Effect of Mineral, Organic and Bio-fertilization on Sweet Pepper (*Capsicum annum* L.) Grown Under Plastic Houses Conditions

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ABSTRACT: Two greenhouse experiments were conducted during 2014/ 2015 and 2015/2016 seasons to layout beneficial fertilization protocol enhances the production and quality of sweet pepper under plastic houses. The target fertilization program seeks to achieve the best combination of various fertilizers (bio-, organic and inorganic) that lead to the highest yield and quality of produced sweet pepper especially during the winter season. Therefore, thirteen treatments were arranged in randomized complete block design with three replicates as follows; mineral fertilization at rates of (0, 25, 50 and 75% NPK from recommended dose) and chicken manure at the rates of (5, 10 and 15 m^3/fed.). All treatments were studied in the presence of a mixture of multi strains inoculants (microbien). Also, the recommended doses of N, P and K fertilizers for pepper plant were put in consideration as a comparable control treatment (100% NPK). The obtained results demonstrated that the treatment combination of microbein + 75% NPK of recommended fertilization + chicken manure at 15 m^3/ fed. brought about the highest significant mean values of most studied characters as vegetative growth characters (i.e. plant height, stem diameter, number of leaves/plant, number of branches /plant, plant fresh weight and plant dry weight); fruit setting percentages character; yield characters {i.e. No. fruits /plant, average fruit weight (g), percentage of fruit dry matter, early fruit yield /plant (kg), early yield/m^2 (kg) , total yield per plant (kg) and total yield/m^2 (kg)}; fruit quality (i.e. fruit length and diameter, TSS %, vitamin C, and non-reducing fruit sugars); chemical analysis characters (*viz*, a, b and total chlorophyll and N, P, K contents in leaves and fruits) during both seasons of the study as compared to the other treatments. Plants fertilized with either microbein without NPK plus 5m^3 /fed. of chicken manure; recorded the least time that spanned or elapsed to occur the first flowers of pepper "Top Star F1" plants during both seasons of the study. Results, also, declared that the combination of microbien+75 NPK of recommended dose + 15 m^3/fed. chicken manure showed the highest significant means of days spanned to the first flower appearance during both seasons, i.e. delay flowering compare to other treatments. In the case of number of flowers/ plant character, the treatments of microbien+ either 50 or 75%NPK of recommended dose+ either 10 or 15 m^3/fed. chicken manure in the first season, the treatment of microbien+75% of recommended dose +15 m^3/fed. chicken manure in the second season, showed the highest significant mean values. Based upon, the reported results, it is possible to conclude that, the combination among microbein + 75% NPK of recommended fertilization +15 m^3/fed. of chicken manure considered as the optimal combination treatment whereas, it gave the highest mean values of vegetative growth characters, yield and its components and fruit quality of pepper plants grown under plastic houses conditions.

Keywords: Pepper, mineral fertilization, inorganic fertilization, organic fertilization, bio-fertilization.

INTRODUCTION

Sweet pepper (*Capsicum annum* L.) is a member of family Solanaceae and genus *Capsicum*. Tropical South America, especially Brazil is thought to be the original home of pepper. It is one of the most popular and favorite vegetable crops cultivated under plastic houses in Egypt for both export and local consumption (Shahein *et al.*, 2015). It occupies the second rank among vegetable crops areas grown under plastic houses. Pepper is recognized as one of the best vegetable source for human health beneficial components (Block *et al*., 1992).

The increase in soil productivity is one of the major key factors, attributing to substantial increase in agricultural production to fulfill the increase in the human population. In order to achieve higher yields and quality, soil health is a critical factor. Therefore, chemical fertilizers must be integrated with biofertilizers and organic manures such as farm yard manure (FYM), Poultry manure, vermicompost, crop residues and green manures which are renewable and eco-friendly to achieve sustainable productivity with minimum deleterious effects of chemical fertilizers on soil health and environment. The yield per unit area can be increased along with the improvement of its quality through the balanced application of organic, inorganic and bio-fertilizers in proper combination. Mineral fertilizers considered a major source of plant nutrition, but the excessive use of mineral fertilizers represent the major cost in plant production and creates pollution of agro-eco system as well as deterioration of soil fertility (Singh and Ryan, 2015).

The mineral nutrients, N, P and K are known to affect growth and yield of the capsicums. Applications of N fertilizer levels showed significant effect on all growth and yield parameters. For instance, yield in pepper; increased with increasing nitrogen (N) level, but excessive N application may, also, decrease the yield (Khan *et al.,* 2014). It was reported that N fertilizer increased fruit weight, yield and fruit number of pepper (Tumbare and Niikam, 2004). Improved nitrogen management can be achieved by matching nitrogen supply with crop need and selecting appropriate nitrogen level to minimize nitrate nitrogen accumulation in soil at times, when the leaching potential is high (Papendick *et al*., 1987). Under severe conditions of excess nitrogen, leaves developed necrotic lesions followed by dropping.

It is evident from literature, that potash affects mostly the quality of fruits and vegetables. Potassium is one of the three major nutrients needed for plant growth (Russo, 1991; Hartz *et al*., 1993). Potassium plays a part in many important regulatory roles in the plant, i.e. osmo-regulation process, regulation of plant stomata and water use, translocation of sugars and formation of carbohydrates, energy status of the plant, the regulation of enzyme activities, protein synthesis and many other processes needed to sustain plant growth and reproduction (Hsiao and Lauchli, 1986). It is, also, a highly mobile element in the plant and has a specific phenomenon, it is called luxury consumption. Potassium is, also, known as the quality nutrient because of its important effects on quality factors (Lester *et al*., 2006). Further, phosphate plays a central, pivotal metabolic and regulatory role on the many of several physiological and biochemical processes in plants, including photosynthesis, energy conservation, inter- and intracellular co-ordination of carbohydrate metabolism and in energy transfers (Abel *et al*., 2002).

Organic matter has beneficial effects on soil chemical and physical characteristics, biological activity and soil structure including pH stabilization and faster water infiltration rate due to enhancing soil aggregation, increasing soil organic matter content. In addition, organic matter protects crops against pathogens and saprophytic through increasing parasitism and antibiosis (Jamir *et al*., 2017).

Biofertilizers are functional groups of microorganisms, mainly biological nitrogen fixers as well as phosphate and potassium group dissolving-bacteria. Therefore, it significantly, reduces application of chemical fertilizer and consequently pollution of environment, hence release of nutrients from rock and plant residue and their availability from plants and another organism. Moreover, biofertilizer offers microbial diversity in rhizosphere zone, provides defense against pathogen attack, plant growth promoting bacteria and antibiotics (Parasad *et al*., 2017).

Nowadays, the best integrated fertilization management which includes inorganic, organic and bio-fertilization; plays crucial roles in this respect. Therefore, the absence of fertilization program for pepper production under greenhouses conditions remains limiting factor, needs more research to develop an appropriate fertilization program satisfies the requirements to achieve the highest yield with best quality of pepper plants grown under plastic houses environments. So, the objectives of these experiments were to examine the beneficial roles of mineral (NPK), organic and bio-fertilization and their combinations on sweet pepper (*Capsicum annum* L.) growth performance under plastic houses conditions to determinate the suitable fertilization program to pepper plants "Top Star F_1 hybrid" during its scarcity period of the year (from September to May).

MATERIALS AND METHODS

Two field experiments were carried out during the winter seasons of 2014-2015 and 2015-2016, at private farm, at Abou El-Matameer city, in Behiera Governorate, Egypt, under unheated plastic houses. Before transplanting, random soil sample of 30 cm depth from different places of the greenhouse were collected and analyzed for some important chemical and physical properties as described by Jackson (1967). The experimental soil physical and chemical properties data are given in Table (1).

Pepper seeds were sown in seedling foam trays (84 eyes) filled with a mixture of peat moss: vermiculite (1:1 v/v), supplemented with 300 g ammonium sulphate (20.5% N), 400 g calcium superphosphate (15% P_2O_5), 150 g potassium sulphate (48% K_2O), 50 ml micronutrient solution and 50 g of a fungicide (thiophenate methyle) for each 50 kg of the mixture under plastic house on October 26th, during both seasons of the study. Seedlings of 22 days old were transplanted in the plastic houses on November 20th during both seasons at 0.3 m apart and 1.0 m width of ridge. The experimental plot consisted of one ridge with 3.0 m long and 1.0 meter width making an area of 3.0 m^2 using drip irrigation system.

All missing transplants were replaced by another ones of the same age, one week later after transplanting.

The plastic house was 24 m long and 6 m width making a total area 144 m^2, during both seasons, 0.5 m from both sides of the plastic house's arch near from plastic and 0.3 m from beginning (entrance) and end (exit or out) of the plastic house were left without planting. So, the total number of plants/ plastic house were 315 plants (2.71 plants/m^2).

Pepper cultivar' seeds coined as "Top Star F_1 hybrid" was used for the experimentation. It was purchased from Newstar for Modern Agriculture Co., Egypt. The bio-fertilizer "Microbein" which is a mixture of non- symbiotic N-fixing bacteria of the genera *Rhizobium*, *Azospirillum*, *Azotobacter* and *klebsiella* as well as the phosphate dissolving bacteria *Baccillus* was purchased from the General Organization for Agricultural Equalization Fund, Ministry of Agricultural, Egypt. Microbein as a biofertilizer was suspended in distilled water, then the transplants were irrigated with it in foam trays; whereas, each plant received 0.5 g microbein suspended in 20 cm^3 distilled water and transplanting after ten minutes from treatment, and some plants were maintained to be control ones (without manipulation).

Table (1). Physical and chemical properties of the experimental site during both seasons 2014/2015 and 2015/2016

Soil properties	Season	
	2014/2015	**2015/2016**
Particle size distribution:		
Clay (%)	3.00	3.50
Silt (%)	0.00	0.00
Sand (%)	97.00	96.50
Textural class	Sandy	Sandy
pH (1:1 soil suspension)	8.10	8.20
EC at 25° C (dS/m)	0.25	0.28
Soluble cations in (1:1) soil: 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: 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
Available N (mg/kg soil)	10	15
Available P (mg/kg soil)	31	37
Available K (mg/kg soil)	175	180

These analyses were carried out at Nubariya Research Station, Agricultural Research Center, Nubariya, El-Behiera Governorate, Egypt.

