European Journal of Academic Essays 2(7): 68-74, 2015
ISSN (online): 2183-1904
ISSN (print): 2183-3818
www.euroessays.org

Responses of Changes in Productivity, Yield and Fruit Quality of Cucumber (*Cucumis sativus* L.) Plant Under Bio - and Chemical Nutrition

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Abstract: Two field experiments were carried out at a private vegetable farm during the two growing seasons of (2012 and 2013) to study the effects of different combinations of mineral fertilizers of nitrogen and phosphorus with bio-fertilizers of Nitrobien and phosphorien on growth, yield and fruit quality as well as chemical constituents of cucumber. The obtained results could be summarized as follows: (1)- Application of 75% recommended dose of mineral NP fertilizers in the presence of bio-fertilizers, i.e., Nitrobien and phosphorien significantly affected positively most of vegetative growth characteristics (stem length, leaf area, dry weight and number of branches/plant), also, this treatment significantly affected the earliness of female flowers production, number of male flowers, number of female flowers and sex ratio in cucumber plants in both seasons of the study. (2)- Application of 75% recommended dose of mineral NP fertilizers with biofertilizers (Nitrobien and phosphorien) significantly increased total yield followed by the treatment of 75% P + phosphorien as well as improvedfruit quality characteristics (fruit weight, fruit length and fruit shape) and increased also ascorbic acid and total soluble solids (TSS) in fruits followed by the treatments of 100% mineral NP (control) and 75% N + Nitrobien treatment in both seasons. However, the highest early yield was obtained from control treatment (full NP recommended dose) followed by 75% NP recommended dose with biofertilizers Nitrobien and phosphorien and 75% N recommended dose plus Nitrobien in both seasons.

Keywords: Cucumber, Bio-fertilizers, Nitrogen, Phosphorus, Vegetative Growth, Flowering, Yield, Chemical Constituents**.**

1. Introduction

The cucumber (*Cucumis sativus*, L.) belongs to the Cucurbitaceae family, one of the more important plant families. The cultivation of cucumber goes back to the beginning of Christian era when it was grown in North Africa, Greek and Asia Minor. The crop was introduced to England in the early Boss, but was not cultivated until 1550. In America, the cucumber was planted for the first time in Massachusetts in 1627 [1]. In Egypt, the cucumber is one of the most important vegetable crops. Its plants grow best at 23.2^{o}C during the day and 18.7^{o}C at night [2]. These plants are grown in Egypt in the open field as a summer crop in the period from March to September and under plastic house conditions from September to May. Development of agricultural production is more important, for several countries, than sustainability, rational use of resources or even environmental quality. However, development and sustainability should not be incompatible; they represent the way through which agricultural growth is achieved [3]. Lake of agricultural development, in several cases, might lead to unsustainability, particularly in low potential areas, where intensification and increased production are needed to take pressure off or actually help restore the fragile natural resources base.

The term (bio-fertilizers) is generally defined as a preparations containing live or latent cells of efficient strains of nitrogen fixing; phosphate solubilizing or cellulolytic micro-organisms used for application to seed or soil with objective of increasing the number of such micro-organisms and accelerate certain microbial processes to augment the extent of the availability of nutrients in the soil which can be easily assimilated by plants. The use of bio-fertilizers may be beneficial in reducing the high rates of mineral fertilizers applied under the Egyptian condition, which may help in increasing vegetable exportation to the European countries. The beneficial effect of N_2-fixing bacteria inoculation has been proved by many scientists at different parts of the world on plant growth, dry weight, total nitrogen content and yield

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of various crops [4]. Some of them reported that the inoculation with N_2-fixers can save half the normal field rate of inorganic nitrogen fertilizer [5]. Several workers indicated that soil inoculation with phosphate solubilizing micro-organisms improved soil fertility and plant productivity by releasing P-element from rock tricalcium-P [6 - 7].

