*J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol. 13 (12):403 -411, 2022*

# Journal of Soil Sciences and Agricultural Engineering

**Journal homepage & Available online at: www.jssae.journals.ekb.eg**

# Cucumber Response to Drip Irrigation and Bio-Mineral Fertilizers Management under Protected Cultivation Conditions

**Khalifa, R. M.***

Soil and water Dept. Fac. Of Agric. Damietta Univ.


## ABSTRACT

Greenhouse experiments were carried out in the Gammsa district of Dakahlya Governorate over two seasons (2016/2017 and 2017/2018), to investigate the impact of three drip irrigation levels, (100 , 80 and 65% of soil field capacity (FC), donated as $I_1$, $I_2$ and $I_3$, respectively and partial replacement of biofertilizers to mineral fertilizers, $F_1$ (100% RNPK), $F_2$ (75% RNPK +50% of mixture of biofertale + rhizobacterien) and $F_3$ (55% RNPK + 100% of mixture of biofertale + rhizobacterien), on cucumber yield and its components. The economic return was considered as well. The results revealed that both irrigation and fertilization treatments had a highly significant impact on cucumber plant yield and attributes. In both seasons, the $I_2$ and $F_3$ treatments produced the highest cucumber fruit yield and the majority of its components. In the first and second seasons, respectively, fruit yield increased by (21.87 and 22.29%) in the $I_2$-treatment compared to $I_1$, and by the comparable values (10.78 and 13.18%) in the $F_3$-treatment compared to $F_1$. In both seasons, the combination of $I_2$ and $F_2$ or $F_3$ produced the highest values of net revenue, net revenue per water unit, and economic efficiency numbers, moreover, the I3 treatment surpassed the $I_1$ treatment in terms of irrigation water productivity and water savings. In conclusion: Under greenhouse conditions using sandy soil, $I_2$ paired with $F_2$ or $F_3$ is the most effective treatment for obtaining an economical cucumber fruit production, economic return, and saving water and mineral fertilizers.

***Keywords:*** Bio-chemical fertilizers, cucumber, drip irrigation, economic return, sandy soil, productivity of irrigation water.

## INTRODUCTION

One of the most common vegetables grown in greenhouses and open fields is the cucumber (Cucumis Sativas L.) worldwide. Cucumbers are a large and important vegetable family in the cucurbitaceous family. Cucumber has enormous economic and nutritional value, (Maqsood *et al*., 2004). Additionally, cucumbers rank among Egypt's most significant commercial veggies and are a preferred item for both local consumption and export. In 2012, Egypt's entire cucumber cultivation area was roughly 26.071 hectare (FAO, 2012).

Recent years have seen a global decline in the amount of water available for agriculture as a result of fast population expansion, climate change, and various human activities (World Bank, 2006, Alam, 2015 and Attia *et al*.,2021). Increasing agricultural output for the Egyptian population requires effective irrigation water use. Agriculture will soon face significant challenges due to a lack of water for irrigation. To increase the output and water consumption efficiency, careful utilization of the limited water resources through more effective water application techniques, such as drip irrigation under greenhouse conditions, is required (Dunage *et al*., 2009). According to Tuzel and Leonardi (2009), greenhouse cultivation has grown rapidly in many parts of the world. Greenhouse vegetable cultivation is the most effective way to increase vegetable productivity and quality, particularly cucurbits. Additionally, greenhouse farming makes efficient use of sparsely populated terrain and labour shortages.

Numerous studies on cucumber cultivation in greenhouses have been published. (Xiaobo *et al*., 2002; Shao *et al*., 2010; Abdul Hakim and Jisha Chand, 2014 and Cakir *et al*., 2017). They investigated the connection between cucumber yield, irrigation water use, and quantity. According to their findings, the maximum water use efficiency (WUE) and irrigation water use efficiency (IWUE) values were reached. Today's tremendous increase in water resource competition necessitates improved water use efficiency, which is feasible under greenhouse cultivation. Additionally, high irrigation water consumption results in environmental contamination and overuse of groundwater resources (Du *et al*., 2014). In order to reduce irrigation water demand, increase water use effectiveness (WUE), and maximize crop yield and quality, an efficient strategy, such as deficient irrigation control (RDI), is used in greenhouses (Ismail, 2010; Shao *et al*., 2010; Cosic *et al*. 2015 ; Hui *et al*., 2017; Hu *et al*., 2021 and wang *et al*., 2022). Additionally, the drip irrigation system has significant potential for uniform distribution and lowering soil evaporation (Karlberg *et al*., 2007).

According to various researchers, integrated nutrient management, which combines chemical and biofertilizers, may be a valuable strategy to increase water utilization and decrease water resource pollution. (Morsy *et al*., 2008; Wu *et al*.,2005; Ayoola *et al*.,2007; Mishra *et al*.,2010 and Manocherhr *et al*.,2013). Additionally, it has been demonstrated that biological fertilizers are particularly important as a suitable alternative to mineral fertilizers by enhancing soil fertility, meeting plant nutrition needs and increasing crop yield. (Poraas EL-Din *et al*., 2008, Khalifa *et al*., 2013, Saeed *et al*., 2015 and Khalifa, 2020). Under

*** Corresponding author.**
**E-mail address: dr_ramykhalifa@yahoo.com**
**DOI: 10.21608/jssae.2022.178978.1117**

limitation of water resources, high prices of mineral fertilizers and fatal environmental pollution a big problem faces the Egyptian Agriculture. This problem can be solved by using biofertilizers instead of mineral ones, which is both economically profitable and effective in reducing soil pollution (Abbas *et al*., 2006; Shahdi Komalah, 2010 and Kamil *et al*., 2015). Poultry manure (PM), an organic substance, is recognised as an appropriate organic fertiliser. Most crops have been reported to benefit from using poultry manure for soil fertility maintenance, growth, and yield (Adekiya and Agbede, 2017; Kolawole, 2014 and Ozores-Hampton, 2012)

In light of the foregoing information, the goal of the current study is to identify and assess the ideal irrigation needs as well as potential biofertilizers as partial substitutes for chemical fertilizers for cucumber fruit production cultivated in greenhouse experiments utilizing sandy soil..

## MATERIALS AND METHODS

The research was carried out in a plastic greenhouse of 280 $m^2$ area (40 m length and 7 m width). The orientation of each plastic greenhouse is a North- South direction. The research area is between $31^0$ 07 N latitude and $30^0$ 57 E longitude in Gammsa region, Dakahlyia Governorate, Egypt. According to the techniques and procedures outlined and described by Klute (1986) and Page *et al*., (1982), some soil physical and chemical properties of the experimental site, as well as chemical analysis of the used irrigation water and poultry manure, were carried out. The results are tabulated in Tables (1-3). Depth of groundwater table is 87cm in both seasons. Soil characteristics of the greenhouse are included in Tables (1a and 1b). The tables indicated that the soil texture is sandy; EC (1.94 dS/m), pH ranged from 7.91 to 8.06 and the dominant cation is $Na^+$, while $Cl^{-1}$ is dominant anion.

Each plastic greenhouse consists of 4 rows. Soil preparation included turn plowing to a depth of about 0.3m and bedding rows 1.25 m apart, prior to the installation of the drip irrigation lines for each row. Additionally, the fertilization is prepared as following: a mixture of 0.5 $m^3$ poultry manure, which uniformly incorporated with 2 kg mineral sulphur, 6 kg urea (46% N) and 40 kg calcium superphosphate (15.5% $P_2O_5$). The mixture was divided to 4 equal parts; each part was applied into a soil depth of 30 cm for each row two weeks as basic fertilizers. The soil was lightly irrigated to establish a good microbial activity for decomposing the poultry manure in suitable time, before the cucumber transplanting.