Table (2). Chemical analysis of the chicken manure of both seasons 2014/2015 and 2015/2016

Properties	Season	
	2014/2015	2015/2016
pH (1:10 manure suspension)	7.57	7.52
EC (1 :10) water extract, dS/m	3.96	3.86
O. M. %	59.31	59.25
O. C. %	34.40	34.37
Soluble cations (meq/L) Ca^{++}	3.06	3.00
Mg^{++}	2.72	2.70
Available nutrients (%)Nitrogen (N)	2.27	2.25
Phosphours (P)	1.02	1.04
Potassium (K)	1.70	1.60
C/N ratio	15.15:1	15.28:1

These analyses were carried out at Nubariya Research Station, Agricultural Research Center, Nubariya, El-Behiera Governorate, Egypt.

Organic fertilization was done using matured chicken manure which obtained from the local area and its chemical analysis is presented in Table (2). Chicken manure treatments were assigned as 5, 10 and 15 m^3/feddan. Mineral fertilization NPK treatments were at the following rates: (0%, 25%, 50%, 75% and 100%) of recommended dose; 200 kg N, 75 kg P_2O_5 and 150 kg K_2O/feddan, respectively. Ammonium nitrate (33.5% N) and nitric acid (15% N) as a source of nitrogen were added. Phosphoric acid (55% P_2O_5) and calcium superphosphate (15% P_2O_5) as a source of phosphorus were used. In addition, potassium sulphate (48% K_2O) as a source of potassium was added and calcium nitrate (15.5%N +19% Ca_2O) as a source of nitrogen and calcium was applied. The amounts of recommended doses were add as 415 kg/fed. ammonium nitrate, 200 kg/fed. calcium nitrate, 200 kg/fed. nitric acid, 100 kg/fed. calcium superphosphate, 82 kg/fed. phosphoric acid and 312.5 kg/fed. potassium sulphate. A drip irrigation network was designed for this study and consisted of lateral's GR of 16 mm in diameter, with emitters at 0.3 m distance, with allocating a lateral for each row. The emitters had a discharge rate of 4 $l.h^{-1}$. Both conducted experiments were layout in a randomized complete blocks design, with three replicates. Each replicate included 13 treatments as follows; mineral fertilization at rates of (0, 25, 50 and 75% NPK from recommended dose) and chicken manure at the rates of (5, 10 and 15 m^3/fed.). All treatments were studied in the presence of a mixture of multi strains inoculants (microbien). Also, the recommended doses of N, P and K fertilizers for pepper plant were put in consideration as a comparable control treatment (100% NPK). All determined treatments were distributed randomly within each block. Each experimental plot area was 3 m^2 (1 m x 3 m) during both seasons and 0.30 m between plants and 1.0 m pathway. The planting distance adopted at both sites was 0.30 m × 1.0 m, and the plant population per plot was ten plants. The experiment plots were tested as free of weeds by hand hoeing. Harvesting of the fruits was done for early yield after 70 days, then for the rest of harvesting, each 5 days in summer season and each 10 days in winter season. The harvesting fruits were counted and weight using electronic scale.

Recorded data:

Four plants form each treatment in each replication were randomly selected and tagged for records of growth, early yield and total yield as well fruit quality parameters.

1. Vegetative growth – related characters, all the following characters were determined after 120 days of transplant, plant height (cm) was recorded in centimeters from the base of the plant to the terminal growing point of tagged plants using a meter scale. The stem diameters were measured using caliper at about 5 cm from the soil surface around the base of the plants. Numbers of leaves and branches per plant were counted. Plant fresh weights were determined as the average fresh weight of plant foliage. Plant foliage was dried in an electrical oven at 70˚ C till the constant weight and then the average dry weight of whole plant foliage was calculated in gram.

2. Flowering characteristics, four plants from each experimental plot were chosen at random and the following data were recorded: time spanned to the first flower appearance (days) was determined as time spanned from transplanting to the first flower appearance (day). The whole numbers of the opened flowers per plant all over the season were counted. Fruits setting percentage was calculated as number of fruits per plant divided be number of flowers per plant.

3. Fruits number and yield parameters were determined *via* mean fruits' number/plant which was determined from the total number of fruits harvested over the entire harvest period (110 days). Fruits weight/plant was calculated from the fruits harvested over the all picking times.

Total fruits weight from the tagged plants was recorded and fruits yield/square meter: fruits yield per square meter =Average fruits yield/plant x number of plants/square meter. Average fruits weight (g) was calculated as total fruits yield (kg)/ total number of fruits per plant. Randomly fruit samples of 100 g of fresh weight were dried in an electrical oven at 70˚ C till the constant weight then the percentage of fruits dry weight was calculated as fruits dry matter (%) = $\frac{\text{Dry weight}}{\text{Fresh weight}} \times 100$. Early yield was considered as the weight of all harvested fruits during the first 30 days of harvesting per plant and per square meter and expressed in kg.

4. Fruits quality, four fruits were randomly taken from each plot of all pickings to study the morphological characters as fruits length (cm) and fruits diameter (cm) were measured using a caliper and fruits shape index was calculated as (fruit length/ fruit diameter). Chemical composition the following fruit constituents were determined in fruit samples which collected for chemical characteristics as follows: (1) Total soluble solids content (TSS %) or degrees Brix (Bx°) which is numerically equal to the percentage of sugar and other dissolved in a solution (Caralcantio *et al*., 2010; Majiid *et al*., 2011). It was estimated in the juice of the fresh fruits using a hand refractometer according to AOAC (1992), (2) Total titratable acidity (%), it was determined in the fruit juice, as citric acid percent (mg/100 cm^3 juice) as the method described in the AOAC

(1992), (3) Total, reducing and non-reducing sugars, which were determined for each fruit sample according to the method described by Malik and Singh (1980) and (4)Vitamin C (Ascorbic acid) was measured by titration with iodide potassium according to method of Ranganna (1986) and calculated as mg vitamin C/ 100 cm^3 juice.

5. Plant chemical analysis, (1) Nitrogen, phosphorus and potassium concentrations were determined in leaves and fruits, by using 100g of fresh samples which were taken from each treatment. The samples were dried at 85˚C to constant weight. The obtained dry matter was ground into fine powder and 0.5g of the ground dried material was digested with H_2O_2 according to Evenhuis and Dewaard (1980). Total nitrogen in digested samples was determined colorimetrically according to Chapman and Pratt (1961). Total P in digested samples was determined colorimetrically as described by Singh *et al*.(2005). Total K in digested samples was measured using flame photometer as described by Singh *et al*.(2005). (2) The leaf pigments chlorophyll a, b and total chlorophyll of the fifth leaf from the growing top of plant were estimated by spectrocolorimeter as described by Moran and Porath (1980) after 60 days from transplanting in both seasons.

All obtained data of the present study were, statistically, analyzed according to the design used by the MSTAT-C computer software program (Bricker, 1991) and were tested by analysis of variance. The comparisons among the means of different treatments were carried out, using the revised least significant difference test at 0.05 level of probability as illustrated by (Duncan, 1965; Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

1. Vegetative growth characters: results listed in Table (3) indicated that the highest significant average values of all studied vegetative growth characters {i.e. plant height (cm), stem diameter (cm), number of leaves/plant, the number of branches /plant, plant fresh and dry weights (g)}, during both seasons were achieved for the plant treated with microbein + NPK at 75% + chicken manure at 15 m^3/fed. compared to the other treatments. The obtained results, in this context, show that the integrated role of the tested combinations on the given traits, i. e. the balanced and better nutrition absorbed and metabolize of more carbohydrate by plants due to providing them with the best combination of nutrition's, which could provide quick release of mineral NPK elements plus those being slowly released *via* organic fertilization, and production of bio-fertilizer (microbein) of plant growth promoting substance, i.e., cytokinins, auxins, gibberellins which could enhance vegetative growth as a whole and plant height in specific (Bareisis *et al*., 2002). El-Shimi *et al*. (2015) reported that a combination of compost tea (20 L/fed.) + yeast (20 L/fed.) + 75% of recommended NPK; affected significantly vegetative growth characters of sweet pepper plants "California Wonder" cv., whereas this combined item brought about, significantly ($p \leq 0.05$), the highest average values of plant height, number of leaves/ plant, number of branches/plant, leaf area as well as fresh and dry weights. The highest values during both seasons were realized for the plants treated with microbien biofertilizer + NPK mineral fertilizers at the rate of 75% from the recommended dose + 15 m^3/fed. chicken manure as compared to the other treatments. This finding may be attributed to the critical part of N in plants, which found in nucleic acids, co-enzymes, and proteins- phosphorus, likewise has a part in N_2 fixation, and increment photosynthesis of plant, although phosphorus has a fundamental part in energy metabolism the high energy of hydrolysis of phosphate and different organic phosphate bonds being used to induce chemical reaction, while potassium activates some enzymes and K^+ ions play an vital part in control leaves stomatal guard cells and as well increment photosynthesis. The stimulating effect of NPK combination on the above-mentioned characteristics were confirmed by Ademola and Agele (2015); Lego *et al.* (2016). The enhancement of vegetative growth parameters with biofertilizer application agree with results obtained by Shafeek *et al.* (2016); Ahmed *et al*. (2017). It is well known that bio-fertilizers are substitutes or alternatives to inorganic fertilizers for increasing soil productivity and plant growth in sustainable agriculture. Bio-fertilization *via* microbein could be attributed to its bacteria which play profound role in improving soil fertility and plant growth development *via* N_2 fixation and releasing such certain nutritive elements such Fe, Zn and Mn, and some phytohormones such as gibberellins, auxins, and cytokinins like- substances which may encourage uptaking and sufficient nutrients, subsequently enhance plant growth (El-Haddad *et al*., 1993; Hameda *et al*., 2015). Increases in the vegetative growth of pepper plants by applying chicken manure might be referred to its role in enhancing soil physical properties as soil texture, water holding capacity and it creates a good aeration in soils and decreased the pH value and consequently nutrients in the soil became more available for enhancing plant growth. This result is in agreement with Baiyeri *et al.* (2016); Khandaker *et al.* (2017). However, the balance among the combined items which led to the highest average values of vegetative growth traits could be taken place due to the presence of mineral fertilization at 75% NPK of the recommended dose; brought about improvement in the given vegetative growth characteristics and increase uptake of nitrogen and its associated role in chlorophyll synthesis and subsequent by the process of photosynthesis and carbon dioxide assimilation (Jasso-Chaverria *et al*., 2005) resulting in enhancement the growth.