Chemical farming allowed us to make giant strides toward raising agricultural production and satisfying growing human needs. At the same time, the extensive worldwide abuse of agrochemicals leads a set of successive environmental deterioration problems, as well as to agricultural unsustainability. So the use of intensive and nutritional doses of mineral fertilizers increases the costs of agricultural production. Also, most of mineral fertilizers elements are either fixed in the soil or leached to pollute the environment. Halime *et al*. [8] they shown that the cucumber fruit yield and quality can significantly be improved with soil and foliar humic acid (HA) application. Potassium plays an important role in many essential processes such as, photosynthesis, synthesis of protein, enzyme activation, phloem transport, maintenance of the osmotic potential of cells in addition to cell extension and walls thickness and stability as indicated by Marschner [9]; Cherel [10]. Also, El-Nemr *et. al*. [11] they found that the application of foliar sprays of humic acid (HA) and bio-stimulators led to positive effect on plant growth, fruit set and improvement production of cucumber plants.

Therefore, it has become essential to use untraditional fertilizers (bio-fertilizers) as supplement or substitute as cheap source for fertilization. More than this, under Egyptian conditions El-Sheekh [12]; Ashour [13] mentioned that utilization of P-bio-fertilizer (phosphorien) with or without of mineral-P markedly increased the available-P concentrations in soil and plants and hence plant growth and yield. In addition, there were many investigators reported that plant growth, yield and chemical constituents in foliage and fruit tissues of different cucurbits were dependent not only on available-P level in the soils but also on the applied P-rate to plants [14-15].

The aim of this study is reducing the use of chemical fertilizers N and P and enhancing the growth, yield and quality of cucumber plants by using low levels of chemical fertilizers combined with bio-fertilizers of Nitrobien and phosphorin under the local conditions. Also, find out if the combinations of these substances have beneficial effects or if they interfere with each other. Therefore, combinations of these substances were also investigated.

2. Materials and Methods

Two field experiments were carried out at a private vegetable farm during the two successive summer seasons of 2012 and 2013**,** to investigate the effect of some bio-fertilizers (Nitrobien and phosphorin) in combination with chemical fertilizers (nitrogen and phosphorus) on the plant growth, flowering, yield, fruit quality and chemical constituents of cucumber (*Cucumis sativus,* L.), Madina cultivar. The soil of the experimental field was clay loam in texture with pH 7.9. Soil available N, P and K contents were 19.6 - 22.3, 2.6 - 2.9 and 290 - 310 ppm during the first and second seasons, respectively. The experiment included 10 treatments were as follows:

1. Full dose of recommended chemical fertilizers rates (72 kg N + 24 kg P_2O_5/fed).
2. 75 % N + Nitrobien +100 % P.
3. 50 % N + Nitrobien +100 % P.
4. 25 % N + Nitrobien +100 % P.
5. 75 % P + Phosphorien +100 % N.
6. 50 % P + Phosphorien +100 % N.
7. 25 % P + Phosphorien +100 % N.
8. 75 % NP + Nitrobien + Phosphorien.
9. 50 % NP + Nitrobien + Phosphorien.
10. 25 % NP + Nitrobien + Phosphorien.

Nitrobien and phosphorien inoculums are commercial bio-fertilizers locally produced by the general organization for agriculture equalization fund (GOAEF), Ministry of Agriculture, Egypt. They contain live cells of efficient bacteria capable of N2-fixation and converting unavailable phosphate soluble forms.

The NP fertilizers doses were applied after 21 and 45 days from planting, likewise, all plants were fertilized with 48 kg K_2O/fed (potassium sulphate, 48% K_2O). The other cultural practices for garlic commercial production were used according to the instruction laid down by the Ministry of Agriculture, Egypt.

Before sowing, seeds divided to three equal parts and treated with a sticky solution and after 15 min, the seeds were inoculated with a sufficient amount of nitrobien, phosphorien and nitrobien + phosphorien at 3 kg/fed from each inoculants far from direct sun, the field was irrigated directly after sowing. The rest of bio-fertilizers were mixed with a sufficient amount of wetted sand then applied as a soil inoculation with the first irrigation.