Seeds of cucumber *(cultivar Mohanad $F_1$)* were divided into three parts. The 1st part was sown one seed in 84 cells, foam tray in each small pod filled with peatmoss. While both of the 2nd and 3rd parts of seeds, inoculated with 50% of mixture of biofertale (BioI) + rhizobactrien (Bio II) and 100% of mixture of BioI+ Bio II, respectively, were also sown one seed in each small pod filled with peatmoss. The used inoculating bactria, biofertale (*Bacillus megatherium var. phosphaticum*) as a phosphate dissolving bacteria presses the ability to bring a soluble phosphate in soluble form excreting organic acids which lower the pH and bring about the dissolution of bonds forms of phosphate and render then available for growing plants, and rhizobactrien (*Azotobacter Chroocum and Azospirillum braensesil*) registered to Biofertilizer unit, Ministry of Agric. Egypt, from which it was obtained. Each bio-fertilizer was applied at rate of 400 g $fed^{-1}$. Date of sowing in the nursery was on Nov. 22th 2016 and 25 th,Nov., 2017. On December 16th, 2016, and December 20th, 2017, cucumber plants from the nursery unit that were at the 3–4 leaf stage were transplanted into the experimental plots (plastic greenhouses) with 1.25 m between the rows and 0.5 m between the plants in each row. Harvesting started from 9th Feb., till 21th may 2017 (102 days) in the 1st season and from 12th Feb. till 26th May 2018 (103 days) in the 2nd season.

**Table 1. Some soil physical and chemical characteristics of experimental site before cultivation (mean of the two seasons)**

**1a- Soil physical properties**

| Soil depth, | Particle size distribution % | | | Textural class | Bulk density, | Total porosity % | *Soil moisture constants, % | | |
|---|---|---|---|---|---|---|---|---|---|
| cm | Sand | Silt | Clay | | $Mg\ m^{-3}$ | | FC | PWP | Aw |
| 0-20 | 91.36 | 3.72 | 4.92 | Sandy | 1.662 | 37.28 | 10.88 | 5.22 | 5.66 |
| 20-40 | 93.72 | 2.27 | 4.01 | Sandy | 1.691 | 36.19 | 10.55 | 5.06 | 5.49 |
| 40-60 | 93.17 | 3.01 | 3.82 | Sandy | 1.683 | 36.49 | 10.72 | 5.14 | 5.58 |
| Mean | 92.75 | 3.0 | 4.25 | sandy | 1.679 | 36.65 | 10.72 | 5.14 | 5.58 |

**FC: Field Capacity, PWP= permanent wilting point, AW= available water, *It was determined as gravimetric method**

**1b- Soil chemical properties**

| Soil depth, | *pH | EC** | SAR | Soluble cations (meq /l) | | | | Soluble anions (meq/l) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| cm | (1:2.5) | $dS\ m^{-1}$ | | $Na^{+1}$ | $K^{+1}$ | $Ca^{+2}$ | $Mg^{+2}$ | $CO_3^{-2}$ | $HCO_3^{-1}$ | $Cl^{-1}$ | $SO_4^{-2}$ |
| 0-20 | 7.91 | 1.80 | 3.7 | 7.74 | 0.52 | 4.23 | 4.51 | - | 6.05 | 8.63 | 2.32 |
| 20-40 | 8.01 | 2.06 | 3.81 | 8.93 | 0.71 | 4.26 | 6.70 | - | 6.11 | 9.92 | 4.57 |
| 40-60 | 8.06 | 1.97 | 4.63 | 9.18 | 0.64 | 4.10 | 5.76 | - | 6.06 | 9.84 | 3.78 |
| Mean | | 1.94 | 4.05 | 8.62 | 0.62 | 4.20 | 5.66 | - | 6.07 | 9.46 | 3.56 |

***it was determined in soil water suspension, ** it was determined in soil paste extract .**

**Table 2. Chemical analysis of the used irrigation water**

| pH | EC | SAR | Soluble cations (meq /l) | | | | Soluble anions (meq /l) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $dS\ m^{-1}$ | | $Na^{+1}$ | $K^{+1}$ | $Ca^{+2}$ | $Mg^{+2}$ | $CO_3^{-2}$ | $HCO_3^{-1}$ | $Cl^{-1}$ | $SO_4^{-2}$ |
| 7.66 | 1.75 | 3.93 | 10.17 | 0.42 | 6.09 | 7.31 | -- | 5.01 | 11.52 | 7.47 |

**Table 3. Chemical characteristics of the used poultry manure**

| pH | EC, $ds\ m^{-1}$ | O.M. | N | P | K | C | C:N | Moisture,% | Density, |
|---|---|---|---|---|---|---|---|---|---|
| 1:10 | 1:10 | $g\ kg^{-1}$ | | | | | | | $Mg\ m^{-3}$ |
| 6.94 | 0.96 | 322 | 15 | 4.8 | 5.9 | 188 | 12.53:1 | 14.2 | 0.45 |

**Three replicates were used in a split-plot design for the study's experimental design. Using a drip irrigation method, three levels of irrigation water application (IWA) were set as a percentage of the soil field capacity (FC) (main plots) as follows:**

$I_1$= Irrigation water applied at the level of 100% of soil field capacity (100% of FC) through drip irrigation system, as control

$I_2$= Irrigation water applied at the level of 80% of soil field capacity (80% of FC) through drip irrigation system

$I_3$= Irrigation water applied at the level of 65% of soil field capacity (65% of FC) through drip irrigation system,

A drip irrigation system comprised of laterals (16mm) connected to a manifold was used to apply irrigation water (63mm). The laterals are 1.25 m apart and equipped with 4L h-1 discharge in-line emitters (GR).

**Three fertilization treatments were allocated in the subplots of the experiment as follows:**

$F_1$= Applying the recommended dose of NPK (100%RNPK, control)

$F_2$= Applying 75% RNPK+50% of mixture of biofertale+ rhizobacterien

$F_3$= Applying 55% RNPK+ 100% of mixture of biofertale+ rhizobacterien

In both seasons, the recommended dose of mineral fertilizers applied to cucumber plants was 60 kg N fed-1, 19.67 kg P fed-1, and 41.5 kg K fed-1 for N, P, and K, respectively. During the growing period, nitrogen fertilizer in the form of ammonium nitrate (33.5%N), phosphorus fertilizer in the form of phosphoric acid (85% P), and potassium fertilizer in the form of potassium sulphate (50% K2O) were applied via drip irrigation using the fertigation technique..

From planting to the end of the crop, cucumber plants were fertigated once every two days with chemical fertilizers at the levels specified in the fertilization treatments. Also, calcium nitrate (26% Ca-oxide&20.6%N) as source of calcium element and Magnisum sulphate (16% Mg) were added to cucumber plants through a drip emitter once weekly and foliar spraying with micro-chelated mineral once in 10 days for all fertilization treatments. The micro-chelated minerals were multi elements ( Fe, 11.1%, Mn, 11.5% , Zn, 10.8% , Cu, 10.8% and B, 10.3%)

Each irrigation treatment consists of 3- plastic greenhouse, each greenhouse represents fertilization treatment of the aforementioned fertilization treatments (4 rows in each greenhouse ×80 plant).

Irrigation treatments began one week after complete germination. Cultural, disease, and pest management practices were identical to those used in local commercial crop production. The amount of IWA applied to each greenhouse during the irrigation regime was calculated using the equation below.

$$IWA = \frac{A \times (\Theta FC - \Theta) \times Di \times \rho a \times Kr}{Ea \times 100}$$

**Where,**

**A= irrigated area for treatment, m$^2$**

**$\Theta_{FC}$= 100% of FC, 80% of FC and 65% of FC for $I_1$, $I_2$ and $I_3$, respectively**

**$\Theta$= soil moisture before irrigation, % (gravimetric)**

**$\rho a$= soil bulk density, Mg m$^{-3}$**

**Kr= is the covering factor, and the Decroix and Ctgref method was used to calculate (kr) (Vermeirem and Jobling, 1980), Kr= (0.1+Gc)> 1, where Gc is the ground cover, which ranged from 0.33 to 0.66.**

**IWA= the irrigation water applied (m$^3$)**

**Ea= the application efficiency, % (Ea=85)**

**$D_i$= the irrigated soil depth (0.6 m)**

Ismail (2002) provided the following equation for calculating irrigation time: T= IWA A/q, where T is irrigation time (hr), A is the wetted area by an emitter (m2), q is the emitter discharge (4 L hr-1), and IWA is the irrigation water applied as a depth in the irrigation event (m).