Additionally, nitrogen stimulates cell division and proliferating the tissues and differentiation of organs could lead to increase the vegetative growth characteristics, too. Likewise, the presence of P and K, and their uptake are enhancing by nitrogenous fertilizers which have been reported by mediating the uptake and utilization of K, P and other elements in plants (Brandy, 1984). In addition, nitrogenous fertilization involves in cytokinins biosynthesis, plays a vital role in nucleic acids and protein synthesis and cell divisions and enlargements which reflect positively on vegetative growth (Marschner, 1995). Furthermore, chicken manure (organic fertilization) plays a crucial role in plant growth as a source of all necessary macro – and micronutrients to be in accessible forms during mineralization process and ameliorate soil physical and chemical properties (Chaterjee *et al*., 2005).

Table (3). Average values of some vegetative growth characters of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons

Treatments (Fertilizers)			Plant height (cm)		Stem diameter (cm)		No. of leaves/ plant		No. branches/plant		Plant fresh weight (g)		Plant dry weight (g)	
Bio-	Mineral	Organic m^3/fed.	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Microbien	0 % NPK	5	51.97j	47.23k	0.78m	0.72l	126.00j	118.33j	7.00k	6.33k	772.10m	763.43m	131.13l	129.83m
		10	52.70j	48.20j	0.80l	0.74k	128.00i	119.33ij	7.33jk	6.67jk	783.33l	774.37l	133.20k	131.67l
		15	55.13h	50.23i	0.82j	0.75j	130.00h	121.33h	8.33h-j	7.67hi	805.33j	796.93j	136.67i	135.23j
	25% NPK	5	54.10i	49.07j	0.81k	0.75j	128.33i	120.33hi	7.67i-k	7.33ij	794.90k	784.73k	134.90j	133.47k
		10	55.87h	51.30h	0.84i	0.77i	131.67g	122.67g	8.67g-i	8.00g-i	814.87i	807.50i	138.63h	137.03i
		15	57.27g	51.93h	0.85h	0.78h	133.00f	124.33f	9.33f-h	8.33gh	825.77h	818.40h	140.60g	138.90h
	50% NPK	5	58.10fg	53.27g	0.86g	0.79g	134.33e	125.00f	9.67e-g	8.67fg	837.07g	829.57g	142.43f	140.60g
		10	61.17d	56.67d	0.90d	0.83d	138.33c	129.33d	11.33b-d	10.33cd	870.43d	862.60d	148.33d	146.17d
		15	63.47b	59.50b	0.93b	0.86b	140.67ab	133.00b	12.33ab	11.33ab	891.70b	884.43b	151.83b	149.50b
	75% NPK	5	58.77f	54.47f	0.88f	0.80f	135.67d	126.67e	10.33d-f	9.33ef	848.43f	840.73f	150.10c	142.50f
		10	62.17c	57.83c	0.92c	0.84c	140.33b	130.67c	11.67a-c	10.67bc	882.17c	873.33c	148.27d	147.77c
		15	64.53a	61.10a	0.94a	0.87a	141.67a	134.33a	12.67a	11.67a	903.40a	894.23a	153.83a	151.53a
Without microbien	100% NPK	0	59.93e	55.43e	0.89e	0.82e	136.33d	128.33d	10.67c-e	9.67de	859.50e	851.47e	146.40e	144.33e

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability

Organic manures, also, have an advantage of slow release of their constituents and has a high cation exchange capacity (CEC) which improves holding nutrients being absorbed by plants, which results in increase mineral content of pepper plants. Furthermore, microbein as a bio- fertilizer is input containing microorganisms which are capable of mobilizing nutritive elements from non –usable form to usable one through biological processes, they include mainly the nitrogen fixing, phosphate solubilizing and plant growth – promoting microorganisms **(**Goel *et al*., 1999). Also, they can produce plant growth promoting substance (i.e gibberellins, cytokinins-like substances and auxins which enhance the plant growth (Akbari *et al*., 2007). Hence the integrated combination of the above- mentioned treatment fortify the vegetative growth. The better performance of the pepper plants with interaction among treatments are supported by the results of Yakout *et al.* (2014); EL Shimi *et al*. (2015).

Pertaining the fresh and dry weights, they exhibited similar trend to those of the other vegetative growth traits, where the highest average values of both characters were registered. These findings could be taken place due to augmenting the combination with 75% of the NPK of recommended dose, with the presence of the other additives factors, i. e. bio- and organic fertilization (15 m^3/fed.), which refer to the best combinations which established the best balance among organic, inorganic and biofertilization. Whereas, the difference between organic and inorganic fertilizers is the carbon, and more specifically the carbon-hydrogen, linkage inorganic fertilizers, which slows the release of nutrient ions. Slower nutrient release results in the most sustained availability of the nutrients and a lower, "burn" and leeches potentially compared to their inorganic counterparts. In addition, organic fertilizers may act as an energy source for microorganisms in the soil, which can improve soil structure and plant growth. This event could take place as the carbon in some organics may provide an energy source for microorganisms in the soil. It is important to note that not all natural or synthetic organic fertilizers are decomposed by microorganisms. Microbial activity in the soil releases nutrients and enzymes that are beneficial to plant and also secretes "glue- like" substances that aggregate soil particles, improving soil structure. Organic fertilizer as chicken manure that stimulates microbial activity are said to feed both the plants and soil. It was observable that combination among the three items under the study (bio-, organic and mineral fertilizer) has a promotive effect on plant growth, expressed as (plant height, stem diameter, the number of leaves/plant, the number of branches/ plant, plant fresh and dry weights), and this may be taken place that total nitrogen fixation which might be in cemented by increasing the available phosphorus in soil's medium which discharged or released by phosphate dissolving bacteria. Phosphate is known to regulate several enzymatic processes, also, function as an activator for some enzymatic activities, resulting in encouragement of the metabolism processes and producing new cells (Dillon, 1987), then increment or enhancement of vegetative growth. Likewise, the phosphorus acts its main roles in protein synthesis and protoplasm formation leading to an increment in cell size; enhance or improve root biomass, and in the biosynthesis of energy rich Phosphate substance as adenosine triphosphate (ATP), which is involved in ion absorption (Marschner, 1995).

2. Flowering characters: results presented in Table (4) declared that plants fertilized with microbein without NPK plus 5m^3 /fed. of chicken manure recorded the least time that spanned or elapsed to occur the first flowers of pepper "Top Star F1" cv. plants which were ranged from 49.5-49.80 days during both seasons of the study, each in turn. Results, also, declared that the combination of microbien+75% NPK of recommended dose + 15 m^3/fed. chicken manure showed the highest significant averages of days spanned to the first flower appearance (as 61.20 and 61.50 days) during both seasons, orderly, i.e. delay flowering compare to other treatments. This finding could be accounted for chemical fertilizers tend to provide the plants with nutrients readily and enhance or encourage vegetative growth, thereby delaying the flowering phenomenon in sweet pepper plants (Adhikari *et al.*, 2016). On the other side, the absence of NPK and the least amount of chicken manure (5 m^3/fed.) caused the least days to the occurrence of first flower.

Table (4). Average values of some flowering characters and percentage of fruit setting of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons.

Treatments (Fertilizers)			Time spanned to the first flower appearance (days)		Number of flowers/ Plant		Fruit setting (%)	
Bio-	**Mineral**	**Organic m^3/fed.**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**
Microbien	0% NPK	5	49.50j	49.80g	29.00f	24.00c	62.33m	58.67m
		10	51.20i	52.30f	29.33ef	23.67c	63.87l	60.23l
		15	53.40h	53.90e	29.00f	24.67c	67.07j	63.23j
	25% NPK	5	52.60h	53.40e	29.00f	24.33c	65.53k	61.67k
		10	54.30g	55.50d	29.67d-f	24.33c	68.80i	64.83i
		15	55.20f	55.80d	30.67c-e	24.33c	70.23h	66.17h
	50% NPK	5	56.30e	57.70c	30.00d-f	24.00c	71.87g	67.57g
		10	59.03bc	59.87b	31.67a-c	24.33c	76.57d	72.20d
		15	60.70a	61.70a	32.33ab	27.00ab	79.80b	75.20b
	75% NPK	5	57.80d	58.20c	30.33c-f	24.33c	73.33f	69.13f
		10	59.70b	60.10b	32.67a	25.67bc	78.20c	73.77c
		15	61.20a	61.50a	32.33ab	28.33a	81.56a	76.90a
Without microbien	100%NPK	0	58.57cd	59.53b	31.00b-d	24.33c	75.07e	70.57e

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

In the case of number of flowers/ plant character, the treatments of microbien + either 50 or 75%NPK of recommended dose+ either 10 or 15 m^3/fed. chicken manure in the first season, brought about 31.67, 32.33, 32.67 and 32.33 flowers/plant, respectively. Also, the treatment of microbien+75% NPK of recommended dose +15 m^3/fed. chicken manure in the second season, showed the highest significant average values as 28.33 flowers/plant. The increments in number of flowers due to the above-mentioned treatments could be accounted for higher accessibility and the absorbance of nutritive elements *via* path organic and inorganic fertilizers in addition to the role of bio-fertilizers in enhancing production of plant growth promoting substances, i.e. cytokinins, auxins, gibberellins etc. which exert significant effects on initiation and flower initials and their developing. The results, also, showed that the highest fruit setting percentages as 81.56 and 76.90% during both seasons, respectively, were observed when pepper plants fertilized with the combination of microbien +75% NPK of recommended dose + 15m^3/fed. chicken manure. This finding supports the findings of Ademola and Agele (2015); Lego *et al.* (2016).