Growth Parameters:

Vegetative growth parameters: At 55 days after sowing, a random sample of 5 plants was taken from each plot to estimate traits of plant Stem length, number of leaves/plant, leaf area/plant.

Flowering characters: For studying flowering behavior, five plants from each replicate were chosen and labeled to determine number of male and female flowers, also, the sex ratio was calculated as the ratio between male to female flowers.

Early yield and total yield: Early yield was calculated as the total yield of the first seven pickins (total fruits weight per plot calculated as tons/feddan). Total yield calculated as the total weight of fruits (kg/plot) through the entire harvesting season as tons/feddan. Fruit qualities were determine fruit characteristics, 5 female flowers were labeled of each plot then the fruits were harvested at the same time of marketable stage. The average fruit weight, fruit length, fruit diameter and fruit shape index (L/D). Total soluble solids (TSS) and Ascorbic acid were determined according to A.O.A.C. [16] and Jacobs [17] respectively.

Statistical analysis:

The obtained data were subjected to statistical analysis using technique of the randomized complete block design according to Snedecor and Cochran [18]. The treatment means were compared using Duncan's Multiple Range Test [19].

3.Results and Discussion

Plant growth parameters: Data presented in **Tables (1&2)** demonstrated that application of different combinations of mineral NP fertilizers in the presence of bio-fertilizers (nitrobien and phosphorien) significantly affected stem length, number of leaves, leaf area, plant dry weight and number of branches of the two study seasons. It is clear from the data that plants that received full dose of NP recommended mineral fertilizers (control) and the treatment of 75% NP recommended dose + bio-fertilizers as a mixture of nitrobien + phosphorien gave the highest values of vegetative growth parameters followed by the treatment of 75% N recommended dose + bio-fertilizer Nitrobien and the treatment of 75% P recommend dose + bio-fertilizer phosphorien. While, the lowest values were obtained from plants that received 25% NP recommended dose + bio-fertilizers (nitrobien + phosphorien) in the two seasons of study. **El-Nemr et al [11]** showed that all morphological parameters including plant height, number of leaves and stems/plant, fresh weights of leaves/plant as well as yield and its components of cucumber plants positive and significant responses with the high concentration of humic acid (3 g/L) and Ecormon (0.45 cm/L) compared with control.

From the obtained results, the enhancing effect of 75% mineral NP of recommended dose combined with bio-fertilizers (nitrobien + phosphorien) on vegetative growth of cucumber plants may be attributed to the bacteria present in Nitrobien. It can play an important role in improving soil fertility and plant growth development via N_2fixation and releasing certain nutrient elements, such as (Fe, Zn and Mn)and some phytohormones such as gibberellins, auxins and cytokinins like substances which may stimulate absorption and efficiency of nutrients and hence plant growth [20-21].

Table (1): The Effects of Bio and Mineral Fertilization on Stem Length (cm/plant), Number of Leaves (leaves/plant), Leaf Area (m^2/leaf) and Plant Dry Weight (g/plant) of Cucumber (*Cucumis sativus* L.) Plant the Average Responses During 2012 and 2013 Seasons.