Commercial growers removed deformed fruits from the plant during pruning operations, and marketable immature fruits were harvested in 2-3 days and weighted. The number of fruits per plant, fruit weight per plant (g), and fruit yield kg fed-1 were also counted and recorded. Irrigation water productivity (PIW) was calculated using the following equation:

**PIW= Y/IWA**,

**where Y = weight of marketable crop produce (kg fed-1) and IWA = irrigation water applied (m3fed-1.)**

According to Gomez and Gomez, the obtained data were statistically analysed, and treatment means were compared using the Duncan's multiple range test at 0.05 and 0.01 probability levels (1984). SAS computer software was used for all statistical analysis.

**Economic evaluation**

From field preparation through harvest, costs were calculated and expressed in Egyptian Pounds (L.E fed-1). The yield of cucumber fruit was calculated per fed., and the total revenue was calculated using the market rate of 5.2 and 5.3 L.E kg$^{-1}$ of cucumber fruit as an average for the first and second seasons, respectively. The cost of cultivation was subtracted from the gross return to determine the net return. Based on current market pricing, the cost of a plastic greenhouse and drip irrigation system for one feddan was calculated.

**Using Palaniappan's (1985) formula, an economic evaluation was calculated, such as:**

Economic efficiency= net return (L.E fed$^{-1}$)/ total cost of cultivation (L.E fed$^{-1}$). Net return from water unit (L.E m$^{-3}$) = net return (L.E fed$^{-1}$)/ water applied (m$^3$ fed$^{-1}$)

## RESULTS AND DISCUSSION

**Fruit yield and components of the cucumber**

Data of Table (4) and Figures (1-4) show that cucumber yield and its attributes were affected significantly by both irrigation regimes, and Bio-chemical fertilizers application and their interaction in both growing seasons. The findings showed that irrigation levels in both seasons had a substantial impact on fruit yield, fruit weight, and fruit number. Irrigation level of $I_2$ produced the highest values of fruit yield (40386.5 and 40684.4 kg fed$^{-1}$), fruit weight (10.52 and 10.64 kg plant$^{-1}$) and fruit number. plant$^{-1}$ (130.2 and 133.42) in both growing seasons, respectively. On the other hand, the lowest values of the aforementioned parameters were achieved by irrigation level of ($I_1$) in both seasons. The reported results in the present study for the highest cucumber fruit yields are close to those reported by (Grewal *et al*, 2011 ; Al-Omran *et al*, 2013, Sahin *et al*.,2015 and wang *et al*., 2019).

The irrigation level of $I_2$ led to an increase of fruit number plant$^{-1}$ by 4.83 and 7.45%, in comparison with $I_1$ for the 1$^{st}$ and 2$^{nd}$ seasons, respectively. The corresponding fruit weights plant$^{-1}$ were 21.90 and 22.29% and fruit yield fed$^{-1}$ were 21.87 and 22.29%. These results were in agreement with those obtained by (Mao *et al*.,2003; Shao *et al*., 2010; Abdul

Hakem and Jisha Chand, 2014 and Cakir *et al*., 2017). They reported that deficit irrigation for cucumber under greenhouse condition increased fruit yield and productivity of irrigation water. Increasing cucumber fruit yield under $I_2$ treatment may be due to improving the rate of aeration which increase decomposition of soil organic matter and hence increasing availability of nutrients, therefore, forming healthy plants with good vegetative growth (Moursi *et al*, 2009, Khalifa *et al*., 2013 and Khalifa, 2020)

In regards to Bio-chemical fertilization, the results shown in Table (4) indicated that fruit number, fruit weight and fruit yield were highly significant affected by Bio-chemical fertilizers application in both growing seasons. The highest mean values of fruit number plant$^{-1}$ were 128.7 and 131.17; fruit weight were 9.73 and 9.98 kg plant$^{-1}$ and fruit yield were 37348.36 and 38317.16 kg fed$^{-1}$ for application fertilizer level ($F_3$) in both growing seasons, respectively. Meanwhile, the lowest values of the aforementioned parameters were detected with $F_1$, in both seasons. According to the highest cucumber yield and its components, the most efficient treatment was $F_3$ which led to saving about 45% of mineral fertilizers in both seasons. It might due to the combination of bio-fertilizers with suitable rate of mineral fertilizers could help plant growth and has been able to supply the plant with nitrogen, one of the most important nutrients for plant growth (Khan *et al*., 2009, Yaghi *et al*., 2013 and Soltan *et al*., 2018). Also, the most significant plant growth-promoting rhizobacteria include the bacterial species Azotobacter, Azospirillum, and Pesudomonas, which have an impact on crop growth, development, and yield. (Zahir *et al*., 2004 and Banerjee *et al*., 2006), By increasing the supply or availability of primary nutrients to the host plant through natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances (auxins, cytokinins, or gibberellins), promotes plant growth when applied to seed or soil and increases plant yield ( Awad *et al*., 2005; Gholami *et al*., 2009; Marulanda *et al*.,2010, Shahdi Komalah, 2010 and Soltan *et al*., 2018).

In comparison with yield and its components of $F_1$-Treatment, $F_3$-treatment gave an increase of fruit number by 3.93 and 6.06%, fruit weight by 10.82 and13.15% and fruit yield fed$^{-1}$ by 10.78 and 13.18%in the 1st and 2nd seasons, respectively.

Also, data showed that the interaction between irrigation regimes and fertilization had significant differences in both growing seasons, but the fruit number plant$^{-1}$ did not differ significantly. The combination between $I_2$-Treatment (80% FC) and $F_2$(1st season) or $F_3$ (2nd season) gave the highest yield and growth traits of cucumber. These results are in a harmony with those obtained by Mahfouz and Sharaf-Eldin, (2007); Omran *et al*., 2009 and Kamil *et al*., (2015), they reported that biological fertilizers have a special importance as appropriate replacement for mineral fertilizer through improving of soil fertility providing nutrition requirement of plant and increasing crop yield. Also, they stated that a combination of biofertilizer and 50% of chemical fertilizers application had significant effect and increased the yield and growth traits of cucumber.

