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THE PRODUCTIVITY OF PEPPER PLANTS AS INFLUENCED BY SOME BIOFERTILIZER TREATMENTS UNDER PLASTIC HOUSE CONDITIONS

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By
A.M. Abdalla, F. A. Rizk and S. M. Adam

Horticulture Department, National Research Centre, Dokki, Cairo, Egypt

ABSTRACT

Two experiments were carried out in the plastic houses of El-Bosaily Protected Cultivation Unit in 1998 and 1999 to study the response of sweet pepper plants to bio-fertilizers, i.e. local media, Microbein, Phosphorein, Phosphorein + biogein (1:1) and Biogein.

Data indicated that all bio-fertilizer treatments improved the vegetative growth of the plant compared with the control (no-biofertilizer). Plant growth, expressed as fresh and dry weight contents of plant organs, was the highest with phosphorein + biogein, followed in decreasing order by microbein, phosphorein and lastly with inoculation by local media. Fruit yield, average fruit weight and number of fruits per plant were the highest with plants inoculated with the mixture of phopshorein + biogein, followed in a descending order by microbien, phosphorein, biogein and local media. Fruit chemical composition showed its highest measurements of N and Zn with phosphorein + biogein treatment, and total acidity with phosphorein. The lowest values of vitamin C, total acidity, N, P, K, Fe, Mn, Zn and Cu were recorded with local media treated plants.

Key words: *biofertilizers, pepper production, protected agriculture .*

1. INTRODUCTION

At present , there is a strong evidence for the beneficial impacts of bio-fertilizer inoculants to field crops. However, little attention was directed to the nature of the relationship between bio fertilizers particularly those possessing a symbiotic activity and vegetable crops (Gomaa, 1995).

There is a great debate among scientists about the role played by the microorganisms present in biofertilizers in promoting plant growth. Some investigators stressed their contribution to N_2-fixation, P-or K solubilization, cellulose decomposition ...etc. while others stress the production of plant growth modifying substances by such bio-fertilizers.

Soil microorganisms known as phosphate solubilizing bacteria play a fundamental role in correcting the solubility problem in many soils, by releasing the fixed form to soluble form to be ready for plant nutrition. The organisms capable of carrying out such process are known as phosphate dissolvers (El-Sheekh, 1997).Microbin, Nitrobien gave the same effect of full nitrogen application which saves about 1/3 of the recommended nitrogen (Bedaiwi *et al.*, 1997).

Biogein has high amounts of symbiotic and non symbiotic bacteria responsible for atmospheric nitrogen fixation. Its application reduces required mineral nitrogen by 25 % , increases the availability of various nutrients ,enhances the resistance of plants to root disease and reduces the environmental pollution from chemical fertilizer application (Rizk and Shafeek, 2000).

Biological fertilization of plants by N2-fixing bacteria gained importance in the last years. This method of fertilization aims to minimize the environmental pollution of mineral fertilizers and decreases costs. The effect of inoculation of plants with such bacteria on plant yield and productivity was studied by some investigators (El-Metwaly, 1998).

Utilization of bio-fertilizers in the form of Microbein is very successful in minimizing chemical fertilizer to half of the recommended dose under newly reclaimed soil conditions. Reducing chemical fertilizers plays a great role in protecting the environment from chemical pollution. The significant effect of bio-fertilizers may be due to the effect of different strain groups such as nitrogen fixers, nutrient mobilizing microorganisms which help in increasing the availability of minerals and their forms in the composted materials and increase

levels of extractable NPK (macro nutrients) or Fe, Zn, Mn (micro-nutrients) (El-Kramany *et al.*, 2000).

This study was carried out to investigate the influence of some bio-fertilizer treatments on the growth and productivity of sweet pepper plants grown under plastic houses in the newly reclaimed soil.