Growth Parameters / I. TREATMENTS	Stem Length (Cm/Plant)		Number of Leaves/Plant		Leaf Area/Plant (m^2/Leaf)		Plant Dry Weight (g/Plant)	
	2012	2013	2012	2013	2012	2013	2012	2013
1. 100 % NP (Control)	80.39 ab	81.33ab	21.59 b	22.02 a	0.2230 c	0.2150 c	13.37 b	13.42 a
2. 75 % N + Nitrobien	80.31 ab	80.30 b	21.98 b	22.35 a	0.2310b	0.2130 d	13.47 b	13.70 a
3. 50 % N + Nitrobien	62.59 d	64.71c	17.93 e	18.66 c	0.1730 e	0.1840 e	11.01 e	10.93 c
4. 25 % N + Nitrobien	50.49 ef	52.79 ef	14.72 f	14.00e	0.1160 h	0.1180 h	8.78 g	9.05 e
5. 75 % P + Phosphorien	79.06 b	79.35b	20.80 c	19.91 b	0.2070 d	0.2280 b	12.89 c	12..65 b
6. 50 % P + Phosphorien	60.99 d	61.01 d	18.45 d	18.43 cd	0.1700 f	0.1760 f	10.43 f	10.31 d
7. 25% P + Phosphorien	53.00 e	53.74 e	13.77 g	14.25 e	0.1190 g	0.1110 i	8.11 h	8.37 f
8. 75 % NP + Bio. + Phos.	82.89a	83.01 a	22.82 a	22.50a	0.2370 a	0.2390 a	13.85 a	13.93 a
9. 50 % NP + Bio. + Phos.	68.72 c	63.94 c	18.32	17.66 d	0.1720 e	0.1770 f	11.36 d	11.32 c
10. 25 % NP+ Bio. + Phos.	50.27 f	51.00 f	13.48 g	13.75 e	0.1190 g	0.1320 g	8.50 g	8.11 f

Means followed by the same letters within each column do not different significantly according to Duncan's Multiple Range Test at the 5% level.

Moreover, phosphate solubilizing bacteria present in phosphorien possess the ability to change insoluble phosphorus into soluble forms by secreting organic acids, such as formic, acetic and succinic acids. These acids lower the soil pH in root zone and bring out the dissolution of bound forms of phosphate compounds and render them available for plants. Besides that, the reduction of soil pH in root zone increase the availability of some micronutrients such as Fe, Zn, Mn and Cu which would be reflected on plant growth [6, 22].

The obtained results are in accordance with those obtained by Gomaa [23], who found that single inoculation of cucumber seeds with *Azotobacter chroococcum* significantly increased plant fresh weight by 16.8%. In this respect, also, Hassouna et al. [24] found that inoculation of cucumber seeds with Halex$_2$ (mixture of *A. chroococum*, *A. brasilense* and

Klebsiella pnenumoneae) caused increments in photosynthetic plant area 22%, shoot dry weight 30% and root dry weight 83% as compared with un-inoculated ones, regardless of level of fertilization. Moreover, applying (30 kg N/fed.) plus seed inoculation gave 52% increase in the photosynthetic area, 21.9 % in shoot and 15.0% in root dry weight as compared with the full dose of recommended N (40 kg N/fed) plus inoculation. Similar results reported also by Chen et al. [25] and Xu Hui et al. [26] on cucumber.

Table (2): The Effects of Bio and Mineral Fertilization on Number of Branches/Plant, Number of Male Flowers/Plant, Number of Female Flowers/Plant and Sex Ratio of Cucumber (*Cucumis sativus*, L.) Plant the Average Responses During 2012 and 2013 Seasons.

Sex Characters / TREATMENTS	Number of Branches/Plant		Number of Male Flowers/Plant		Number of Female Flowers/Plant		Sex Ratio	
	2012	2013	2012	2013	2012	2013	2012	2013
1. 100 % NP (Control)	4.34 ab	4.24 a	34.82 e	35.11 d	10.75ab	11.50a	3.25 de	3.06 de
2. 75 % N + Nitrobien	4.32 b	4.33 a	34.79 e	34.56 d	10.75ab	11.50 a	3.24 de	3.01 de
3. 50 % N + Nitrobien	3.66 e	3.41bcd	39.97 d	40.30c	9.50 c	9.75 b	4.22 c	3.14 d
4. 25 % N + Nitrobien	3.14 f	3.08 cd	46.31 b	46.23a	7.75 d	8.00 c	5.90 b	5.83 b
5. 75 % P + Phosphorien	4.17 bc	4.08 a	34.91 e	34.57 d	10.50abc	11.25a	3.33 de	3.09 de
6. 50 % P + Phosphorien	3.99 cd	3.49bc	42.17 c	42.02 b	10.00bc	10.25 b	4.22 c	4.11 c
7. 25% P + Phosphorien	3.08 f	3.08 cd	48.96 a	46.53a	8.00 d	8.25 c	6.17 ab	5.65b
8. 75 % NP + Bio. + Phos.	4.56 a	4.41 a	31.65 f	31.53 e	11.50 a	11.75 a	2.77 e	2.69 e
9. 50 % NP + Bio. + Phos.	3.91 d	3.58 b	39.55 d	39.55 c	10.25bc	10.00 b	3.86 cd	3.95 c
10. 25 % NP+ Bio. + Phos.	3.22 f	3.00 d	46.04 b	47.09 a	7.00 d	7.50 c	6.71 a	6.31 a