**Table 4. Cucumber fruit yields and its components as affected by irrigation regimes and Bio-chemical fertilizers in the two growing seasons**

| Treatments | 1st season | | | 2nd season | | |
|---|---|---|---|---|---|---|
| | Fruit number plant$^{-1}$ | Fruit weight kg plant$^{-1}$ | Fruit yield kg fed$^{-1}$ | Fruit number plant$^{-1}$ | Fruit weight kg plant$^{-1}$ | Fruit yield kg fed$^{-1}$ |
| Irrigation regime (I) | | | | | | |
| $I_1$ | 124.2$^{C}$ | 8.63$^{b}$ | 33139.12$^{c}$ | 124.17$^{c}$ | 8.70$^{b}$ | 33415.44$^{c}$ |
| $I_2$ | 130.2$^{a}$ | 10.52$^{a}$ | 40386.56$^{a}$ | 133.42$^{a}$ | 10.64$^{a}$ | 40864.40$^{a}$ |
| $I_3$ | 125.2$^{b}$ | 9.00$^{b}$ | 34558$^{b}$ | 126.25$^{b}$ | 9.01$^{b}$ | 34603.92$^{b}$ |
| F-Test | * | * | ** | * | ** | ** |
| Fertilizers applications(F) | | | | | | |
| $F_1$ | 123.83$^{c}$ | 8.78$^{b}$ | 33713.84$^{c}$ | 123.67$^{c}$ | 8.82$^{b}$ | 33856.76$^{c}$ |
| $F_2$ | 127.06$^{b}$ | 9.64$^{a}$ | 37021.48$^{b}$ | 128.92$^{b}$ | 9.56$^{a}$ | 36709.84$^{b}$ |
| $F_3$ | 128.7$^{a}$ | 9.73$^{a}$ | 37348.36$^{a}$ | 131.17$^{a}$ | 9.98$^{a}$ | 38317.16$^{a}$ |
| F-Test | * | ** | ** | * | ** | * |
| Interaction (I×F) | | | | | | |
| $I_1$×$F_1$ | 124.0 | 8.54$^{ab}$ | 32783.28$^{g}$ | 123.50$^{d}$ | 8.65$^{abc}$ | 33204.60$^{g}$ |
| $I_1$× $F_2$ | 122.5 | 8.30$^{ab}$ | 31858.68$^{h}$ | 121.50$^{e}$ | 8.51$^{abc}$ | 33686.92$^{h}$ |
| $I_1$× $F_3$ | 126.1 | 9.06$^{ab}$ | 34775.40$^{f}$ | 127.25$^{c}$ | 8.95$^{abc}$ | 34354.8$^{f}$ |
| $I_2$× $F_1$ | 127.75 | 9.65$^{ab}$ | 37046.4$^{c}$ | 126.25$^{c}$ | 9.57$^{abc}$ | 36736.68$^{d}$ |
| $I_2$× $F_2$ | 132.25 | 11.43$^{a}$ | 43900.8$^{a}$ | 138.00$^{a}$ | 11.19$^{ab}$ | 42956.28$^{a}$ |
| $I_2$× $F_3$ | 130.50 | 10.47$^{ab}$ | 40212.48$^{b}$ | 136.00$^{a}$ | 11.17$^{a}$ | 42900.18$^{a}$ |
| $I_3$× $F_1$ | 119.75 | 8.15$^{b}$ | 31311.84$^{j}$ | 121.25$^{e}$ | 8.24$^{c}$ | 31629.00$^{d}$ |
| $I_3$× $F_2$ | 126.25 | 9.19$^{ab}$ | 35304.96$^{e}$ | 127.25$^{c}$ | 8.98$^{bc}$ | 34486.32$^{e}$ |
| $I_3$× $F_3$ | 129.50 | 9.65$^{ab}$ | 37057.20$^{d}$ | 130.25$^{b}$ | 9.82$^{abc}$ | 37696.44$^{c}$ |
| F-Test | Ns | * | * | * | * | * |

**$I_1$= 100%FC, $I_2$= 80%FC, $I_3$= 65% FC, $F_1$=100%RNPK, $F_2$=75%RNPK+50% mixture of biofertale+ rhizobacterien, $F_3$= 55% RNPK+ 100% biofertale + rhizobacterien**

**NS, insignificant *, **, significant at 0.05 and 0.01 level of probability, respectively. Mean values designed by the same letter in each column are not significant according to Duncan's Multiple Range Test.**

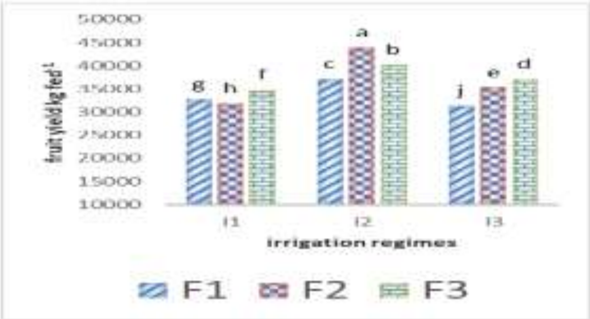


**Fig. 1. Fruit yield of cucumber as influenced by the interaction between irrigation regimes and Bio-chemical fertilizers in the 1st season**

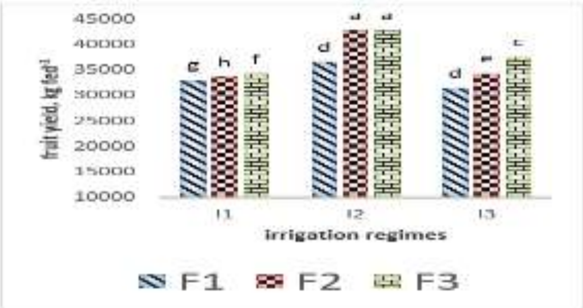


**Fig. 2. Fruit yield of cucumber as influenced by the interaction between irrigation regimes and Biochemical fertilizers in the 2nd season**

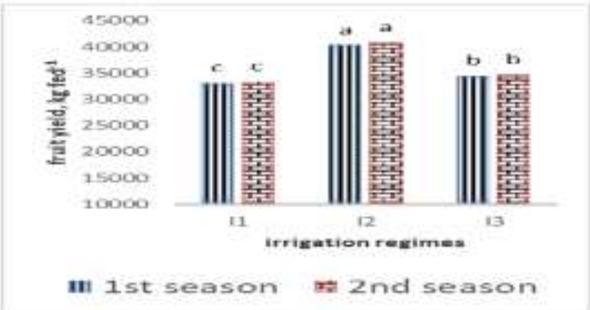


**Fig. 3. Mean of fruit yield of cucumber as influenced by irrigation regimes in the two growing seasons**

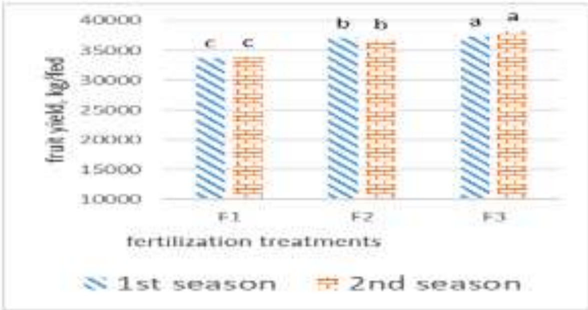


**Fig. 4. Mean fruit yield of cucumber as affected by bio-chemical fertilizers application in the two growing seasons**

**Means that share a single letter do not differ significantly ($P \leq 0.05$)**

**$I_1$= 100%FC, $I_2$= 80%FC, $I_3$= 65% FC, $F_1$=100%RNPK, $F_2$=75%RNPK+50% mixture of biofertale+ rhizobacterien, $F_3$= 55% RNPK+ 100% biofertale + rhizobacterien**

### Amount of water applied and water saving, %.

Table (5) shows the amount of irrigation water applied to cucumber plants at various growth stages during the two growing seasons and under different irrigation treatments. After the first growth stage, during which all experimental plots received an equal amount of irrigation water to guarantee excellent plant establishment, the irrigation treatments were given. Following this, the amounts of irrigation water applied for $I_2$ and $I_3$ were 80% and 65% of $I_1$. As shown in Table (5), the amount of water applied increased with the development stage to reach the peak at mid-season stage and then decreased at late season stage. Data of the same table indicate the average values of applied water to cucumber plants through drip irrigation. These averages were 1008 $m^3$. $fed^{-1}$ (24 cm), 834 $m^3$. $fed^{-1}$ (19.8 cm) and 703.5 $m^3 fed^{-1}$ (16.75 cm) for the irrigation level of $I_1$, $I_2$ and $I_3$, respectively, in the 1st season. The corresponding average values for the 2nd season were 1011.35 $m^3$. $fed^{-1}$ (24.1 cm), 836.78 $m^3$. $fed^{-1}$ (19.92 cm) and 705.85 $m^3$ .$fed^{-1}$ (16.81 cm). These results are in agreement with those obtained by (Wang *et al.*, 2009 and Zhang *et al.*, 2011). In addition, data show that in comparison the amount of applied water for $I_1$ treatment, average water saving were 17.27 and 30.21% for the irrigation amount of water used for $I_2$ and $I_3$ in both seasons, respectively. So, irrigation of water at 80% FC could be enough to give high cucumber yield with low amount of irrigation water. The obtained results in this study fall in line with findings of Kamil *et al.*,( 2015) ; Cakir *et al.*, (2017) and Wang *et al.*, (2022).