2. MATERIALS AND METHODS

Two experiments were carried out in the plastic houses at the Protected Cultivation Unit of El-Bosaily, Behira Governorate during 1998 and 1999 seasons to study the influence of four types of bio-fertilizers, viz., Local Media (prepared by the National Research Centre containing Mychorrizae, Pseudomonas, Putrde, *Bacillus megatherium*, Fungi mixture), Microbein (a nitrogenous biofertilizer containing nitrogen fixation bacteria like *Rhizobium*), Phosphorein (a phosphorus biofertilizer containing phosphate dissolvers or Vesicular Arbuscular mycrohizas and silicate bacteria), Biogein (a nitrogenous biofertilizer containing nitrogen fixation bacteria like *Azotobacter*) Biogein (produced by Ministry of Agriculture) and a 1:1 mixture of Phosphorein and Biogein , as compared to the control (without bio-fertilizer) on pepper plants growth and fruit yield and quality.

The experimental soil was sandy in texture with a pH of 7.92 and E.C. 3.0 mmhos. Soil chemical analysis shows that it contains 11.6 meq/l. of Mg, 12.77 meq./l of Na, 11.8 meq./l of Ca, 2.95 meq./l of HCO3 and 3.46 meq./l of Cl.

Each experiment included 6 treatments, *i.e.* five bio-fertilizer treatments and a control (without bio-fertilizer).Bio-fertilizer treatments were added at a rate of 2 kg/plastic house *i.e.* 540 m^2.

All treatments received chemical fertilizers according to the recommended rate by the National Committee of Protected Cultivation (El-Beltagy and Abou-Hadid, 1988), *i.e.* 3 m^3 chicken manure + 100 kg ammonium sulphate (20 % N) + 75 kg calcium superphosphate (16.5 % P_2O_5) + 50 kg potassium sulphate (48 % K_2O)/house.

Pepper seedlings of cv. Golden hybrid were planted on 20 and 28 of August 1998 and 1999 seasons, respectively.The experimental treatments were arranged in a completely randomized block design with three replicates. Experimental plot area was 20 m^2.

2.1.Samples

2.1.1. Vegetative growth samples

During the vegetative growth period, a random sample of three plants from each replicate was taken, 60 and 90 days after planting, Plant length (cm), number of leaves and branches per plant, fresh and dry weights of whole pepper plant and its leaves and branches were recorded.

2.1.2. Fruit yield and its quality

At harvest time, yield parameters, *i.e.* fruit number per plant and average fruit weight., early and total fruit yield as tons per house were recorded.

2.1.3. Chemical composition

A random sample of ten fruits was taken from each treatment during the 4th harvesting time and was subjected to the determinations of ascorbic acid (Vitamin C) and total acidity contents according to A.O.A.C. (1975), nitrogen, phosphorus and potassium contents according to Black (1983), Watanab and Olsen (1965) and Jackson (1965), respectively.

Micro-elements, *i.e.* Fe, Mn, Zn and Cu were measured using the Atomic spectrophotometer (Philips) according to Chapman and Pratt (1961).

Data obtained in both seasons were subjected to statistical analysis and means were compared using the L.S.D. method at 5 % level of significance according to Snedecor and Cochran (1980).

3. RESULTS AND DISCUSSION

3.1. Growth

Tables (1 & 2) show the growth characters of pepper plants at stages of 60 and 90 days after transplanting during the seasons of 1998 and 1999 as affected by the inoculation of different bio-fertilizer compounds. The bio-fertilizers used significantly increased all plant growth parameters, growth of pepper plants was more vigorous as compared to the control. These findings were true at stages of 60 and 90 days after transplanting. It could be abstracted that the best plant growth, expressed as number, fresh and dry weight of leaves and/or branches was associated with the use of phosphorein + biogein. In a decreasing order by the inoculation with microbein, biogein, phosphorein and lastly by the local media.

Table (1) : Effect of inoculation by bio-fertilizers on the vegetative characters of pepper plants during the season of 1998.