Means followed by the same letters within each column do not different significantly according to Duncan's Multiple Range Test at the 5% level.

Flowering characteristics:

Number of male flowers, **female flowers and sex ratio (male/female flowers)**: It is obvious from data in Table (2) that the highest number of female flowers was obtained from plants fertilized by 75% mineral NP recommended dose + bio-fertilizers Nitrobien and phosphorien in the first season. In the second season the highest number of female flowers was obtained from plants fertilized with 75% mineral NP + nitrobien + phosphorien, 75% mineral P + phosphorien, 75% mineral N + Nitrobien and 100% mineral NP recommended dose (control).

More ever, plants fertilized by 75% mineral NP + nitrobien and phosphorien gave the best results in the number of male flowers/plant. The same data in **Table (2)** revealed that the obtained results from the second season were better than these obtained from first season. Also, this treatment significantly decreased the ratio of male to female flowers compared with the other treatments in both seasons. These results may be attributed to the increase of soluble form of phosphorus as a result of presence of soil micro-organisms. It is known as phosphate dissolving bacteria (PDB) plays a fundamental role in correcting the solubility problem in many soils by transforming this insoluble forms to a soluble form to be ready for plant nutrition [6]. In addition, phosphorus plays an important role in plant metabolism, root development processes, flower and fruit ripening. It is also a constituent for the development of meristemitic tissues [27]. The obtained results are in harmony with those reported by Aboul-Nasr [28] showed that the number of flowers of squash was significantly affected by *Gloums intraradices* inoculation as compared with non-mycorrhizal plants. Also, Shebl [29] found that the flowering parameters (sex ratio and early flowering) in squash plant were improved with bio-fertilizers, (nitrobein and phosphorein).

Yield and its components:

Early yield and total yield: The obtained results in **Table (3)** showed that the early yield was significantly affected by various combinations of mineral NP fertilizers with bio-fertilizers of nitrobien and phosphorien in both seasons. The highest early yield was obtained from plants fed on 100% mineral NP recommended dose (control) and the lowest early yield was obtained from plants fed on 25% mineral NP + nitrobien + phosphorien in the first season. While, in the second season the highest early yield was obtained from plants fed on 100% mineral NP (control) and plants fed on 75% mineral NP + nitrobien + phosphorien. The lowest early yield was obtained from plants fed on 25% mineral P + bio-fertilizer phosphorien and plants that fed on 25% mineral NP + Nitrobien + phosphorien. Also, plants fed on 50% mineral NP + nitrobien + phosphorien were better than those fed on 50% N + nitrobien and 50% P + phosphorien in both seasons of the study.

Regarding the total yield, data in **Table (3)** also, showed that plants fertilized with 75% NP + nitrobien + phosphorien gave the highest total yield in the two seasons. Also, there was no significant difference between plants fed on 75% P + phosphorien and plants fed on 75% N + nitrobien as compared with the plants fertilized with 100% mineral NP recommended dose (control) in both seasons. Also, the lowest total yield of cucumber plants was obtained from plants that fed on 25% NP + nitrobien + phosphorien. These results may be attributed to the strong vegetative growth, i.e., the increases of plant leaf area and plant dry weight **(Table 1)** as a result of optimum benefit from. Moreover, humates influence the respiration-process, the amount of sugars, amino acids and nitrate accumulated, and make the plants resistant against diseases and viruses [30-31]. Nevertheless, it is very important to stabilize the supply of macro elements; much more essential for plant growth in substrate culture is the sufficient supply with microelements, often there are disorders of them especially the problem of iron deficiency [31]. All bio-stimulators have beneficial effects on plants in stress situations, however, their main effects they have in different stresses. The bio-stimulators can be applied in the root zone or on the leaves. It should be investigated which treatment is the most effective one [31].