**Table 5. Seasonal amount of applied water to cucumber crop under plastic greenhouse according to its growth stages in the two growing seasons**

| Cucumber growth stages | Period days | 1st season applied water, $m^3$ $fed^{-1}$ | | | 2nd season applied water, $m^3$ $fed^{-1}$ | | |
|---|---|---|---|---|---|---|---|
| | | $I_1$ | $I_2$ | $I_3$ | $I_1$ | $I_2$ | $I_3$ |
| Initial stage | 20 | 138 | 138 | 138 | 138.5 | 138.5 | 138.5 |
| Development | 25 | 240 | 192 | 156 | 241.65 | 193.32 | 157.07 |
| Midseason | 60 | 504 | 403.2 | 327.6 | 504.75 | 403.8 | 328.09 |
| Late season | 15 | 126 | 100.8 | 81.9 | 126.45 | 101.16 | 82.19 |
| Seasonal applied water ($m^3$/fed.) | | 1008 | 834 | 703.5 | 1011.35 | 836.78 | 705.85 |
| Water saving, % over $I_1$ | | - | 17.26 | 30.21 | - | 17.26 | 30.21 |

**$I_1$=100%FC, $I_2$=80%FC, $I_3$=65%FC**

### Productivity of irrigation water (PIW)

Productivity of irrigation water (PIW) is an indicator to the yield of applied water unit. PIW values determined for irrigation and fertilization treatments during the two seasons of the study are illustrated in figures (5 and 6). In general, PIW values increased in both seasons as seasonal water use decreased and cucumber yields increased. When the treatments were compared, the highest average values of PIW were 49.13 and 51.39 kg fruit m-3 for the (I3) level in both seasons, indicating a comparatively more efficient use of irrigation water. Meanwhile, the lowest average values of PIW (32.88 and 33.37 kg fruit $m^{-3}$) were recorded under ($I_1$) level in both seasons, respectively. The reported results in the present study for the highest PIW for cucumber plants are close to those reported by Rahil and Qanadillo (2015); Cakir *et al* (2017) and Wang *et al*., (2019). These findings may be attributed to the differences among fruit cucumber yield, as well as, differences between applied water values. Therefore, the irrigation using the $I_3$, saved of 30.21% over $I_1$ . These results agreed with those obtained by Shao *et al.*, (2010), Abdul Hakim and Jisha Chand (2014), Buttaro *et al.*, (2015), Rahil and Qanadillo (2015) and Wu *et al.*, (2021). They stated that the quantity of water applied to cucumber under deficit irrigation conditions through drip irrigation system gave higher values of irrigation water use efficiency.

Concerning the fertilization treatments, data in Fig. (6) show that $F_3$-treatment produced the highest values of PIW (45.10 and 46.22 kg fruit $m^{-3}$) in both seasons, respectively, followed by $F_2$-Treatment. This trend may be attributed to increasing the cucumber fruit yield in both seasons. On the other hand, the lowest values of PIW (40.45 and 42.87 kg $m^{-3}$) were recorded with $F_1$ in both seasons.

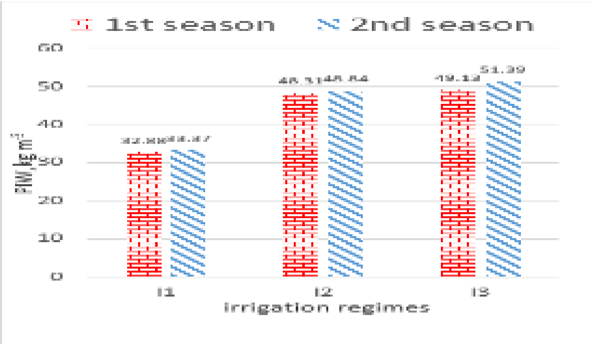


**Fig. 5. Productivity of irrigation water (PIW) as influenced by irrigation regimes in the two growing seasons**

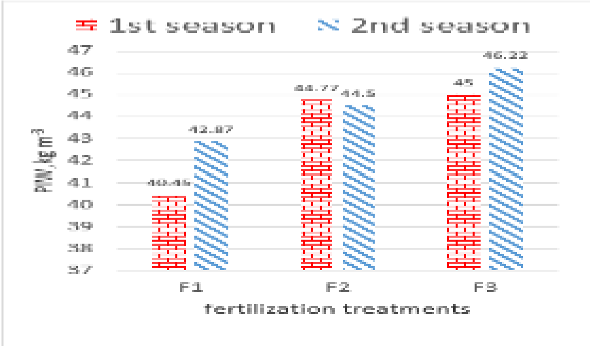


**Fig. 6. Productivity of irrigation water (PIW) as influenced by fertilization treatments in the two growing seasons**

**$I_1$= 100%FC, $I_2$= 80%FC, $I_3$= 65% FC, $F_1$=100%RNPK, $F_2$=75%RNPK+50% mixture of biofertale+ rhizobacterien, $F_3$= 55% RNPK+ 100% biofertale + rhizobacterien**

## Economic evaluation

Economic assessment requires some items through which the evaluation process can be conducted. Table (6) show the production cost values for the various involved components in the evaluation process according to Egyptian local market price (L.E). The total return, net return, net return from water unit and economic efficiency for irrigation and fertilization treatments for cucumber yield under drip irrigation system inside greenhouse of both seasons are tabulated in Table (7).

**Table 6. Values of production cost components for cucumber per feddan for different treatments (L.E $fed^{-1}$) under plastic greenhouse during the two growing seasons**

| Cost items | Cost values for various agronomic operations L.E $fed^{-1}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $I_1$ | | | $I_2$ | | | $I_3$ | | |
| | $F_1$ | $F_2$ | $F_3$ | $F_1$ | $F_2$ | $F_3$ | $F_1$ | $F_2$ | $F_3$ |
| 1-Drip irrig. Net | 5300 | 5300 | 5300 | 5300 | 5300 | 5300 | 5300 | 5300 | 5300 |
| 2- White plastic | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| 3- Iron wires for greenhouse | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| 4-Mulch (Black plastic) | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| 5- seedlings | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |
| 6-superphosphate 15.5%$P_2O_5$ | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| 7-Poultry manure (6 $m^3$ $fed^{-1}$) | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 |
| 8-Urea (46%) | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 9-Sulphur mineral | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 |
| 10-N-ammonium Nitrate (33.5% N) | 1800 | 1350 | 990 | 1800 | 1350 | 990 | 1800 | 1350 | 990 |
| 11-K- as potassium sulphate (48%K) | 4800 | 3600 | 2640 | 4800 | 3600 | 2640 | 4800 | 3600 | 2640 |
| 12-P-as phosphoric acid (85%P) | 2400 | 1800 | 1320 | 2400 | 1800 | 1320 | 2400 | 1800 | 1320 |
| 13- Magnesium sulphate | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |
| 14- Calcium Nitrate(24kg) | 1344 | 1344 | 1344 | 1344 | 1344 | 1344 | 1344 | 1344 | 1344 |
| 15-Biofertilizer | - | 15 | 30 | - | 15 | 30 | - | 15 | 30 |
| 16-Land rent | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 | 5000 |
| 17- Fungi, pestsides and trace element | 3112 | 3112 | 3112 | 3112 | 3112 | 3112 | 3112 | 3112 | 3112 |
| | Machinery cost, L.E | | | | | | | | |
| Plowing | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 230 |
| Corrugations for fertilizers | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |
| Irrigation | 600 | 600 | 600 | 550 | 550 | 550 | 500 | 500 | 500 |
| | Wages, L.E | | | | | | | | |
| Transplanting | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |
| Fertilizer broadcast | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 |
| Irrigation | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 |
| Harvesting | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| Transporting | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| Spraying fungi, pestsides and trace elem. | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| Total cost (1st season) | 50636 | 48401 | 46616 | 50586 | 48351 | 46566 | 50536 | 48301 | 46516 |
| Total cost (2nd season) | 49212 | 47240 | 45522 | 49162 | 47190 | 45472 | 49112 | 47140 | 45422 |