Characters	Plant height (cm)		Number/plant				Fresh weight (g./plant)						Dry weight (g./plant)					
			Leaves		Branches		Leaves		Branches		Leaves+ Branches		Leaves		Branches		Leaves+ Branches	
	Plant stage (days after transplanting)																	
Bio-fertilizers	60	90	60	90	60	90	60	90	60	90	60	90	60	90	60	90	60	90
Control (without)	87	121	68	97	5	9	112	133	89	118	201	251	17.2	20.8	16.7	21.6	33.9	42.2
Local media	88	120	69	95	6	9	114	136	94	123	208	259	18.0	22.3	17.1	22.4	35.1	44.8
Microbein	112	140	85	116	8	16	120	160	106	147	226	307	18.3	29.0	19.2	23.3	37.5	51.3
Phosphorein	91	125	72	101	6	12	116	143	98	135	214	278	18.0	25.1	17.5	22.5	35.5	47.6
Phosphorein+ Biogein (1:1)	116	142	86	119	9	16	124	167	109	153	233	320	18.9	31.2	19.5	24.7	38.4	55.9
Biogein	103	131	77	104	7	14	118	155	101	141	219	296	18.3	27.6	18.7	22.6	37.0	50.2
L.S.D. at 5% level	7.2	8.1	5.8	7.6	1.1	1.4	5.2	8.8	4.7	5.7	8.3	11.6	0.9	1.2	0.7	1.3	2.3	5.3

Table (2): Effect of inoculation by bio-fertilizers on the vegetative characters of pepper plants during the season of 1999.

Characters	Plant height (cm)		Number/plant				Fresh weight (g./plant)						Dry weight (g./plant)					
			Leaves		Branches		Leaves		Branches		Leaves + Branches		Leaves		Branches		Leaves+ Branches	
	Plant stage (days after transplanting)																	
Bio-fertilizers	60	90	60	90	60	90	60	90	60	90	60	90	60	90	60	90	60	90
Control (without)	93	120	70	95	5	9	113	130	85	122	198	252	16.8	20.2	16.3	21.9	33.1	42.1
Local media	95	121	71	94	5	8	116	137	94	125	210	262	17.1	21.6	16.9	22.1	34.0	43.7
Microbein	113	143	84	114	8	15	122	162	103	151	225	313	18.2	30.3	18.7	24.3	36.9	54.6
Phosphorein	96	126	74	105	7	12	118	145	96	136	214	281	17.9	26.5	17.3	22.6	35.2	49.1
Phosphorein+ Biogein (1:1)	116	142	88	121	9	16	126	166	112	157	238	323	19.0	32.0	20.1	24.8	39.1	56.8
Biogein	102	133	76	113	6	13	119	156	99	139	218	375	18.0	28.2	19.4	23.0	37.4	51.2
L.S.D. at 5% level	7.2	8.4	6.3	8.0	0.9	1.2	4.8	7.9	4.4	6.3	14.3	28.0	0.8	1.7	0.8	1.4	2.3	4.1

According to the obtained results, the use of phosphorein together with biogein caused a superiority in dry weight of whole plant of (18.7 and 34.9 %) over the control respectively for stages of 60 and 90 days in the 1st season. This superiority was also obtained in 2nd season amounting (9.1 and 18.4 %). The superiority of using the bio-compound of phosphorein + biogein compared to any individual treatment may be due to the release of the fixed phosphorus from the soil, and fixing nitrogen, hence increasing the concentration and availability of these two elements (P and N) in the root zone. Phosphorus plays a great role in enlargement and cell division as well as the synthesis of nucleic acids. Nitrogen also enhances protein synthesis, division and enlargement of cells as well as it is important for the photosynthetic processes. Thus, an increase in plant growth and its development was obtained. Application of microbein resulted in the second order of biofertilizer stimulation effect after using phosphorein + biogein, hence microbein contains bacterial strains which act on releasing P and N from soil materials. Other investigators recorded a similar trend (El-Khattat, 1992 on wheat and broad bean, El-Awag *et al.*, 1993 on soybean, and El-Sheekh, 1997, El-Kramany *et al.*, 2000 and Rizk and Shafeek, 2000 on other crops).

