed (Kurepin, 2014), that induced overall plant growth, maintenance of green leaves, and number of branches per plant, increasing photosynthetic pigments, followed by increasing sink capacity fulfilled supply of photoassimilates from green leaves and/or re-translocation of stem reserve (Saravanan, 2003). The favorable influences of biostimulants on the chemical characteristics of fruit may be ascribed to its simulative effect on photosynthesis process and its concentration of some promoter hormones such as cytokinins which are closely involved in cell division, protein, carbohydrates, and chlorophyll formation (Featonby–Smith and Van, 1984).

Enhancement of early yield by mulching probably was due to enhancing the top growth (Wien and Minotti, 1987); reduced nutrient loss by leaching and retention of soil heat and moisture (Bhella, 1988); and because of increase of the sink capacity of tomato fruits (Abdul-Baki, 1997) and increase early flower number (Wien and Minotti, 1988 a); a direct effect of an early vegetative growth of the plants due to reflected photosynthetically active light and FR:R ratio reflection and their role in phytochrome mechanism, heat accumulation and the enhancement of nutrient uptake (Adams, 1997); hastening maturity of fruits on mulch treatments (Gad El-Hak, 1989).

This enhancement effect on black mulching on total yield may be attributed to its effect on inhibiting the weed growth and subsequently lowering the competitive effect between the growing plants and weeds (Nylund *et al.,* 1961) and may be due to the higher soil temperatures under plastic mulch (Riekels, 1960); modification of the nutrient and moisture environment of the root system (Geraldson, 1962).

CONCLUSION

Water is a major source of life for all living organisms not only in agricultural production. Recently, water quantities have been threatened with decline. Therefore, scientific research has been necessary to reduce the amount of water used in irrigation while maintaining the highest productivity to meet the needs of population growth. In this research, it was possible to achieve the highest productivity of cucumber under sandy soil conditions and open field in Aswan Governorate. The best treatment was the 2 of drip irrigation periods/week x 1000 mg/l seaweed extract x black polyethylene mulch + sugar cane straw mulch. This treatment showed superiority in the majority of vegetative growth, yield, fruit quality and earliness (No. of days to harvested). The use of black polyethylene mulch + sugar cane straw mulch has the highest effect in reducing the number of irrigation periods/week due to the important role in reducing the evaporation of water from the surface of the soil and achieving the highest efficiency in water use. Seaweed extract also helped to increase the yield and improve the fruit quality through an effective course in the improvement of vegetative growth, which in turn reflected the crop and fruit quality and the earliness.

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تأثير الرى و بعض المغذيات النباتية والملش على النمو والانتاجية فى الخيار

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أجريت تجربتان حقليتان خلال موسمى الدراسة 2016 and 2017 بمزرعة التجارب البحثية بكلية الزراعة والموارد الطبيعية جامعة اسوان ، لدراسة تاثير عدد مرات الرى بالتنقيط خلال الاسبوع (مرتان – ثلاث مرات /الاسبوع)، الرش باربعة مستويات من المغذيات النباتية (ماء مقطر – 100 مللجم زنك مخلبى - 500 مللجم حديد مخلبى – 1000 مللجم مستخلص طحالب البحر) ثلاث مرات كل 15 ، 30 ، 45 يوم من الشتل، وثلاث مستويات من تغطية التربة (بدون تغطية - التغطية بالبولى اثيلين الشفاف + مخلفات قصب السكر - التغطية بالبولى اثيلين الاسود + مخلفات قصب السكر) وتاثير ذلك على بعض صفات النمو الخضرى والمحصول لنباتات الخيار النامية فى تربة رملية تحت ظروف محافظة اسوان ومنها "ارتفاع النبات (سم) ، وعدد الافرع/ النبات ،عدد الاوراق/النبات، الوزن الجاف للنبات (جم)، التبكير" عدد الايام للحصاد" ،المحصول المبكر (طن / فدان) ، متوسط وزن الثمرة (جم)، المحصول الكلى (طن / فدان) ، والمواد الصلبة الذائبة الكلية، % لفيتامين سى ، % للسكريات المختزلة، % للحموضة و% لمحتوى النبات من (الكلوروفيل - نيتروجين – فوسفور – بوتاسيوم %). ووضعت المعاملات فى تصميم القطع المنشقة مرتين لثلاث مكررات. أظهرت النتائج التي تم الحصول عليها أن المعاملة (مرتين للرى /الاسبوع X التغطية بالبولى اثيلين الاسود + مخلفات قصب السكر X 1000 مللجم /لتر مستخلص طحالب بحرية) ادت إلى زيادة معنوية فى صفات النمو الخضرى، % لمحتوى اوراق النبات من (الكلوروفيل - النيتروجين - الفوسفور - البوتاسيوم) والصفات المحصولية والمواد الصلبة الذائبة الكلية بالثمار، ومحتوى حمض الاسكوربك (فيتامين سى) بالثمار، بينما ادت الى نخفاض فى % للسكريات المختزلة و% للحموضة بالثمار كما ادت الى خفض عدد الايام للحصاد في كلا الموسمين.