**$I_1$= 100% of FC, $I_2$= 80% of FC, $I_3$= 65% of FC, $F_1$=100% RNPK, $F_2$=75%RNPK+50% of mixture of biofertale+ rhizobacterien, $F_3$= 55% RNPK+ 100% of mixture of biofertale + rhizobacterien**

***items 6, 7, 8 and 9 were mixed and added to the soil depth of 30cm before installation drip irrigation net above the rows**

***items 10, 11, 12, 13 and 14 were added through drip irrigation Net system.**

It seen from the results of both seasons, that the combination of $I_2$ and $F_2$ treatments (1st season) achieved the highest values of net return (179933.2 L.E $fed^{-1}$), net return from water unit (215.23 L.E $m^{-3}$) and economic efficiency (3.72). Meanwhile, in the 2nd season, the corresponding values were 181899.59 L.E $fed^{-1}$., 217.40 L.E $m^{-3}$ and 4.0 were resulted from the combination of $I_2$ and $F_3$ treatments, respectively. It is also seen in the first and second seasons from Table (7) that the lowest values of net return, net return from water unit and economic efficiency were obtained under the combination of $I_1$ and $F_1$ treatments in both seasons. The obtained results are consistent with the findings of Kamil *et al*., (2015) and Cakir *et al*., (2017)

**Table 7. Economics of cucumber as affected by irrigation and fertilization treatments in the two growing seasons**

| Treatments Irrigation regime (I) | fertilization (F) | Total return L.E $fed^{-1}$ | *Total cost L.E $fed^{-1}$ | Net return L.E $fed^{-1}$ | Water applied m3$fed^{-1}$ | Net income from water unit L.E $m^{-3}$ | Economic efficiency |
|---|---|---|---|---|---|---|---|
| 1st season | | | | | | | |
| | $F_1$ | 170473.0 | 50636 | 119837 | 1008 | 110.14 | 2.37 |
| $I_1$ | $F_2$ | 165665.1 | 48401 | 117264 | 1008 | 116.33 | 2.42 |
| | $F_3$ | 180832.1 | 46616 | 134216 | 1008 | 133.15 | 2.88 |
| | $F_1$ | 192641.3 | 50586 | 142055.3 | 836 | 169.92 | 2.81 |
| $I_2$ | $F_2$ | 228284.2 | 48351 | 179933.2 | 836 | 215.23 | 3.72 |
| | $F_3$ | 209104.9 | 46566 | 162538.9 | 836 | 194.42 | 3.50 |
| | $F_1$ | 162281.6 | 50536 | 111745.6 | 703.5 | 158.84 | 2.21 |
| $I_3$ | $F_2$ | 183585.8 | 48301 | 135284.8 | 703.5 | 192.30 | 2.80 |
| | $F_3$ | 192697.4 | 46516 | 146181.4 | 703.5 | 207.80 | 3.14 |
| 2nd season | | | | | | | |
| | $F_1$ | 175984.4 | 49212 | 126772.4 | 1011.35 | 125.35 | 2.57 |
| $I_1$ | $F_2$ | 178540.6 | 47240 | 131300.6 | 1011.35 | 129.82 | 2.78 |
| | $F_3$ | 182080.4 | 45522 | 136558.4 | 1011.35 | 135.03 | 2.99 |
| | $F_1$ | 194704.4 | 49162 | 145542.4 | 836.74 | 173.94 | 2.96 |
| $I_2$ | $F_2$ | 227668.2 | 47190 | 180478.2 | 836.74 | 215.69 | 3.82 |
| | $F_3$ | 227371 | 45472 | 181899 | 836.74 | 217.40 | 4.00 |
| | $F_1$ | 167633.2 | 49112 | 118521.2 | 705.82 | 167.92 | 2.41 |
| $I_3$ | $F_2$ | 182777.5 | 47140 | 135637.5 | 705.82 | 192.17 | 2.88 |
| | $F_3$ | 196158.8 | 45422 | 150736.8 | 705.82 | 213.56 | 3.31 |

**$I_1$= 100% of FC, $I_2$= 80% of FC, $I_3$= 65% of FC, $F_1$=100% RNPK, $F_2$=75%RNPK+50% of mixture of biofertale+ rhizobacterien, $F_3$= 55% RNPK+ 100% of mixture of biofertale + rhizobacterien**

***Includes the costs of all agricultural operations (fixed and variables) as follows: installation greenhouse, drip irrigation system, organo-mineral fertilizers added to soil, bio-mineral fertilizers application, labor wages for (irrigation, harvesting, fungi and bestsides control and transplanting) and land rent.**

**Net income from water unit= Net income L.E $fed.^{-1}$/ water applied $m^3$ $fed^{-1}$ , economic efficiency= net income L.E $fed.^{-1}$/ total coast (L-E/fed)**

## CONCLUSION

According to the results of this study, using biofertilizers as partial replacement of mineral fertilizers had significantly increased fruit yield and yield constituents of cucumber. Also, irrigating cucumber plants at 80% of FC using the drip irrigation system gave the highest fruit yield and its components. Besides that, the combination of $I_2$ and $F_2$ or $F_3$ gave the highest values of net return, net return from water unit and economic efficiency. So, the combination of $F_3$-treatment (applying 55% RNPK+ 100% of mixture of biofertale+ rhizobacterien) and $I_2$-treatment (irrigating cucumber plants with 80% of FC) are the most efficient treatment for cucumber grown on sandy soil under plastic greenhouse for maximizing cucumber fruit yield while conserving both water and mineral fertilizers.

## REFERENCES


Abbas, H. H., Noufal, E. H. A., Farid, I. M. and Ali, I. M. E. (2006). Organic manuring and Biofertilization Approaches as potential economic and safe substitutes for mineral Nitrogenous fertilization. Egypt. J. Soil. Sci.,46(2):219-235

Abdul Hakim, V.M. and JishaChand, A. R. (2014). Effect of drip irrigation levels on yield of salad cucumber under Naturally ventilated polyhouse. IOSR Journal of Engineering. Vol. 04, PP:18-21

Adekiya, A. O. and Agbede, T. M., (2017). Effect of methods and Time of poultry manure application on soil and leaf nutrient concentrations, growth and fruit yield of Tomato (*Lycopersicon esculentum Mill*). J. of the Saudi Society of Agric. Sciences, 16: 383-388.

Alam, K. (2015). Farmers, adaptation to water scarcity in drought- prone environments. A case study of Rajshahi District, Bangladesh. Agric. Water Manage. 148,196-206.

Al-Omran, A. M., Louki, I. I., Aly, A. A., Nadeem, M. E. (2013). Impact of deficit irrigation on soil salinity and cucumber yield under greenhouse condition in an arid environment. J. Agric. Sci. Technol. 15,1247-1259.