3.2. Total fruit yield

Table (3) and Fig. (1) present the total and early fruit yield (ton/house of 540 m^2) as well as the average number of fruits/plant and the average weight of fruit obtained in both seasons. All traits were significantly affected at the 5 % level by the different biofertilizer treatments where the mixture of phosphorus with biogein together produced the heaviest tonnage per house, followed in descending order by the inoculation of microbein, phosphorein, biogein, then local media. On the other hand , the results obtained showed that the lowest fruit yield of pepper was recorded with plants which did not receive any type of bio-fertilizer (control). The superiority of using the mixture of phosphorein with biogein together over the control treatment amounted to 2.81 ton/house, (79.1%) in the first season and 2.48 ton/ house (65.6%) in the second season.

Concerning the early fruit yield of pepper, the data obtained revealed a trend completely similar to that of total fruit yield. In other words it could be shown that the pepper plants inoculated with a mixture of

phosphorein and biogein resulted in the highest value of early fruit yield (0.51 and 0.50 ton/house in 1st and 2nd season, respectively).

The average number of fruits per plant recorded its highest value (29 fruits/plant) by using the mixture bio-fertilizer. Moreover, the heaviest pepper fruits, *i.e.* 183 and 180 g.were associated with applying the mixed bio-fertilizer.

It could be summerized that all types of bio-fertilizers used gained an enhancement in total and early fruit yield of pepper. In addition, within the different bio-fertilizers, the mixture of phopshorein and biogein gave the heaviest total and early fruit yield. On the contrary, application of local media resulted in the lowest total and early fruit yield. These findings were similar in the two experimental seasons. The high total yield obtained from using the mixture of bio-fertilizer may be due to the increase of the estimated attributes either in leaves or branches. However, the picture reflected a significant increase in leaves and branche number, fresh and dry weight of pepper plants, and its organs leading to a large increase in the production of pepper in this experiment. On the other hand, the mixture of phosphorein and biogein together, acted mainly in increasing the availability of phosphorus and nitrogen, and consequently increasing their absorption by the plant. It is well known that each of the two elements plays a main role in the plant development and production. Nitrogen is present in chlorophyll molecule and a component of all proteins. Phosphorus is important for early maturity and for fruit production. It functions as a part of the enzyme system having a vital role in the synthesis of other compounds from carbohydrates and is a constituent of nuclear proteins.

The results reported by Ahmed *et al.*, (1997) working with Nitrobeine, El-Sheekh, (1997), Bahr, (1997) and Livosa *et al.*, (1997) working on broad bean, as well as Mansour, (1998), El-Kramany and Bahr (1999) and Rizk and Shafeek (2000) are in good agreement with the present results.

Table (3): Effect of inoculation of bio-fertilizers on total fruit yield of pepper plants during 1998 and 1999 seasons.

Characters / Bio-fertilizers	1998		1999	
	Number of fruits/plant	Average fruit wt. (g.)	Number of fruits/plant	Average fruit wt. (g.)
Control (without)	20	148	21	150
Local media	23	157	23	156
Microbein	28	179	28	175
Phosphorein	26	163	27	165
Phosphorein + Biogein (1:1)	29	183	29	180
Biogein	24	170	25	170
L.S.D. at 5% level	2.1	10.3	2.6	9.7