3. Yield and its components: results presented in Table (5 and 6) disclose that the combination among microbein +75% NPK of the recommended dose + 15 m^3 organic manure (chicken) /fed; recorded the highest average values of No. fruits /plant, average fruit weight (g), percentage of fruit dry matter, early fruit yield /plant (kg), early yield (kg/m^2), total yield per plant (kg) and total yield/m^2 (kg) during both seasons of the study, compare to the check treatment (100% NPK). Meanwhile, intermediated average values were recorded and distributed among other treatments. This reflects the need for the establishment of a balanced program of nutrition of bio-organic and inorganic combination to achieve the best results. The results obtained could be attributed to the great vegetative growth which taken place initially, the turnover into floral stage extensively, due to the enrich nutrient status of the plants which reflected on the production of higher number of flowers, number of fruits/plant and highest average fruit weight which were positively contributes towards fruit's yield. Increased yield was correlated to balanced nutrition, better uptake of nutrients by plants which exerted such good fruit set and yield. The profound effect of both bio-and organic fertilizers on yield and quality of pepper's outcomes may be attribute to either the execute or pass off growth promoting substance such as cytokinins (Tomer *et al*., 1995), the auxin Indole acetic acid (Marha *et al*.,2000), gibberellins like-substances (Brown *et al*.,1995) and /or *via* releasing siderophores compounds (Marin *et al*., 2001) that function as chelating agents for iron elements acting its function to enhance the facilitating of iron for different biophysical and biochemical activities of cucumber plants. The indirect effect of microbein is basically through or *via* amelioration of soil structure and by means of the delivery or discharge of polysaccharides- like substance which enhance the soil physical and chemical properties (Hamdi, 1982). In other words the combination of microbien+ 75%NPK of recommended dose + 15 m^3/fed. chicken manure; caused a high improvement in plant hormones as auxin as IAA and GAs in addition to the vitamin "Biotin, folic acid and vitamin B group" of bio-fertilizer in addition to the impact of organic fertilizer as a source of slow releasing nutritive elements and rapid dissolved NPK elements as a mineral (inorganic) fertilizer represent a synergism of combination components that to be available for plants to improve the plants quantitative vegetative growth [plant height, leaf number /plant ,branches number/ plant, fresh and dry weight of plants]. The obtained results are in agreement, more or less, with many studies found that the combination among biofertilizer + mineral fertilization with NPK + chicken manure led to increase yield and yield components of pepper plants such as those reported by Yakout *et al.* (2014); EL Shimi *et al*. (2015).

Table (5). Average values of some yield characters of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons

Treatments (Fertilizers)			No. of fruits per plant		Fruit fresh weight (g)		Fruit dry matter (%)		Early yield/ plant (kg)		Early yield/m^2 (kg)	
Bio-	**Mineral**	**Organic m^3/fed.**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**
Microbien	0% NPK	5	18.00i	14.00j	36.97l	34.81m	8.64m	7.81l	0.645 m	0.569 k	1.749m	1.542k
		10	18.67hi	14.33ij	37.43k	35.26l	8.77l	7.93k	0.669 l	0.589 j	1.814l	1.597j
		15	19.33gh	15.33g-i	38.36i	36.13j	8.98j	8.11i	0.722 j	0.632 h	1.957j	1.712h
	25% NPK	5	19.00hi	15.00h-j	37.89j	35.63k	8.85k	8.00j	0.698 k	0.610 i	1.892k	1.654i
		10	20.33fg	15.67f-h	38.53i	36.57i	9.09i	8.22h	0.751 i	0.655 g	2.035i	1.774g
		15	21.33ef	16.00f-h	38.99h	37.08h	9.20h	8.21h	0.776 h	0.639 h	2.102h	1.732h
	50% NPK	5	21.67e	16.33e-g	39.44g	37.55g	9.31g	8.31g	0.797 g	0.661 g	2.161g	1.792g
		10	24.33bc	17.67d	40.85d	38.89d	9.65d	8.59d	0.878 d	0.728 d	2.379d	1.972d
		15	25.67a	20.33b	41.81b	39.95b	9.87b	8.84b	0.920 b	0.777 b	2.492b	2.107b
	75% NPK	5	22.33de	16.67d-f	39.92f	37.99f	9.42f	8.39f	0.827 f	0.680 f	2.242f	1.844f
		10	25.33ab	19.00c	41.30c	39.35c	9.75c	8.70c	0.903 c	0.751 c	2.448c	2.035c
		15	26.33a	22.00a	42.26a	40.52a	9.98a	8.94a	0.942 a	0.802 a	2.552a	2.174a
Without microbien	100% NPK	0	23.33cd	17.33de	40.36e	38.50e	9.54e	8.52e	0.853 e	0.693 e	2.311e	1.877e

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

Table (6). Average values of some yield characters of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons.

Treatments (Fertilizers)			Fruit yield/ plant (kg)		Fruit yield/m^2 (kg)	
Bio-	**Mineral**	**Organic m^3/fed.**	**2014/2015**	**2015/2016**	**2014/2015**	**2015/2016**
Microbien	0% NPK	5	0.925 l	0.810 m	2.506l	2.194m
		10	0.960 k	0.839 l	2.601k	2.275l
		15	1.027 i	0.906 j	2.784i	2.456j
	25% NPK	5	0.994 j	0.873 k	2.693j	2.366k
		10	1.061 h	0.940 i	2.874h	2.548i
		15	1.094 g	0.973 h	2.964g	2.636h
	50% NPK	5	0.763 m	1.013 g	2.068m	2.744g
		10	1.231 d	1.104 d	3.337d	2.993d
		15	1.309 b	1.161 b	3.548b	3.145b
	75% NPK	5	1.163 f	1.039 f	3.153f	2.815f
		10	1.264 c	1.138 c	3.426c	3.085c
		15	1.358 a	1.185 a	3.680a	3.210a
Without microbien	100% NPK	0	1.197 e	1.086 e	3.243e	2.942e

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

4. Fruits quality characters, these characters will be presented and discussed as follows:

4.1. Fruits length, diameter and shape index: results exhibited in Table (7) demonstrated that pepper's plants which fertilized with microbein + 75% NPK of recommended dose + 15 m^3/fed. chicken manure, led to the highest significant average values for fruit length and diameter during both season, compare with the control treatment (i.e., 100% NPK). Nevertheless, non-significant effects were found among all treatments on fruit shape index during both seasons of the study. In this connection, Fawzy *et al*. (2012) and Ahmed *et al*. (2013) reported that application of mineral NPK in combination with bio-fertilizers and chicken manure; gave the highest mean values of pepper fruit length and diameter.

The former recorded results, i.e., the highest average values of fruit length and diameter may be brought about due to the function of bio-fertilizer (microbein) which involve life effective bacteria which have the capability to fix nitrogen, and they have the ability to provide some micro-nutrients, and phytohormones as cytokinin-like, auxin-like, and gibberellins-like substances. Additionally, the slow releasing of the organics NPK which need a mineralization process which provide for long time and mineral NPK of the rapid release, both play the major role in this respect. Further, the phytohormones - like substance affect, also, fruit characters (length and diameter) *via* their functions on cell growth indirectly (longitudinal and equatorial), subsequently all the fruit characters (Yakout *et al.*, 2014). Many investigators reported enhancing the physical quality of pepper fruits by application of biofertilization as those found by El-Hifny and El-Sayed (2011); Shafeek *et al.* (2016). Also, many studies reported increases in pepper fruit length and diameter as application with NPK mineral fertilization such as those found by Fawzy *et al*. (2012); Bahuguna *et al.* (2015). Increases in pepper fruit length and diameter due to application with combination of bio-, NPK mineral and chicken manure fertilization were found by López-Espinosa *et al.* (2013) and Khandaker *et al.* (2017). The results of present study showed similar trend to the findings of Ahmed *et al*. (2013); EL Shimi *et al*. (2015).

4.2. Chemical fruits quality: results in Table (8) reflected that the mixture of microbien bio-fertilizers + 75% NPK recommended dose + 15 m^3/fed. chicken manure; gave the highest, significant ($p \leq 0.05$), values for TSS % (Brix), Vitamin C (Ascorbic acid) and non-reducing fruit sugars during both seasons, and increase total sugars in the first season only compared to the other treatments. The combination of microbien + 75% NPK of recommended dose plus 5m^3 of organic manure; caused significant increases of fruit reducing sugars during both season, and fruit total sugars in the second season.

This finding of reducing sugars could be attributed to the nature of inorganic or mineral fertilization (NPK) as salts capable of increasing soil salinity and lead to increase the osmotic pressure of soil water potential formation *via* activation many reactions involved in carbohydrates metabolism. In another way, it has been known that NPK are salts capable of inducing such stress caused by these salts presented in soil, which change water status and brings about osmotic effects outside the cells leading to hypertonic state (water drowns out of the cells by osmosis) accompanied with water deficit, and accumulation of compatible solutes (soluble sugars, proline, glycine, betaine, free amino acids and polyamine) which may help to maintain the relatively higher water content obligatory for plant growth and cellular functions (Ranganayakulu *et al*., 2013), achieved clearly in form and of reducing sugars. The finding of TSS could be explained on the basis that the nutritional integration in the defined combination (microbien+75% NPK of recommended dose + 15 m^3/fed. chicken manure) which its contents, rapidly, released nutritive elements (NPK) and slow release nutritive elements of organic fertilizer too, in addition to the key role of microbein, enhanced vegetative growth to photosynthize more photosynthates *viz* carbohydrates and starch which convert into sugars.