Attia, A., EL-Hendawy, S., AL-Suhaibani, N., Tahir, M.U., Mubushar, M., Dos Santos Vianna, M. (2021). Sensitivity of the DSSAT model in simulating maize yield and soil carbon dynamics in arid Mediterranean climate: effect of soil, genotype and crop management. Filed crops Res.260,107981

Awad, N. M., Turky, A. Sh. and Mazhar, A. A. M. (2005). Effect of Bio-and chemical Nitrogenous fertilizers on yield of Anise priminella anisum and biological activities of soil irrigated with agricultural drainage water. Egypt J. Soil Sci., 45(3):265-278

Ayoola, O. T. and Makinde, EA. (2007). Complementary organic and inorganic fertilizer application. Influence on growth and yield of Cassava, Maize, Melon intercrop with a relayed cowpea. AUS. J. Bas APPL. Sci;1(3).

Buttaro, D., Santamaria, P.; Signore, A., Cantore, A., V., Boari, F., Montesano, F. and Parente., A. (2015). Irrigation management of greenhouse tomato and cucumber using tenshiometer effects on yield, quality and water use. Agric. Sci. ProCEDIA, 4:440-444.

Cakir, R.; Kanburoglu-Cebi, U.; Altintas, S. and OZdemir, A. (2017). Irrigation Scheduling and water use efficiency of cucumber grown as a spring summer cycle crop in solar greenhouse- Agricultural water management, 180,78-87.

Cosic, M., Dijurovic, N.; Todorovic, M., Maletic, R.; Zecevic, B.; and Stricevic, R. (2015). Effect of irrigation regime and application Koelin on yield, Quality and water use efficiency of Sweet Pepper. Agric. Water Manag., 159, 139-147.

Du, T.S.; Kang, S.Z.; Zhang, J.H. and Davies, W. J. (2014). Deficit irrigation and sustainable water resources strategies in agriculture for china's food security. J. Fxp.Bio,66(8), 2253-2269.

Dunage, V.S., Balakrishnan, B. and Patil, M.G. (2009). Water use efficiency and economic of tomato using drip irrigation under net house conditions. Kanataka J. Agric.Sci. 22(1),133-136.

FAO, 2012. FAO statistical year book; Agriculture Production. Available from:http :// www .fao .org/economic/ess/esspublications/ess-year-book/ess-yearbook 2012/en/(accessed 06.01.15)

Gholami, A., Shahsavani, S. and Nezarat, S. (2009). The effect of Plant Growth Promoting Rhizobacteria (PGPR) on germination, seedling growth and yield of maize. World Acad. Sci. Eng. Technol., 49:19-24.

Gomez, K.A. and Gomez, A.A.(1984). "Statistical procedures for agricultural research",2nd ed. John Wiley and Sons, New York.

Grewal, H.S., Maheshwari, B., and Parks, S. E. (2011). Water and nutrient use efficiency of a low-cost hydroponic greenhouse for cucumber crop: an Australian case study. Agric. Water manage.98, 841-846.

Hui, Y.; DU, T.; Qiu, R.; Chen, J.; Wang, F.; Li, Y., Wang C., Gao, L. and Kang, S. Z. (2017). Improved water use efficiency and fruit quality of greenhouse crops under regulated deficit irrigation in Northwest China. Agricultural water management, 179:1936-204.

Hu, J., Gettel, G., Fan, Z., LV, H. and Lin, S. (2021). Drip fertigation promotes water and Nitrogen use efficiency and yield stability through improved root length for Tomatoes in plastic greenhouse production. J. Agric. Ecosystem Environ.313,107379.

Ismail, S. M. (2002). Design and Management of field irrigation system 1st Ed., Monshaet EL-Maaref, Alexandria, Egypt, PP 367.

Ismail, S.M. (2010). Influence of deficit irrigation on water use efficiency and bird pepper production (Capsicum annuum L.) met. ENV. Arid and Agric. Sci.21 (2).29-43.

Kamil, S. S.; Sarkawt, A. A.; Ismael, A. H. and Pshtiwan, H. A. (2015). Effect of Bio-fertilizer and chemical fertilizer on growth and yield of cucumber (*Cucumis Sativus*) in greenhouse condition. Pakistan Journal of Biological Sciences, 18(3):129-134.

Karlberg, L.; Rockstrom, J.; Annandale. J. G. and Steyn, J. M., (2007). Low cost drip irrigation – a suitable technology for southern Africa: An example with tomatoes using saline irrigation water. Agric. Water Manag.89 (1):59-70.

Khalifa, M. R.; Soltan, I. M. and EL-Henawy, A. S. (2013). Effect of irrigation regimes and Biofertilizers on yield and some water relations of soybean plant. J. Soil Sci. and Agric. Eng. Mansoura Univ., 4 (6) :553-561.

Khalifa, R. M. (2020). Effect of different irrigation water levels and Bio-minerals fertilization on fruit yield, quality and water productivity of watermelon grown in sand soil, Egypt. J. Soil. Sci. Vol. 60, No.3, pp.231-246.

Khan, A. A., Jilani, G., Akhtar, M. S., Naqvi, S. S. and Rasheed, M. (2009). Phosphorus solubilizing bacteria: Occurrence, mechanisms and their role in crop production. J. Agaric. Biol. Sci., :48-58.

Klute, A. (1986). Methods of soil analysis (part 1) American society of Agronomy, Madison, Wisconsin, USA.

Kolawole, G. D. (2014). Effect of time of poultry manure application on performance of maize in Ogbomoso, Oyo State, Nigeria. J. Appl. Agric. 6(1):253-258.

Mahfouz, S. A. and Sharaf- ELdin, M. A. (2007). Effect of mineral vs. biofertilizer on growth, yield and essential oil content of fennel (*Foeniculum Vulgare mill.)* Int. Agrophys., 21: 361-366.

Manocherhr S. J.; Raei, Y. G.; Gasemi-Golezani, K. and Garzad N. A. (2013). Soybean response to biological and chemical fertilizers. Inter. L. Agric. and crop Sciences, 5(3):261-266.

Mao, X., Liu M., Wang, Xi, Liu, C. and Houshi, J. Z. (2003). Effects of deficit irrigation on yield and water use of greenhouse grown cucumber in the North China Plain. Agric. water Manage. 16, 219-228.

Maqsood, A., Abdul Hamid B. and Akbar, Z. (2004). Growth and yield performance of six cucumbers (*Cucumis Sativus L.*) cultivars under agro-climatic conditions of Rawalakot, Azad Jamanu and Kashmir. International J. of Agriculture &Biology, 6(2), 396-399.

Marulanda, A.; Azcon, R.; Chaumont, F.; Ruiz-Lozano, J. M. and Aroca, R.(2010). Regulation of plasma membrane aquaporins by inoculation with a Bacillus megatherium strains in maize (*Zea mays L.*) plants under unstressed and salt-stressed conditions. Planta, 232: 533-543.

Mishra, A.; Prasad, K. and Rai, G. (2010). Effect of Bio-fertilizers inoculations on growth and yield of dwarf field pea (*Pisumum sativum L.*) in conjunction with different doses of chemical fertilizers. J. Agron.9:163-168.

Morsy, Eb. M., Abd EL-Kader, A. A. and EL-Dwiny, C. Y. (2008). Growth, yield and nutritional status of Egyptian Lupine in sandy soil in relation to Bio- and Non-conventional potassium fertilization. Egypt. J. Soil Sci.,48(4):447-455

Moursi, E. A., Mehassen, M. A., and Kassab, M. M. (2009). Optimum water requirement of soybean in the clay soil under Rhizobial inoculation and urea fertilization. J. Agric. Res. Kafr El-Sheikh Univ., 33(1) 328-344.

Omran, S. E. H., Mohamed, E. A. I. and EL-Guibali, A. H. (2009). Influence of organic and Bio-fertilization on productivity, viability and chemical components of Flax seeds. Egypt J. Soil Sci., 49 (1):49-64.

