Evaluation of Two Types of Bio-Fertilizer with Nitrogen Fertilizer Levels on Pepper Plants under Controlled Greenhouse Macroclimate

Mostafa, Doaa M.,[1] G.D.M. Youssef and T.R. Yakout[2]

ABSTRACT

Two experiments were carried out during of 2012 and 2013 seasons under controlled macroclimate of greenhouses on sweet pepper plant (*Capsicum annuum* L.) CV. Spanish to investigate the effects of two bio-fertilizer types, i.e., microbin and blue-green algae and different levels of nitrogen, i.e., 0, 60, 120 and 180 kg N/fed on plant growth, yield and its components as well as N, P and K concentrations (%) in both foliage and pepper fruits. The interaction between the two factors was also studied.

Treating pepper plants with bio-fertilizer, i.e., microbin or blue-green algae significantly increased foliage fresh and dry weights, plants height, fruit yield/plant and average fruit weight as well as nitrogen concentration in both foliage and fruits in the two seasons. On the other hand, number of main stems and fruits dry weight were not significantly affected by bio-fertilizer in both seasons. In addition the number of fruits/plant was not significantly affected in the first season only.

Increasing nitrogen level up to 120 kg N/fed led to significant increases in plant height, fresh and dry weights of foliage/plant, fruit yield/plant as well as average fruit weight in the two seasons. Also, nitrogen had positive effect on nitrogen concentrations percentage in both foliage and fruits in the two seasons.

The interaction between bio-fertilizer and nitrogen levels exerted significant effects on fruit yield/plant, number of fruits/plant and nitrogen concentrations in both foliage and fruits in the two seasons. Treating pepper plants with bio-fertilizer at the rate of 2 kg/greenhouse and 2 liter/greenhouse, intervals in addition to 60 kg N/fed gave the highest total fruit yield/plant.

Key word: bio-fertilizer, nitrogen, pepper, greenhouse, yield, growth.

INTRODUCTION

Pepper is one of the most popular and widely grown vegetable crops, it is highly responsive to nitrogen (N) fertilizer application where N availability may be limited and time of the application is critical (Taber, 2001).

One of the major essential elements for growth of plants is nitrogen. Nitrogen is required in large quantities for plants to grown, since it is the basic constituent of proteins and nucleic acids. Nitrogen is provided in the form of synthetic chemical fertilizer. Such chemical fertilizers dose a health hazard and microbial population problem in soil besides beings quite expensive and making the cost of production high. In such situation, the bio-fertilizer plays a major role (Tiwany et al., 1998).

Bio-fertilizers are the formulation of living microorganism, which are able to fix atmospheric nitrogen in the available form for plants either by living freely in the soil or being associated symbiotically with plants (Subba Rao et al., 1979). Bio-fertilizers are in puts containing microorganism which are capable or mobilizing nutritive elements from non-usable form to usable form through biological processes (Tien et al., 1979). Biological nitrogen fixation is carried out both symbiotic and free living bacteria and blue-green algae. Nitrogen fixing bacteria are very selective in choosing roots of particular legume species to infect, invade from root nodules (Subba Rao, et al., 1979). A unique blend of organic manure using micro nutrients and some beneficial micro organisms with sugarcane press mud as base reported as useful (Arangarasan et al., 2000)

Bio-fertilizers are eco-friendly inputs and are less damaging to the environment chemical fertilizers use (Gentili and Jumpponen, 2006; El- Zeiny et al., 2001) indicated that inoculation of tomato seedlings with bio-fertilizer containing Azotobacer, Azosperillium and Bacillus, increased plant height, leaf number per plant, when compared with control (without bio-fertilizer).

Khalequzzaman and Hossain, (2007) showed that bio-fertilizer application increased germination, plant height and yield of bush bean. Suberamanian et al., (2006) reported that bio-fertilizer increased flower and fruit number per plant yield of tomato.

This study was aimed to evaluate the effect of different N rates applied as ammonium nitrate and two bio-fertilizers (microbin and blue-green algae) on growth and yield of pepper plants cultivar under controlled greenhouse conditions; to predict the optimal N fertilizer requirement under the application of two types of bio- fertilizer for improving pepper production, and to evaluate the mode of action of applying two kinds of bio-fertilizer in agricultural farms.