Table (7). Average values of some physical fruit quality characters of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons

Treatments (Fertilizers)			Fruit length (cm)		Fruit diameter (cm)		Fruit shape index	
Bio-	Mineral	Organic m^3/fed.	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Microbien	0% NPK	5	9.13l	8.41l	7.83m	7.20l	1.17a	1.17a
		10	9.28k	8.51k	7.93l	7.28k	1.17a	1.17a
		15	9.56i	8.75i	8.16j	7.46i	1.17a	1.17a
	25% NPK	5	9.41j	8.65j	8.05k	7.36j	1.17a	1.17a
		10	9.70h	8.86h	8.28i	7.57h	1.17a	1.17a
		15	9.85g	8.97g	8.41h	7.64g	1.17a	1.17a
	50% NPK	5	9.89g	9.07f	8.54g	7.74f	1.16a	1.17a
		10	10.35d	9.44c	8.89d	8.02c	1.16a	1.18a
		15	10.69b	9.59b	9.13b	8.17b	1.17a	1.17a
	75% NPK	5	10.05f	9.18e	8.63f	7.83e	1.16a	1.17a
		10	10.52c	9.49c	9.02c	8.11b	1.17a	1.17a
		15	10.88a	9.70a	9.24a	8.28a	1.18a	1.17a
Without microbien	100% NPK	0	10.20e	9.28d	8.78e	7.92d	1.16a	1.17a

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

Table (8). Percentages of some chemical fruit quality characteristics of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons

Treatments (Fertilizers)			TSS %(Brix)		Acidity %		Vitamin C (Ascorbic acid) mg/100 g		Fruit sugars (%D. W.)					
									Reducing sugars		Non-reducing sugars		Fruit total sugars	
Bio-	Mineral	Organic m^3/fed.	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Microbien	0% NPK	5	6.02l	5.87jk	0.70a	0.80a	129.20j	125.20l	2.78m	2.48l	1.48k	1.32j	4.10l	3.80m
		10	6.10k	5.84k	0.67a	0.80a	130.30j	126.20kl	3.09l	2.67k	1.56j	1.43i	4.35k	4.10l
		15	6.22j	5.99i	0.61b	0.74bc	132.23i	127.90ij	2.94j	2.98i	1.70h	1.55gh	4.79i	4.53j
	25% NPK	5	6.19j	5.92j	0.60b	0.76ab	131.63i	127.00jk	3.21k	2.83j	1.64i	1.49hi	4.58j	4.31k
		10	6.30i	6.07h	0.57b	0.72cd	133.70h	128.77hi	3.42i	3.18h	1.77g	1.62g	4.99h	4.79i
		15	6.37h	6.13g	0.52c	0.67de	134.83gh	129.67gh	3.58h	3.30g	1.82g	1.72f	5.24g	5.02h
	50% NPK	5	6.43g	6.19f	0.47d	0.63ef	135.87fg	130.67fg	4.07g	3.48f	1.89f	1.78ef	5.47f	5.26g
		10	6.64d	6.48c	0.36e	0.52h	139.07cd	133.27cd	4.37e	3.94d	2.12d	1.99cd	6.19d	5.93e
		15	6.75b	6.63b	0.29f	0.43ij	141.40b	135.30b	4.71c	4.12bc	2.27b	2.11ab	6.64b	6.23c
	75% NPK	5	6.49f	6.25e	0.45d	0.59fg	136.67ef	131.53ef	4.26a	4.64a	1.98e	1.83e	6.70b	6.47a
		10	6.70c	6.51c	0.32ef	0.46i	140.20bc	134.17c	4.53d	4.05c	2.18c	2.04bc	6.44c	6.09d
		15	6.81a	6.71a	0.28f	0.40j	142.73a	136.43a	2.78b	4.18b	2.35a	2.17a	6.88a	6.35b
Without microbien	100% NPK	0	6.57e	6.36d	0.43d	0.56gh	137.87de	132.37de	3.91f	3.83e	2.04e	1.94d	5.94e	6.07f

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

In other words, this finding could be achieved due to the gradual and steady release of inorganic nutrients and gradual release of organic fertilizer during the whole both seasons, compare to those recorded the lowest values of TSS. Similar results, more or less, were, also, reported by Voth *et al.* (1967); El-Gizy (1978). These findings may be taken place owing to the negative relationship between N-supplying and fruit sugar content could be attributed to that under high N conditions; greater amounts of carbohydrates probably directed and utilized in mounting vigorous vegetative growth and little proportion may be left to supply the growing fruits with sufficient carbohydrates.

The observed reduction in fruit total soluble solids might be due to corresponding decrement in the sugar content which make up 70-80% of TSS as stated by Culpepper *et al*. (1935). On the other hand, acidity % was decreased, significantly, with applying the above-mentioned treatment and the highest values recorded with the combination of microbien plus either 5 or 10 m^3/ fed. during both seasons. The findings of acidity may be taken place due to the presence of 75% NPK of recommended dose within the combination, and the synergistic effect of the combination among bio-, mineral and organic fertilizer as amendments. This is owing to the amelioration or amendment of soil chemical and physical properties and accessibility or facilitation of nutritive elements either mineralize slowly or rapidly and enhancement of bio-fertilizer (microbien) in turn improve plant growth and fruit production and their quality (Itoo and Manivannan, 2004). The increases in chemical fruit quality as application with biofertilizer were found by many researchers such as El-Hifny and El-Sayed (2011); Fawzy *et al*. (2012). The findings of increases in chemical characters quality of pepper fruits with NPK mineral application are in agreement with those reported by El-Bassiony *et al.* (2010). Also, many investigators found increases in chemical characters quality of pepper fruits by application with chicken manure such as those reported by Aminifard *et al.* (2013); Khandaker *et al.* (2017).

The results of the present study reported that the combination among microbien + 75% NPK recommended dose + 15 m^3/fed. chicken manure caused increases in chemical of pepper fruits quality. This result may be attributed to the synchronization of availability of the proper forms of nutritive elements *via* organic or inorganic fertilization in addition to the bio-fertilization, or this combination was not the appropriate formulae to achieve better feedback of the given trait. In other words, organic manure mineralizes and uptake slowly, compare to the inorganic fertilization NPK which release readily to the plants which may affect microbein function. These findings could be accounted to the presence of nitrogen either in mineral or in combination with the other two resources (organic and bio-fertilization) which could activate many enzymes having a direct effect on photosynthesis and might increase the dry matter and subsequently enhanced reducing sugar content or many enzymes involved in metabolism of reducing sugar content (Mottaghian *et al*., 2008). These findings are in line with those reported by Ahmed *et al*. (2013); EL Shimi *et al*. (2015).

5. Plant chemical analysis:

5.1. Chlorophyll content, N, P and K nutrient contents of leaves: according to the results illustrated in Table (9), it is evident that using the combination of microbien + 75% NPK of recommended dose + 15 m^3/fed. chicken manure; gave rise to the highest significant average values of the chlorophyll (a, b and total a+b) and nutritional elements (N, P and K) in pepper leaves compared to the other treatments. The average values were 0.882 and 0.829 (mg/g FW) for chlorophyll a; 0.609 and 0.583 (mg/g, FW) for chlorophyll b; 1.491 and 1.412 (mg/g, FW) for total chlorophyll; 3.17 and 3.01% for N content of leaves; 0.293 and 0.313% for P content of leaves and 3.39 and 3.44% for K content of leaves during both seasons, respectively.

Table (9). Average values of leaves chlorophyll and nutrient contents of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons

Treatments (Fertilizers)			Leaves chlorophyll content (mg/g f.w.)						Nutrient contents of leaves (% D.W.)					
			Chlorophyll a		Chlorophyll b		Total chlorophyll		N		P		K	
Bio-	Mineral	Organic m^3/fed	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Microbien	0% NPK	5	0.718l	0.693h	0.497m	0.484k	1.216m	1.177m	2.08m	1.91m	0.196j	0.210j	2.27m	2.34m
		10	0.734k	0.702h	0.507l	0.493j	1.241l	1.196l	2.19l	2.02l	0.203j	0.221i	2.33l	2.46l
		15	0.751j	0.728f	0.524j	0.512h	1.275j	1.239j	2.36j	2.20j	0.219h	0.236h	2.58j	2.67j
	25% NPK	5	0.746j	0.716g	0.514k	0.502i	1.260k	1.218k	2.26k	2.12k	0.212i	0.225i	2.48k	2.55k
		10	0.766i	0.739e	0.532i	0.516h	1.298i	1.255i	2.46i	2.30i	0.229g	0.246g	2.69i	2.74i
		15	0.781h	0.749e	0.540h	0.526g	1.321h	1.275h	2.55h	2.37h	0.230g	0.254f	2.78h	2.83h
	50% NPK	5	0.795g	0.763d	0.551g	0.533f	1.346g	1.296g	2.64g	2.46g	0.244f	0.262e	2.87g	2.93g
		10	0.839d	0.795c	0.580d	0.561c	1.419d	1.356d	2.89d	2.73d	0.268d	0.283d	3.11d	3.20d
		15	0.868b	0.818b	0.600b	0.576b	1.468b	1.393b	3.09b	2.92b	0.286b	0.303b	3.28b	3.36b
	75% NPK	5	0.810f	0.772d	0.561f	0.542e	1.371f	1.314f	2.72f	2.54f	0.254e	0.268e	2.96f	3.01f
		10	0.854c	0.807b	0.587c	0.570b	1.440c	1.377c	2.98c	2.84c	0.277c	0.293c	3.22c	3.27c
		15	0.882a	0.829a	0.609a	0.583a	1.491a	1.412a	3.17a	3.01a	0.293a	0.313a	3.39a	3.44a
Without microbien	100% NPK	0	0.824e	0.784c	0.568e	0.551d	1.392e	1.336e	2.82e	2.64e	0.260e	0.279d	3.02e	3.12e

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

On the other hand, the lowest significant average values for chlorophyll a; chlorophyll b; total chlorophyll and N, P and K content of leaves were found when pepper plants fertilized by the combination of microbien+ 5 m^3/fed. chicken manure during both seasons of the study. The findings of chlorophyll could be giving rise to the beneficial effects of each component of the give combination. Chicken manure contains major nutrient elements associated of photosynthetic activities as Mg^{+2}, N, P, K and thus cooperate with the other variables in promoting roots and vegetative growth, and the very close relationship between chlorophyll and nitrogen content especially in mineral (inorganic) forms (Field and Mooney, 1986; Amalitois *et al*., 2004). It is an acceptable finding owing to considering nitrogen as a structural element of chlorophyll and protein molecules, thereby affects the formation of chloroplasts and accumulation within or inside them (Tucker, 2004; Daughtry *et al*., 2000).

These findings may be taken place owing to the availability of various sources for nitrogen (bio-, mineral, and organic) containing N which is involved in biosynthesis of various amino acids, hence proteins function as a structural of chloroplast (Marschner, 1995), subsequently its favorable impact on chlorophyll content is quite expected. The promotive impact of organic and inorganic fertilizer on chlorophyll content may give rise to the fact that N is a component of chlorophyll molecule. These findings are matching with those reported by Maya *et al*. (1999); except for amount of carotenoids. Meanwhile, the lowest values of studied traits were recorded upon using 100 % mineral fertilizer.