Ozores-Hampton, M. (2012). Developing a vegetable fertility program using organic amendments and inorganic fertilizers. Hort. Tech-zz(6):742-750.

Page, A.I.; Miller, R.H., Keeny, D.R. (1982). Methods of soil Analysis. Part II. Chemical and Microbiological Methods,2nd ed. American Society of Agronomy, Madison, WI, USA, PP.225-246.

Palaniappan, S.P. (1985). Cropping systems in the tropics Principles and Management. Wiley Eastern Ltd., New Delhi,215.

Poraas El-Din, M. M., Eisa, S. A. I., Shaban, Kh. A. and Sallam, A. M. (2008). Effect of applied organic and biofertilizers on the productivity and grains quality of maize grown in saline soil. Egypt J. Soil Sci., 48 (4):431-509.

Rahil, M. A. and Qanadillo, A. (2015). Effects of different irrigation regimes on yield and water use efficiency of cucumber crop. Agric. Water manage. 148,10-15.

Saeed, K. S.; Ahmed, S. A., Hassan, I. A. and Ahmed, P. H. (2015). Effect of Biofertilizer and chemical fertilizer on growth cucumber (Cucumis Sativus) in Greenhouse condition. Pakistan J. of Biological Sciences, 18 (3):129-134.

Sahin, U., Kuslu, Y. and Kiziloglu, F. M. (2015). Response of cucumber to different irrigation regimes applied through drip-irrigation system. J. Anim. Plant Sci.25(1),198-205.

Shahdi Komalah, A. (2010). The investigation of effects of three promoting biological organic products and plant growth regulator on the qualitative and quantitative yield of rice (*Oriza sativa*). Research Report of special project in years,2008, 2009, Rice Research Institute, Iran

Soltan, I. M., EL-Mantawy, R. F. and Abosen, Tn. M. (2018). Response of soybean cultivars to different systems of phosphorus fertilizers in North Delta Rgion. J. Plant Production, Mansoura Univ. Vol.9(4):339-344.

Shao, Li; XueXu-Zhang; Guo Wen-Shan; Li Xia and Chen Fei(2010). Effects of water supply tension on yield and water use efficiency of greenhouse cucumber. Journal scientiaAgricultura Sinica,2.

Tuzel, Y. and Leonardi, C. (2009). Protected cultivation in Mediterranean region. Trends and needs. Ege Univ., ZirratFak. Derg., 46 (3), 215-223.

Vermeirem, L. and Jobling, G. A. (1980). Localized irrigation: Design, Installation, operation and Evaluation. Irrigation and Drainage Paper No.36, FAO, Roma, Italy.

Wang, Z., Liu, Z., Zhang, Z., Liu, X. (2009). Subsurface drip irrigation scheduling for cucumber (*CucumisSativus L.)* grown in solar greenhouse based on 20 cm standard pan evaporation in North east china. Sci. Hortic.123 (1), 51-57.

Wang, H.; Li, J.; Cheng, M.; Zhang, F.; Wang, X.; Fan, J.; Wu, L.; Fang, D.; ZOU, H. and Xiang, Y.(2019). Optimal drip fertigation management improves yield, quality, water and nitrogen use efficiency of greenhouse cucumber. Scientia Horticultura. 243,357-366.

Wang, H. Xiang, Y. Zhang, F. Tang, Z., Gue, J., Zhang, X. Hou, X., Wang, H. Cheng, M. and Li, Z. (2022). Responses of yield, quality and water -Nitrogen use efficiency of greenhouse sweet pepper to different drip irrigation regimes in Northwest China. Agric. Water manage. 260,107-279

Wu, S.C.; Cao, Z. H..; Li, Z. G., Cheung, K. C. and Wong, N. H. (2005). Effects of biofertilizer containing N-fixer, and solubilizers and AM Fungi on maize growth in A greenhouse Trial. Geoderma, 125:155-166.

Wu, Y., Yan, Sh., Fan, J., Zhang, F., Xiang, Y., Zheng, J. and Guo, J. (2021). Response of growth, fruit yield, quality and productivity of greenhouse Tomato to deficit irrigation. Scientia Horticulturae 275 (2021) 109710.

Xiaobo, P., Fuman, Z. and Lihong, G. (2002). Study on water requirement of cucumber of different cropping in solar greenhouse. J. Chinese Agricultural Science Bukketin,04.

Yaghi, T., Arslan, A. and Naoum, F. (2013). Cucumber water use efficiency under plastic mulch and drip irrigation. Agric. Water Manage.128(13),149-157.

Zahir, A. Z.; Arshed, M. and Franken berger, W. F. (2004). Plant growth promoting rhizobacteria: applications and perspectives in agriculture. Advances in Agronomy, 81: 97-168.

Zhang, H. X., Chi, D-Cai, Wang, Q,. Fang, X.-Yu, (2011). Yield and quality response of cucumber to irrigation and nitrogen fertilization under subsurface drip irrigation in solar greenhouse. Agric. Sci China, 10(6),921-930.


# استجابة الخيارلادارة الري بالتنقيط و الأسمدة الحيوية المعدنية في ظل ظروف الزراعة المحمية


**رامي محمد خليفة**

قسم الاراضي والمياه -كلية الزراعة- جامعة دمياط


## الملخص


أجريت تجربة حقلية داخل الصوب البلاستيكية في منطقة جمصة محافظة الدقهلية خلال موسمين 2016/2017&2017/2018 لدراسة تأثير 3 معاملات لري نبات الخيار كالتالي $I_1$ (الري عند 100% من السعة الحقلية)، $I_2$ (الري عند 80% من السعة الحقلية)،$I_3$( الري عند 65%من السعة الحقلية كمعاملات رئيسية )، 3 معاملات للتسميد الحيوي و المعدني كمعاملات تحت رئيسية وهيF1( التسميد ب100% من الجرعة الموصي بها من NPK) ، F2( التسميد ب 75% من الجرعة الموصي بها من NPK + 50% من خليط من سماد بيوفيرتال+ ريزوباكتيرين) ، F3 (التسميد ب 55% من الجرعة الموصي بها من NPK +100% من خليط من البيوفيرتال + ريزوباكتيرين علي الانتاج ومكوناته لنبات الخيار ، كذلك بعض العلاقات المائية والعائد الاقتصادي. أوضحت النتائج المتحصل عليها أن كلا من معاملات الري والتسميد ذات تأثير عالي المعنوية على الانتاج ومكوناته لنبات الخيار في كلا الموسمين، حيث تحصل علي أعلي القيم لإنتاج ثمار الخيار/الفدان، عدد الثمار /نبات، وزن الثمار/نبات تحت كلا من $I_2$ و $F_3$في كلا الموسمين. معاملة الري $I_2$ أدت الي زيادة انتاج ثمار الخيار بنسبة 21.87%، 22.29% مقارنة بمعاملة الري $I_1$ والقيم المقابلة كانت 10.78% و13.18% في معاملة التسميد $F_3$ مقارنة ب $F_1$ في الموسم الأول والثاني على الترتيب. أوضحت النتائج ان التفاعل بين معاملة الري $I_2$ ومعاملة التسميد $F_2$ أو $F_3$ أعطت أعلي عائد صافي للفدان، العائد الصافي لوحدة المياه، الكفاءة الاقتصادية في كلا الموسمين. أعطت المعاملة $I_3$ أعلي القيم للإنتاجية المائية لمياه الري وتوفير المياه. من نتائج الدراسة الحالية فانه يمكن التوصية بالري عند 80% من السعة الحقلية خلال نظام الري بالتنقيط مع اضافة 55% من السماد المعدني +100% من خليط سماد البيوفيرتال+ ريزوباكتيرين لانتاج الخيار داخل الصوب البلاستيكية للحصول علي أعلي انتاج اقتصادي من الخيار وتوفير مياه الري والسماد المعدني.