Fruit qualities:

The parameters used for measuring the fruit qualities in this study are average fruit weight, fruit length, fruit diameter and fruit shape, as well as Ascorbic acid and total soluble solid (TSS) constituents. The effect of different fertilization treatments on fruit qualities of cucumber was presented in **Tables (3 and 4),** data showed that the application of 75% mineral NP recommended dose in combination with bio-fertilizers of Nitrobien and phosphorien gave the highest fruit weight, fruit length, fruit diameter followed by 75% chemical N + Nitrobien then the control treatments in both seasons. More ever, the different fertilization treatments had significant effect on fruit shape. The plants fertilized with 75% NP recommended dose + Nitrobien + phosphorien gave the highest values of fruit shape in both seasons. Also, the differences between the treatment of 75% N + Nitrobien and the treatment of 100% NP recommended dose (control) were not significant in both seasons. Also, the lowest records of fruit shape were produced by the low level of N, P or NP (25%) combined with bio-fertilizers in both seasons. The previous results are in harmony with those reported by Hassouna et al. [24] who indicated that inoculation of cucumber seeds with a multi bio-fertilizer consisting of *Azotobacter* + *Azospirillum* and *Klebsiella* increased fruit weight compared with un-inoculated ones. Similarly, Wang [32] studied the effect of different fertilizer rates (solid bio-fertilizer + foliar applied fertilizer) on growth and yield of cucumber. The fruit quality improved after application of the fertilizers. Shebl [29] on squash, showed that fruit weight, fruit length and diameter were significantly increased by application of 50% mineral NP + bio-fertilizers (nitrobein + phosphorien + microbein).

Table (3): The Effects of Bio and Mineral Fertilization on Early and Total Yield (Ton/Fed.), Ascorbic Acid Constituents and Total Soluble Solids (TSS) (mg/100gm F. Wt.) of Cucumber (*Cucumis sativus* L.) Plant the Average Responses During 2012 and 2013 Seasons.

Yield Production (Parameters) / TREATMENTS	Early Yield (Ton/Fed)		Total Yield (Ton/Fed)		Ascorbic Acid (Mg/100g F. Wt.)		T.S.S. (Mg/100g F. Wt.)	
	2012	2013	2012	2013	2012	2013	2012	2013
1. 100 % NP (Control)	3.904a	3.849a	8.903a	8.825b	14.73b	14.69b	3.86a	3.90a
2. 75 % N + Nitrobien	3.621 c	3.506b	8.897a	8.813b	15.02a	15.02a	3.89a	3.87a
3. 50 % N + Nitrobien	3.110e	3.133d	7.949d	7.722c	14.05d	14.11d	3.47c	3.41c
4. 25 % N + Nitrobien	2.361f	2.475e	6.351c	6.268f	13.11f	13.10f	3.12d	3.07e
5. 75 % P + Phosphorien	3.605c	3.522b	8.965a	8.900b	14.40c	14.41c	3.59b	3.55b
6. 50 % P + Phosphorien	3.066e	3.131d	7.977b	7.403d	13.62e	13.65e	3.45c	3.37cd
7. 25% P + Phosphorien	2.338f	2.183f	6.395c	6.516e	12.95f	13.19f	3.05d	3.02e
8. 75 % NP + Bio. + Phos.	3.777b	3.773a	8.987a	9.075a	14.52b	14.53b	3.91a	3.91a
9. 50 % NP + Bio. + Phos.	3.160d	3.325c	7.938b	7.311d	13.89d	13.91d	3.45c	3.41c
10. 25 % NP+ Bio. + Phos.	2.266g	2.250f	6.153d	6.003g	12.50g	12.98f	3.07d	3.26d

Means followed by the same letters within each column do not different significantly according to Duncan's Multiple Range Test at the 5% level.