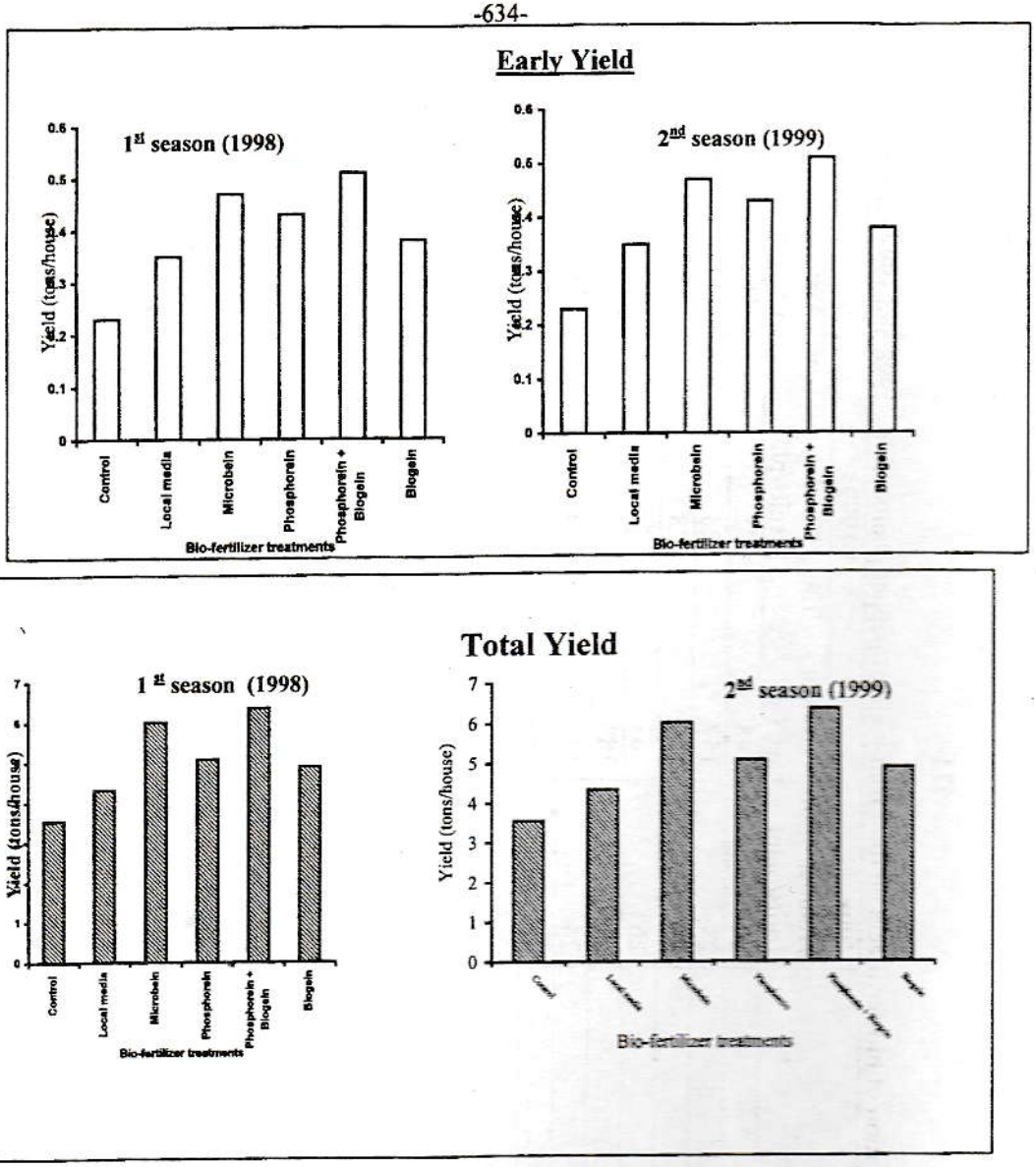

Fig. (1): Effect of inoculation with biofertilizers on total and early fruit yield of pepper in 1998 and 1999 seasons.

Table (4): Effect of inoculation of bio-fertilizers on some nutritional values of pepper fruits during 1998 and 1999 seasons.

Characters	1998									1999								
	mg./g		%			ppm				mg./g		%			ppm			
Bio-fertilizers	V.C	Acidity	N	P	K	Fe	Mn	Zn	Cu	V.C	Acidity	N	P	K	Fe	Mn	Zn	Cu
Control (without)	2.53	164	1.8	0.54	2.38	54	16.2	15.8	8.7	2.57	165	1.9	0.53	2.35	85	16.5	15.6	8.9
Local media	2.59	168	2.0	0.56	2.62	64	17.4	17.9	8.8	2.58	168	2.1	0.55	2.66	61	17.5	17.6	8.7
Microbein	2.71	173	2.2	0.59	2.80	75	19.6	20.6	9.8	2.72	176	2.4	0.59	2.76	73	19.5	20.3	9.7
Phosphorein	2.67	182	1.9	0.59	2.51	74	19.0	19.7	9.5	2.68	183	2.0	0.58	2.55	71	19.1	19.4	9.6
Phosphorein + Biogein (1:1)	2.78	170	2.4	0.61	2.89	76	20.3	21.2	10.6	2.75	170	2.5	0.62	2.80	74	19.8	20.6	9.8
Biogein	2.63	175	2.2	0.56	2.73	69	18.6	19.0	9.3	2.62	179	2.3	0.56	2.71	68	18.4	19.3	9.4
L.S.D. at 5% level	N.S	9.2	0.23	N.S	N.S	N.S	N.S	1.2	N.S	N.S	9.7	0.31	0.04	N.S	N.S	N.S	1.6	N.S