Measure crop canopy reflectance in the visible and infrared (IR) wave bands chlorophyll is the most important pigment in leaves, and it is responsible of their greenness. Leaf chlorophyll content can be used as a nitrogen status indicator because this is an essential element in photosynthetic protein synthesis (Taiz and Zeiger, 2010). Initially, in living plants, chlorophyll plays a critical function as primary photosynthetic pigment to capture light intensity from the sun.

Combining together with carotenoids (the accessory photosynthetic pigments–protein complexes), exhibits color appearance which is specific for plant leaf and even as parameter of maturity, quality, and freshness of food crops (Qibing *et al*., 2005; Yan *et al*., 2006). Hence, the above- mentioned results of nutrient content of leaves reflect the positive effect of the presence of a combination among the three sources of nutritive constituents, especially in the presence of mineral fertilizer components and neither its absence (Microbein + 5 m^3 /fed. chicken manure) nor its presence alone (100% NPK of recommended dose).

Subsequently, the critical balance among them especially at treatment of microbien + 75% NPK of recommended dose + 15 m^3/fed. chicken manure declared its significant for the sake of high contents of N, P and K in leaf tissues. These results may be taken place due to the applying biofertilizers contain nutrients and inoculation with nitrogen fixing organisms increased the nitrogen percentage and chlorophyll component which is made up from nitrogen and it is functioning in promoting vegetative growth and green coloration of plant foliage (Mahmoud and Amana, 2000). Also, Ghoname *et al*. (2010) concluded that biofertilizers applied have positive effect on sweet pepper and chemical composition effect by providing supplement doses of nutrient to the plants and in some cases to provide plants with some promoting growth regulators biofertilizer increase microorganisms living in the soil and these microorganism working on the organic matter in the soil to convert organic N to mineral N (Lampkin, 1990), biofertilizer play a fundamental role in and converting P and K fixed form to be soluble ready for plant nutrition making the uptake of nutrients by plants more easy (Abou-Hussein *et al*., 2002). This agreed with the work of Khan *et al.* (2012); Shafeek *et al.* (2016).

Likewise, results of Table (9), illustrates the influence of 75 % NPK-fertilizer rates on chlorophyll a, b and total chlorophyll as well as N, P and K concentration, declared that application of mineral fertilization produced announced increase the traits above-mentioned comparing to other treatments. However, the rate of NPK at 75% recorded the highest values of plant pigment and nutritional.

The superiority concentration of pepper leaf tissues may be attributed to increase the availability of N, P and K in the soil solution becomes available to the plant and improves root growth, hence increase the root absorption area. Consequently, absorption would be higher and nutrient accumulation in leaves tissue increased. These results corroborate with Ortas (2013); Ayodele *et al.* (2015). The obtained results of increases of chlorophyll and nutrient content of leaves by pepper plants treated with microbien + 75% NPK of recommended dose + 15 m^3/fed. chicken manure are in line, more or less, with those reported by Ahmed *et al*. (2013); EL Shimi *et al*. (2015).

5.2. N, P and K nutrient contents of roots and fruits: results postulated in Table (10) exhibit that, Generally, pepper plants fertilized with microbein + 5 m^3 /fed. chicken manure only led, generally, to the highest significant percentages of N, P and K within root tissues of treated plants, during both seasons. On the contrary, the lowest significant percentages of the above-reported contents were recorded at the combination of microbein + 75% NPK of recommended dose + 15 m^3 /fed. chicken manure during both seasons of the study. Regarding nutrient contents of fruits, the results were opposite of nutrient contents of roots, generally, pepper plants treated with the combination of microbein + 75% NPK of recommended dose + 15 m^3 /fed. chicken manure showed the highest significant percentage of N, P and K contents within fruit tissues; whereas their dry fruits contained N as 2.85 and 2.79 %, P as 0.287 and 0.297 %, K as 3.05 and 3.28 %, during both season i.e. 2014/2015 and 2015/2016, orderly.

On the other hand, the lowest significant percentages of the above-reported contents were recorded at the combination of microbein + 5 m^3 /fed. chicken manure during both seasons of the study. The highest percentages of N, P, and K contents in roots, in case of absence of NPK, and presence of both microbien and 5m^3/fed. of chicken manure, could be attributed to the slow release of macro- and micro nutrients during course of microbial decomposition of microbien and organic matter also functions as source of energy for soil microflora which results in improve soil physical properties in the rhizosphere zone, and improving the nutrient in the roots. These findings are in corresponding to those reported by Khan *et al.* (2012); Shafeek *et al.* (2016). On the other extreme, the obtained results, also, indicated that increasing NPK-applied level of 75% of recommended dose, besides microbien and organic manure (15 m^3/fed.), significantly, increased N, P and K percentages in the fruits of pepper and decreased it in the roots. these results may be owned to the quick availability of N, P and K elements of mineral fertilizer at the given percent (i.e., 75%), and the slow release of organic manure of nutrient constituents during the crop growth cycle, in addition to the crucial function of microbien, in this respect, which reflect on vegetative and reproductive organs (fruits). Similar results were reported by Shahein *et al.* (2015); Khandaker *et al.* (2017). The results recorded that pepper plants treated with microbien +75% NPK +15 m^3/fed. chicken manure gave the significant highest N, P and K of fruits, while the highest mean values for N, P and K % in roots recorded with 5 m^3/fed chicken manure in presence of microbien. These results are in line with Ahmed *et al*. (2013); EL Shimi *et al*. (2015).

Table (10). Percentages of N, P, and K contents of both roots and fruits of pepper plants "Top Star" cv. as affected by bio-, mineral and organic fertilizers during 2014/2015 and 2015/2016 growing seasons

Treatments (Fertilizers)			Nutrient contents of roots (% D.W.)						Nutrient contents of fruits (% D.W.)					
			N		P		K		N		P		K	
Bio-	Mineral	Organic m^3/fed.	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Microbien	0% NPK	5 m^3	0.894a	0.986a	0.197a	0.200a	1.269a	1.404a	1.78m	1.60m	0.177m	0.188l	1.93l	2.07m
		10 m^3	0.859b	0.953b	0.187b	0.191b	1.247ab	1.386b	1.86l	1.71l	0.187l	0.196k	2.07k	2.19l
		15 m^3	0.818d	0.910d	0.168d	0.176d	1.195c	1.349d	2.02j	1.89j	0.207j	0.216i	2.23i	2.36j
	25% NPK	5 m^3	0.836c	0.936c	0.178c	0.183c	1.223bc	1.368c	1.96k	1.81k	0.196k	0.207j	2.15j	2.30k
		10 m^3	0.796e	0.887e	0.161e	0.166e	1.160d	1.328e	2.14i	1.98i	0.218i	0.225h	2.37h	2.48i
		15 m^3	0.773f	0.863f	0.151f	0.160f	1.130d	1.299f	2.22h	2.08h	0.224h	0.234g	2.44g	2.58h
	50% NPK	5 m^3	0.750g	0.841g	0.142g	0.152g	1.093e	1.268g	2.31g	2.16g	0.232g	0.244f	2.52f	2.66g
		10 m^3	0.689j	0.778j	0.114j	0.130i	1.030f	1.176j	2.57d	2.52d	0.261d	0.274c	2.81c	2.94d
		15 m^3	0.649l	0.739l	0.098l	0.113k	0.937gh	1.123l	2.77b	2.71b	0.276b	0.293a	2.97b	3.20b
	75% NPK	5 m^3	0.732h	0.820h	0.132h	0.149g	1.061ef	1.237j	2.42f	2.34f	0.239f	0.256e	2.64e	2.77f
		10 m^3	0.668k	0.758k	0.106k	0.122j	0.970g	1.148k	2.66c	2.61c	0.266c	0.282b	2.87c	3.12c
		15 m^3	0.628m	0.715m	0.089m	0.105l	0.907h	1.093m	2.85a	2.79a	0.287a	0.297a	3.05a	3.28a
Without microbien	100% NPK	0	0.712i	0.797i	0.122i	0.142h	1.030g	1.208i	2.51e	2.43e	0.248e	0.264d	2.72d	2.85e

Values having the same alphabetical letter (s) in common, within each column, do not significantly differ, using the revised L.S.D. test at 0.05 level of probability.

CONCLUSION

under the same conditions of this investigation, it could be recommended that application of 75% NPK of recommended dose, in combination with chicken manure at rate of 15 m^3 fed^{-1}, in the presence of microbien to sweet pepper plants "Top Star F1" are preferable and considered as the most suitable treatment for realizing the highest economic and safe yield of sweet pepper. Hence, this combined treatment will save some of the high costs of chemical fertilizers and may reduce the risk of environmental pollution.

REFERENCES

AOAC (1992). Official methods of analysis of the Association of Official Analytical Chemists, 15^{Th} Ed. Published by the Association of Official Analytical Chemists III. North Nineteenth suite 210 Arlington, Virginia 2220/U.S.A.

Abel, S., C. A. Ticconi and C. A. Delatorre (2002). Phosphate sensing in higher plants. Physio. Plant., 115: 1-8.

Abou-Hussein, S. D., I. I. El-Oksh, T. El-Shorbagy and U. A. El-Behairy (2002). Effect of chicken manure, compost and biofertilizers on vegetative growth, tuber characteristics and yield of potato crop. Egypt J. Hort., 29(1): 135-149.

Ademola, O. and O. S. Agele (2015). Effects of nutrient sources and variety on the growth and yield of three cultivars of pepper (*Capsicum annum* l.) in southwestern Nigeria. New York Sci. J., 8(10): 21-29

Adhikari, P., A. Khanal and R. Subedi (2016). Effect of different sources of organic manure on growth and yield of sweet pepper. Adv. Pl. Agric. Res., 3(5): 111-118.

Ahmed, A. A. A., A. A. A. Gabal, A. A. Alkharpotly, F. I. Radwan, A. I. A. Abido (2017). Effect of Mineral, Organic and Bio-fertilization on Cucumber (*Cucumis sativus* L.) Grown Under Plastic Houses Conditions. J. Adv. Agric. Res., 22 (2): 374-400.

Ahmed, M. E. M., A. A. A. Asem, A. Al Araby (2013). Growth, yield and fruit quality of sweet pepper plants as affected by some bioorganic and mineral fertilizers application. Life Sci. J., 10 (4): 2756-2766.