On the other hand, constituents of ascorbic acid and total soluble solids TSS in cucumber fruits are recorded in **Table (3)**. Data demonstrate that using different combination of mineral NP–fertilizers with bio-fertilizers of Nitrobien and phosphorien significantly affected the ascorbic acid content in cucumber fruits. The highest values were obtained by application of 100% mineral NP recommended dose (control) and 75% mineral NP as alone or in combination with Nitrobien, phosphorien as a single or a mixture application. Also, the data revealed that the treatments of 75% NP + Nitrobien + phosphorien and 75% N + Nitrobien gave the highest values of TSS in both seasons. These results may be due to the effect of bio-fertilizers Nitrobien and phosphorien contain live efficient bacteria which have the

ability to fixed air nitrogen and have the ability to transform the un-available P to the available form in addition to some micronutrients and phytohormons, which could stimulate nutrients absorption, photosynthesis and thereby increasing chemical constituents in different plant tissues. Moreover, nitrogen element is very important in metabolic processes, because it is a main constituent of many organic compounds in plants (proteins, enzymes, chlorophylls, vitamins, hormones and nucleic acids), while, phosphorus element is an essential component of phosphoproteins, phospholipids, notable nucleic acids, nucleotides and energy compounds (AT P and ADP).

The obtained results were similar to those reported by Shebl [29] on squash, who found that TSS and vitamin C significantly increased by applying 50% mineral NP + 2 kg nitrobin + 2 kg phosphorien + 2kg microbein/fed). Humic substances are generated through organic matter decomposition and employed as soil fertilizers in order to improve soil structure and soil microorganisms [8].

Table (4): The Effects of Bio and Mineral Fertilization on Fruit Weight (g/fruit), Length (cm/fruit), Fruit Diameter (cm^2/fruit) and Shape Index of Cucumber (*Cucumis sativus* L.) Plant the Average Responses During 2012 and 2013 Seasons.

Yield Parameters / TREATMENTS	Average fruit weight (g/fruit)		Fruit length (cm/fruit)		Fruit diameter (cm^2/fruit)		Fruit shape index	
	2012	2013	2012	2013	2012	2013	2012	2013
1. 100 % NP (Control)	104.25b	104.80b	14.49b	14.45b	3.47b	3.50ab	4.17a	4.12ab
2. 75 % N + Nitrobien	104.37b	105.01b	14.60ab	14.72a	3.57a	3.52a	4.08a	4.17a
3. 50 % N + Nitrobien	102.70c	101.95d	13.38d	13.38d	3.50b	3.50ab	3.81c	3.81cd
4. 25 % N + Nitrobien	96.36e	93.69f	12.96e	12.47e	3.37c	3.32d	3.83c	3.74cd
5. 75 % P + Phosphorien	104.83a	105.19a	14.71a	14.67a	3.57a	3.50ab	4.11a	4.19a
6. 50 % P + Phosphorien	100.75d	100.378	13.47d	13.51cd	3.50b	3.47ab	3.84c	3.13ab
7. 25% P + Phosphorien	93.86f	92.00g	12.85e	12.56e	3.37c	3.40c	3.80c	3.69cd
8. 75 % NP + Bio. + Phos.	105.30a	105.83a	14.72a	14.79a	3.57a	3.52a	4.11a	4.19a
9. 50 % NP + Bio. + Phos.	103.02c	102.75c	13.71c	13.54c	3.45b	3.45bc	3.97b	3.92bc
10. 25 % NP+ Bio. + Phos.	91.85g	91.29g	12.03f	12.20f	3.35c	3.32d	3.58d	3.66d

Means followed by the same letters within each column do not differ significantly according to Duncan's Multiple Range Test at the 5% level.

Acknowledgements

The authors are thankful to *Prof. Dr. El-Morsy, A. H.*, Horticulture Research Institute, Agric. Res. Center and Vegetable Crops, for his great help in planning and carrying out the field work and also for offering all facilities at preparation of the manuscript.

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