3.3. Fruit chemical composition

The effect of the inoculation with bio-fertilizers as compared to the control (without) treatment on some nutritional values of pepper fruits during the two experimental seasons is shown in Table (4). Data indicate that the total acidity, nitrogen and zinc contents in two seasons, and nitrogen content only in the 2nd season recorded significantly high values at 5 % level as compared with the control.

Moreover, the highest values of N and zinc were obtained by using the mixture of phosphorein and biogein, whereas the highest value of total acidity was recorded by addition of phosphorein only. These results held good in both experiments. Generally, under the conditions of this study it could be concluded that the bio-fertilizer addition produced an increase in values of all studied parameters of the chemical composition of pepper fruits when compared with the control (without bio-fertilizer). In spite of the non-significant differences in some cases, it could be stated that the highest values of the above mentioned criteria were estimated when phosphorein and biogein were mixed and used together. On the opposite, within the different media used here, using local media resulted in the lowest values of vitamin C, total acidity, N, P, K, Fe, Mn, Zn and Cu in tissues of pepper fruit. The studies of several workers (Abd El-Ghaffar, 1994, Ahmed *et al.*, 1997 who worked with Nitrobein , El-Sheekh, 1997, Mansour, 1998 and El-Kramany *et al.*, 2000). support the results reported here.

4.REFERENCES

Abdel-Ghaffar S.A., Hanna A.M. and Mohamed F.G. (1994).Effect of inoculation and foliar application of trace elements on nodulation and yield of bean. Egypt. J. Appl.Sci.,9 (4): 875 – 889.

Ahmed F.F., Aki A.M. , El-Morsy F.M. and Ragab M.A. (1997). The beneficial effect of biofertilziers for Red Roomy grapevines *(Vitis vinifera* L.). 1. The effect on growth and vine nutritional status. Annals Agric. Sci., Moshtohor 4.

A.O.A.C. (1975). Official Methods of Analysis Chemists. 12th ed. A.O.A.C. Washington D.C. USA.

Bahr A.B. (1997). Response of chickpea crop to some fertilization treatments. Ph. D.Thesis Fac. Agric. Suez Canal Univ. Egypt.

Bedaiwi E.H., Mitkees R.A., Eid M.A.M., Iskandar M.H., Iman M.M. , Sadek A.M. Abu-Warda and Hamada A.M. (1997). Effects

of some Egyptian bio-fertilizers on wheat plants (*Triticum aestivum*, L.). Egypt. J. Appl. Sci., 12 (1) : 57 – 67.

Black C.A. (1983). "Methods of soil analysis". Parts I and II. Amer. Soc. Agron. Inc. Publ., Madison, Wisc., USA.

Chapman H.D. and Pratt P.F. (1961). Methods of analysis for soil, plant and water. Department of Soil and Plant Nutrition, Univ. of California, Citrus Exp. Sta. Reverside, California.

El-Awag T.I., Hanna A.M. and El-Naggar I.M. (1993). Influence of bio and mineral phosphate fertilization on soybean production and some water characters under different levels of soil moisture. Zagazig Univ. Egypt. J. Appl. Sci., 8 (11) : 575 – 594.

El-Beltagy A.S. and Abou-Hadid A.F. (1988). Lectures in protected cultivation.Technical publication by National Committee of Protected Cultivation. Ministry of Agriculture, Cairo, Egypt. (In Arabic), pp. 214 – 367.

El-Khatat M.B.O.(1992). Studies on dissolving phosphorus by some microorganisms. M. Sc. Thesis, Botany Dept., Fac. ofAgric. Al-Azhar Univ.