Akbari, G. A., S. M. Arab, H. A. Alikhani, I. Allahadi and M.H. Arzanesh (2007). Isolation and selection of indigenous *Azospirillium* spp. and the IAA of superior strains effects on wheat roots. world. J. Agric. Sci., 3(4) :423- 429.

Amalitois, D., I. Therios and M. Karatissiou (2004). Effect of nitrogen fertilization on growth, leaf nutrients concentration and photosynthesis in three peach cultivars ISHS, Acta Hort. 449:36-42.

Aminifard, M. H., H. Aroiee, M. Azizi, H. Nemati and H. Z.E. Jaafar (2013). Effect of compost on antioxidant components and fruit quality of sweet pepper (*capsicum annuum* L.). J.Cent. Eur. Agric., 14(2): 47-56.

Ayodele, O. J., E. O. Alabi and M. Aluko (2015). Nitrogen fertilizer effects on growth, yield and chemical composition of hot pepper (Rodo). Int. J. Agric. Crop Sci., 8(5): 666-673.

Bahuguna, A., K. P. Singh and S. Bahuguna (2015). Consequence of nitrogen, phosphorus and potash efficiency on the growth and yield attributes of sweet pepper (*Capsicum frutescens*). Int. J. Adv. Res. Biol. Sci., 2(12): 360-365.

Baiyeri, P. K., G. T. Otitoju, N. E. Abu and S. Umeh (2016). Poultry manure influenced growth, yield and nutritional quality of containerized aromatic pepper (*Capsicum annuum* L., var 'Nsukka Yellow'). Afr. J. Agric. Res., 11(23): 2013-2023.

Bareisis, R., P. Sniauka and G. Viselga (2002). Investigation of ecological potato cultivation possibilities. Progressive eco-friendly technological processes in agricultural engineering. Proceedings of the Inter. Conference Raudondvaris Lithuania, 57 (66): 221-222.

Block, G., B. Patterson and A. Subar (1992). Fruit, vegetables and cancer prevention: a review of the epidemiological evidence. Nutr. Cancer, 18: 1-29.

Brandy, C. (1984). The nature and properties of soils. Macmillan publishing Company, New York.

Bricker, B. (1991). MSTATC: A Micro Computer Program from the Design Management and Analysis of Agronomic Research Experiments. Michigan State University, USA.

Brown, J. E., C. H. Gilliam, R. L. Shumack, D. W. Porch and J. O. Donald (1995). Comparison of broiler litter and commercial fertilizer on production of Tomato, *Lycopersicon esculentum*. J. Veg. crop Prod., 1: 53-62.

Caralcantio, A. L., M. C. Oliveira, V. G. Florentina, J. A. dos Santos, F.F. Vierira and C.L. Cavalcanti. (2010). Short cemmuni-Cation: Invitro assessment of erosive potential of energy drinks. Eur. Arch. Paediatr dent.; 11: 253- 255. (C.F.Abilio *et al.*2011. Rev. Odonto Cienc, 26(4) :310- 314).

Chapman, H. D. and P. F. Pratt (1961). Methods of analysis for soils, plant and water. University of California-Division of Agri. Sci. Rev. California**.**

Chaterjee, B., P. Ghanti; U. Thapa and P. Tripathy. (2005). Effect of organic nutrition in sport broccoli (*Brassica oleraceae* var. italic plenck). Veg. Sci., 33(1) :51-54.

Culpepper, C.W., J.S. Caldwell and H.H. Moon. (1935). A physiological study of development and ripening in the strawberry. J. Agric. Res., 50 (8): 645-695.

Daughtry, C. S. T., C.I. Walthall, S. K. Kim, D.E. Broun and J. E. McMurtrey (2000). Estimation corn leaf chlorophyll concentration from leaf and canopy reflectance. Rem. Sens. Environ, 74: 229-239.

Dillon, S.S. (1987). Influence of varied phosphorus supply on growth and xylem cytokinin level of sycamore *(Platamus occidentalis*, L.). Seed linp. Physiol., 61 :521-524.

Duncan, D. (1965). Multiply range and multiple F test. Biometrics, 11, 1-42.

El-Bassiony, A. M., Z. F. Fawzy, E. H. Abd El-Samad and G. S. Riad (2010). Growth, yield and fruit quality of sweet pepper plants (*Capsicum annuum* L.) as affected by potassium fertilization. J. Am. Sci., 6 (12): 722-729.

El-Gizy, S. M. H. (1978). Effect of some fertilizer treatments on growth and yield of strawberries. M.Sc. Thesis. Fac. Agric. Ain-Shams Univ. Cairo, Egypt.

El-Haddad, M. E., Y. Z. Ishac and M. I. Moustafa. (1993). The role of bio-fertilizers in reducing agriculture costs, decreasing environmental pollution and raising crop yields. Arab Univ. J. Agric. Sci., 1 (1): 147-195.

El-Hifny, I. M. M. and M. A. M. El-Sayed (2011). Response of sweet pepper plant growth and productivity to application of ascorbic acid and biofertilizers under saline conditions. Aust. J. Basic App. Sci., 5(6): 1273-1283.

EL-Shimi, N. M. M., E. H. M. El-Badawy and H. I. Tolba (2015). Response of Sweet Pepper Plants to some Organic and Bio-fertilizers and its Effect on Fruit Yield and Quality. Middle East J. Agric. Res., 4(3): 435-445.

Evenhuis, B. and P. W. Dewaard (1980). Principles and practices in plant analysis. FAO Soils bull. 38 (1): 152-163.

Fawzy, Z. F., A. M. El-Bassiony, L. Yunsheng, O. Zhu and A. A. Ghoname (2012). Effect of mineral, organic and bio- fertilizers on growth, yield and fruit quality of sweet pepper. J. of Appl. Sci. Res. 8(8): 3921-3933.

Field, C. and H. A. Mooney (1986). The photosynthesis nitrogen relationship in wild plants In: On the economy of plant from (Givnion T. J, Ed. Cambridge univ. press, 25- 53).

Ghoname, A. A., M. A. El-Nemr, A. M. R. Abdel-Mawgoud and W. A. El-Tohamy (2010). Enhancement of sweet pepper crop growth and production by application of biological, organic and nutritional solutions. Res. J. Agri. And Bio. Sci., 6(3): 349-355.

Goel, A. K., R. D. Laura, D. V. Pathak, G. Anuradha and A. Goel (1999). Use of biofertilizers: potential, constraints and future strategies review. Intl. J. Trop. Agric., 17: 1-18.

Gomez, K. A., and A. A. Gomez (1984). “Statistical Procedures for Agricultural Research”. John Wiley and Sons, Inc., New York.pp:680.

Hamdi, Y. A. (1982). Application of nitrogen –fixing system in soil improvement and management. FAO. Rome. Oil Bullet. 49Pp.

Hameda, E. A. E., R. O. Younis and H.S. Al Othaimen. (2015). Responses of changes in productivity, yield and fruit quality of cucumber (*Cucumis sativus* L) plant under Bio-and chemical nutrition. Eu. J. Acad. Essaps., 2 (7): 68-74.

Hartz, T. K., M. LeStrange and D. M. May (1993). Nitrogen requirements of drip-irrigated peppers. Horti. Sci., 28: 1097-1099.

Hsiao, C. and A. Läuchli (1986). Role of potassium in plant-water relation. In: Advances in plant nutrition 2nd ed., pp. 281-312., Tinker and A. Läuchli (eds.). Praeger, New York.

Itoo, B. A. and K. Manivannan (2004). Effect of macro and micronutrients in different form in comparison with humic acid on growth, yield and quality of tomato (*Lycopersicon esculentum* mill) cv. Annapurra. South. India. Hort. 52 (1/6): 342- 346.

Jackson, M. L., (1967). "Soil Chemical Analysis Advanced Course" Publisher By the author, Dept. of Soils, Univ. of Wise., Madison 6, Washington, U.S.A.

Jamir, T., V. B. Rajwade, V. M. Prasad and C. Lyngdoh (2017). effect of organic manures and chemical fertilizers on growth and yield of sweet pepper (*Capsicum annuum* l.) hybrid indam bharath in shade net condition. Int. J. Curr. Microbiol. Appl. Sci., 6(8): 1010-1019.

Jasso-Chaverria, C., G.J. Hochmuth, R.C. Hochmuth and S.A. Sargent. (2005). Fruit yield, size, and colour responses of two Greenhouse cucumber types to nitrogen fertilization in perlite soilless culture. Horticulture Technology, 15:565.

Khan, A., S. N. M. Shah, A. Rab, M. Sajid, K. Ali, A. Ahmed and S. Faisal (2014). Influence of Nitrogen and potassium levels on growth and yield of chilies. Int. J. Farming and Allied Sci., 3(3): 260-264.

Khan, Z., S. A. Tiyagi, I. Mahmood and R. Rizvi (2012). Effect of N-fertilization, organic matter and biofertilizers on growth and yield of chilli in relation to management of plant-parasitic nematodes. Turk. J. Bot. 36: 73-81.

Khandaker, M. M., F. Rohani, T. Dalorima and N. Mat (2017). Effects of different organic fertilizers on growth, yield and quality of *Capsicum annuum* I. Var. Kulai (Red Chilli Kulai). Biosci., Biotech. Res. Asia, 14(1): 185-192.

Lampkin, N. (1990). "Organic Farming" Farming Press Books and Video-Wharfedule Road, Ipswich (P), 4 LG, United, kingdom, pp: 681.

Lego, M., D. Singh and S. Tsanglao (2016). Effect of different levels of NPK on growth, yield and economic of capsicum (*Capsicum annuum l.*) cv. asha under shade net house cultivation. Int. J. Agric. Sci. Res., 6 (4): 5-8.

Lester, G. E., J. L. Jifon and D. J. Makus (2006). Supplemental foliar potassium applications with or without a surfactant can enhance netted muskmelon quality. Hortic Sci 41(3): 741-744.

López-Espinosa, S. T., A. Moreno-Reséndez, P. Cano-Ríos, N. Rodríguez-Dimas, V. Robledo-Torres and C. Márquez-Quiroz (2013). Organic fertilization: An alternative to produce jalapeño pepper under greenhouse conditions. Emir. J. Food Agric., 25 (9): 666-672.