El-Kramany M.F. and Bahr A.B. (1999). Effect of mineral fertilization, organic manuring and bio-fertilization on yield and yield components of chickpea (*Cicer arietinum* L.) cultivation in sandy soil. Egypt. J. Appl. Sci. 14 (11) : 68 – 76.

El-Kramany M.F., Ahmed M.K.A., Bahr A.A. and Kabesh M.O. (2000). Utilization of bio-fertilizers in field crop production. Egypt. J. Appl. Sci. 15 (11) : 137 – 155.

El-Metwaly I.M. (1998). Effect of herbicides and bio-fertilization on growth and yield of wheat under different nitrogen fertilization levels. Ph. D. Thesis, Mansoura Univ. Fac. of Agric.

El-Sheekh H.M. (1997). Effect of bio and mineral phosphate fertilizers on growth, yield, quality and storability of onion. Egypt. J. Appl. Sci., 12 (12) : 213 – 231.

Gomaa A.M. (1995). Response of some vegetable crops to bio-fertilization. Ph. D. Thesis, Cairo Univ., Fac. of Agric.

Jackson M.L. (1965). Soil chemical analysis advanced course. Publ. By Author, Madison, Wisconsin, U.S.A.

Livosa N. Yu, Koval-Chuk E., Lorkavich Z., Galan M.S., Koublczuk E. and Lorkeiwicz Z. (1997). Efficiency of competitiveness of rhizobial strains of broad bean under different soil climatic condition. Mikrobiologich rhizurnal, 59 (4) : 42 – 45.

Mansour A.E.M. (1998). Response of Anna apples to some bio-fertilizers. Egypt. J. Hort. 25 (2) : 241 – 251.

Rizk F.A. and Shafeek M.R. (2000). Response of growth and yield of *Vicia faba* plants to foliar and bio-fertilizers. Egypt. J. Appl. Sci., 15 (12) : 652 – 670.

Snedecor G.W. and Cochran W.G. (1980). Statistical Methods. 7th Ed. Iowa State Univ. Press, Ames, Iowa, USA.

Watanab F.S. and Olsen S.R. (1965). Test of an ascorbic acid method for determining phosphorus and $NaHCO_3$ extracts for soil. Soil Sci. Soc. Amer. Proc. 29 : 677 – 678.

استجابة نباتات الفلفل الحلو للمعاملة ببعض الاسمدة الحيوية تحت ظروف البيوت البلاستيكية

ابو الفتوح محمد عبدالله – فاطمة احمد رزق – صفيه محمد آدم

قسم بحوث البساتين – المركز القومى للبحوث – الدقى – القاهرة

ملخص

تمت زراعة تجربتين متتاليتين فى البيوت البلاستيكية بمحطة بحوث الزراعة المحمية بمنطقة البوصيلى – محافظة البحيرة فى عامى ١٩٩٨ ، ١٩٩٩ وذلك لدراسة تاثير معاملة نباتات الفلفل الحلو ببعض الاسمدة الحيوية تحت ظروف البيوت البلاستيكية.

استخدمت ٥ انواع من الاسمدة الحيوية كالتالى :

البيئة المحلية (المنتج بالمركز القومى للبحوث)، الميكروبين ، الفوسفورين والفوسفورين+البيوجين (١:١) والبيوجين بالاضافة الى الكنترول(بدون تسميد حيوى) .

اشتملت الدراسة على ستة معاملات وزعت بنظام القطاعات الكاملة وتمت اضافة السماد الحيوى بمعدل ٢ كجم بيت البلاستيك (مساحة ٥٤٠ م^2) .

اظهرت النتائج تفوق معاملات السماد الحيوى على الكنترول فى كل من صفات النمو الخضرى والمحصول والتركيب الكيماوى للثمار وكانت افضل معاملات السماد الحيوى هى الفوسفورين + البيوجين (١:١) يليها معاملة الميكروبين ثم البيوجين ثم الفوسفورين واخيرا معاملة البيئة المنتجة محليا .

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٥٢) العدد الرابع (أكتوبر ٢٠٠١): ٦٢٥-٦٤٠.