Mahmoud, H. A. F. and M. A. T. Amana (2000). Response of tomato to biological and mineral fertilizers under calcareous soil conditions. Bull. Fac. Agric., Cairo Univ., 51: 151-174.

Majiid, H., S. Minali, M. Almasi and Y. Mostofi (2011). Total Soluble solids, Titrable acidity and ripenicg index of tomato in various storage conditions. Aust. J. Basic. Appl. Sci., 5(12) :1723- 1726.

Malik, C. P. and M. B. Singh (1980). Plant Enzymology and Histo-Enzymology-A text Manual, PP. 276- 277, Kalyani Publishers, New Delhi, India.

Marha, G., V. Sandera, B. Jaine and M. Practice (2000). Isolation of *Entrabacteria*, Azotobacter and *Pseudomoans* sp. Producers of IAA and siderophores from Colombian., rice rhizoosphere. Rev. Amer. J. Microbiol., 42 :171-176.

Marin, A., L. J. Lirmann, S. L. Brantley and V. Lebron (2001). The release of Fe and Mo from silicates by *Azotobacter* Vineland. Seventh ann. V. M. Gold Schmidt Corf. USA.

Marschner, H. (1995). Mineral Nutrition of higher Plants. 2nd Ed. Academic. press, Harcourt Brace and Co. Publishers, London.

Maya, P., S. Natarajan and S. Thamburaj (1999). Flowering, Fruit characters and quality as influenced by spacing N and P in sweet pepper cv. California wonder. South India. Hort., 45 (314): 125-127.

Moran, R. and D. Porath (1980). Chlorophyll determinations in intact tissue using N,N-dimethylformamide. Plant Physiol. 65, 478–479.

Mottaghian, A., H. Pidashti, M. A. Bahmanyar and A. Abbasian (2008). Leaf and seed micronutrients accumulation in soybean cultivars in response to integrated organic and chemical fertilizer application. Pak. J. Biol. Sci. 11: 1227–1233.

Ortas, I. (2013). Influences of nitrogen and potassium fertilizer rates on pepper and tomato yield and nutrient uptake under field conditions. Acad. J., 8 (23): 1048-1055.

Papendick, R. I., L. F. Elliot and J. F. Power (1987). Alternative production systems to reduce nitrates in ground water. Am. J. Alternative Agr., 11: 19-24.

Parasad, R., D. Bhola, K. Akdi, C. Cruz, K. V. S. S. Sairam, N. Tuteja and A. Varma (2017). Introduction to mycorrhiza: historical development. In: Varma A.; Prasad R.; Tuteja N. (eds) Mycorrhiza. Springer, Chem., 1-7.

Qibing, W., C. Jianjan, H. S. Robert and L. Yuncong (2005). Correlation of visual quality grading SPAD reading of green-leaved foliage plants. J. Pl. Nutr., 28(7): 1215 – 1225.

Ranganayakulu, G. S., G. Veeranagamallaiah and C. Sudhakar (2013). Effect of salt stress on osmolyte accumulation in two ground nut cultivars (*Arachis hypogaea* L.) with contrasting salt tolerance. Afri. J. pl. Sci., 7 (12) :586- 592.

Ranganna, S. (1986). Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Edn., McGraw-Hill Publishing Co. Ltd., New Delhi, Pages: 1112.

Russo, V. M. (1991). Effect of fertilizer rate, application timing and plant spacing on yield and nutrient content of bell pepper. J. Pl. Nutr., 14: 1047-1056.

Shafeek, M. R., Y. I. Helmy and A. A. Ahmed (2016). Productivity of squash plant to mineral and bio-nitrogen fertilizers on plant growth, total fruit yield and leaves mineral content on a sandy soil. Int. J. Chem. Tech. Res., 9(3): 66-75.

Shahein, M. M., S. F. El Sayed, H. A. Hassan and S. Abou-El-Hassan (2015). Producing Sweet Pepper Organically Using Different Sources of Organic Fertilizers under Plastic House Conditions. Inter. Conference on Advances in Agric., Biol. & Environ. Sci., July 22-23.

Singh, B. and J. Ryan (2015). Managing fertilizers to enhance soil health. International Fertilizer Industry Association, Paris, France, 1-24.

Singh, D., P. K. Chhonker and B. S. Dwivedi (2005). Manual on soil plant and water analysis. West Ville publishing house, New Delhi: 200.

Taiz, T and E. Zeiger. (2010). Plant physiology, 5^{th} ed.; Sinauer Associates In., sunder land, MA, USA, 67- 86 pp.

Tomer, R. K., S. K.N. Namdeo, J. S. Raghu and K. P. Tuwar. (1995). Effect of *Azotobacter* and plant growth regulators on productivity of wheat (*Triticum sativum*) in relation to fertilization. Indian J. Agric. Sci., 56(4): 256-259.

Tucker, M. (2004). Primary nutrients and plant growth. In: Essential plant nutrients (Scribed, Ed.). Morth Carolina Dept. Agric.

Tumbare, A. D. and D. R. Niikam (2004). Effect of planting and fertigation on growth and yield of greenchili (*C. annuum*). Indian J. Agri. Sci., 74: 242–245.

Voth, V., K. Uriu and R.S. Bringhurst (1967). Effect of high nitrogen application on yield, fruit quality, and leaf composition of california strawberries. Proc. Amer. Soc. Hort. Sci., 91:249-256.

Yakout, T. R., D. M. Mostafa and G. D. M. Youssef (2014). Utilization of Dried Biogas Digester Residue as an Organic Fertilizer with Mineral and Bio-Fertilizer on Growth and Yield of Sweet Peppers. Alex. Sci. Exch. J., 35(4): 325-333.

Yan, J. L., P. T. Yi, G. Z. Yong, D. Hui and S. rew (2006). Leaf chlorophyll readings as an indicator for spinach yield and nutritional quality with different nitrogen fertilizer application. J. Pl. Nutria. 29 (7): 1207- 1217.

الملخص العربي

تأثير التسميد المعدني والعضوي والحيوي على نباتات الفلفل الحلو النامية تحت ظروف البيوت البلاستيكية

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أجريت هذه الدراسة بغرض إعداد برنامج تسميدي شامل يؤدي إلى زيادة إنتاجية وجودة محصول الفلفل الحلو النامي تحت ظروف البيوت البلاستيكية. وكان الهدف من برنامج التسميد هو تحقيق أفضل توليفة من مختلف الأسمدة (الحيوية والعضوية والغير عضوية) التي تؤدي للحصول على أعلى محصول وجودة من نباتات الفلفل الحلو وخصوصا خلال الموسم الشتوي. تم اجراء التجارب خلال موسمي ٢٠١٤/٢٠١٥ و٢٠١٥/٢٠١٦ في تصميم القطاعات العشوائية الكاملة بثلاث مكررات. واشتملت كل مكررة على ١٣ معاملة. ووزعت كل المعاملات بطريقة عشوائية داخل كل قطاع. وكانت المعاملات المستخدمة عبارة عن التوليفة بين أربع مستويات من التسميد المعدني (صفر و٢٥ و ٥٠ و ٧٥% NPK من كمية السماد الموصي بها) وثلاث مستويات من السماد الداجني (٥ و ١٠ و ١٥ م^{٣}/فدان) مع استخدام السماد الحيوي ميكروبين في كل المعاملات مقارنة بالكنترول (١٠٠% NPK من كمية السماد الموصي بها). وأظهرت النتائج المتحصل عليها أن المعاملة المكونة من التوليف بين السماد الحيوي الميكروبين + ٧٥٪ NPK من كمية السماد الموصي به + ١٥م ^{٣} / فدان سماد داجني، قد أدت للحصول على أعلى متوسطات القيم من صفات النمو الخضري (ارتفاع النبات و قطر الساق وعدد الأوراق والأفرع للنبات والوزن الطازج والجاف للنبات)، و صفة النسبة المئوية للثمار العاقدة، كما أدت لزيادة صفات المحصول معنوياً (عدد الثمار ومتوسط وزن الثمرة و النسبة المئوية للمادة الجافة بالثمار و المحصول المبكر للنبات وللمتر المربع و المحصول الكلي للنبات وللمتر المربع)، وصفات الجودة للثمار (طول وقطر الثمرة و المواد الصلبة الذائبة الكلية و فيتامين سي والسكريات الكلية الغير مختزلة بالثمار)، كما أدت لزيادة معنوية في صفات كلوروفيل أ و ب

والكلوروفيل الكلي أ+ب و محتوى الأوراق والثمار من النيتروجين والفوسفور والبوتاسيوم، خلال موسمي الدراسة مقارنة بباقي المعاملات. كما أوضحت النتائج المتحصل عليها أن نباتات الفلفل "هجين توب ستار" المعاملة بالسماد الحيوي الميكروبين وبدون NPK مع ٥ م٣/فدان سماد داجني سجلت أقل عدد أيام من الشتل حتى ظهور أول زهرة (أدت للتبكير في الإزهار) خلال موسمي الدراسة. كما أظهرت النتائج المتحصل عليها أن معاملة النباتات بالميكروبين+ ٧٥% NPK من كمية السماد الموصي بها+ ١٥ م٣ سماد داجني أدت إلى تأخير التزهير خلال موسمي الدراسة. أما في حالة صفة عدد الأزهار للنبات، فقد أوضحت النتائج أن النباتات المعاملة بالسماد الحيوي الميكروبين + أياً من ٥٠ أو٧٥% NPK + أياً من ١٠ أو ١٥ م٣ سماد داجني في الموسم الأول واستخدام المعاملة ميكروبين+ ٧٥%NPK + ١٥م٣ سماد داجني خلال الموسم الثاني أدت إلى الحصول على أعلى متوسطات القيم لهذه الصفة.

وبناء على النتائج المتحصل عليها يمكننا أن نستنتج أن المعاملة بالميكروبين + ٧٥% NPK من الجرعة الموصي بها + ١٥م ٣ / فدان من سماد الدواجن قد أدت للحصول على أعلى متوسطات القيم لصفات النمو الخضري ومحصول وجودة ثمار نباتات الفلفل النامية تحت ظروف الصوب البلاستيكية مقارنة بالمعاملات الأخرى.