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[1]Veg. Res. Dept., Horti. Res. Inst., Agric. Rec. Center.
[2]Protected Cultivation Res. Dept., Horti. Res. Inst., Agric. Rec. Center.
Received February 5, 2015, Accepted March 12 , 2015

Table1. Physical and chemical characteristics of soil sampled collected for greenhouse

Properties	Season 2013	Season 2014
Physical properties		
Clay %	45.2	39.5
Silt %	35.1	37.2
Sand %	21.8	23.4
Soil texture	Clay loam	Clay loam
Chemical properties		
*pH	8.5	8.3
**EC (dSm^{-1})	3.35	3.32
Soluble cations (meq ll):		
Ca^{++}	3.8	4.6
Mg^{++}	3.6	2.9
K^{+}	21	19
Na^{+}	7.2	7.4
Soluble anions:		
CO_3^{--}	3.1	3.3
HCO_3^{-}	1.7	1.9
Cl^{-}	5.5	5.6
SO_2^{--}	2.9	3.2
Total N%	0.19	0.18
Available phosphorus	30.9	30.7

* measured in 1:2.5 soil water suspension.

** measured in the water extract of saturation soil paste.

MATERIALS AND METHODS

Two experiments were carried out during 2012 and 2013 seasons under controlled macroclimate of greenhouses on sweet pepper plants (*Capsicum annuum* L.) CV. Spanish, to investigate the effects of bio-fertilizer, i.e., microbin and blue-green algae at different levels of nitrogen, i.e., 0, 60, 120 and 180 kg N/ fed as well as their interaction on growth of pepper plants. Analysis of soil were conducted according to (Black, 1965). Physical and chemical analysis of the experimental soil is shown in Table (1).

Pepper transplants were planted in the 3rd of September in first season and 12th September in second season. The experiment included 12 treatments which were the combination of four nitrogen levels, i.e., 0, 60, 120 and 180 kg N/fed with microbin, or with blue-green or without bio-fertilizer. Treatments were distributed in a split plot design with 3 replicates. The bio-fertilizer treatments occupied the main plots which were subdivided to 4 sub plots each contained one of the nitrogen levels. Each experimental plot area was 9 m^2 (three ridges each was 0.5 m in width and 3 m in length). The pepper plants were treated with microbin and blue-green at the rate of 2 kg/greenhouse and 2 liter/greenhouse, respectively at equal doses one by one of the nitrogen fertilizer which was added also at three equal doses.

All field practices were utilized according to the recommendations of the †Ministry of Agriculture. A random sample of 3 plants from each plot was taken to determine average fresh and dry weights of foliage per plant (gm) as well as fruit dry weight (%). The same sample was used for measuring plant height (cm), number of main stems/ plant, weight and number of fruits/plant. Also, N, P and K concentrations (%) were determined in foliage and fruits according to the methods described by Yuen and Pollard (1952) and King (1951) and Fawzy et al., (2012) for the three elements, respectively.

The data were statistically analyzed and treatment means were compared by using least significant differences (L.S.D.) as reported by Gommez and Gommes (1984).

RESULTS AND DISCUSSION

Vegetative growth:

Data presented in Table (2) showed that treating pepper plants with microbin or blue-green algae (bio-

† Bullentin No. (902), 2004. Agriculture Research Centre, Ministry of Agriculture Egypt.

fertilizer) significantly increased certain vegetative plant characteristics, i.e., foliage fresh and dry weights/plant as well as plant height in both seasons. On the other hand, there was no significant effect on the number of main stems/plant in the two seasons. Concerning the effect of different bio-fertilizer types treatments on the plant growth character, the presented data showed that, pepper plants which supplied with bio-fertilizer as blue-green algae type gained lower plant growth values in comparison with bio-fertilizer as microbin type, i.e., foliage fresh and dry weights/plant and plant height in both seasons. On the contrary, there was significant effect on the number of main stems/plant in the two seasons. A similar trend was reported by El-Zeiny et al., (2001) on tomato plants, Gentiti and Jumpponen (2006) and Imam and Badawy (1978) on potato, they found that treating plants with bio-fertilizer led to an increase in plant growth.

Concerning the effects of nitrogen levels, the fresh and dry weights of the foliage/plant as well as plant height were significantly increased when the nitrogen level was raised up to 120 kg N/fed in the two seasons (Fawzy et al., 2012).

On the other hand, number of main stems/ plant was not significantly affected by nitrogen levels in the two seasons. The increase in vegetative growth by increasing nitrogen level could be due to the role of nitrogen in increasing meristematic activities and consequently the vegetative growth of plant (Russell, 1950). Similar results were reported by (Santeliz and Ewing, 1981; Widjojanto and Widoda, 1982; El-Gamal, 1985; Shehata and Bakeer, 1995). Data also, indicated that the effect of the interaction between treatments were significant for all parameters of vegetative growth in both seasons, except the plant height and number of main stems/plant in the two seasons.

Yield and its components:

Data in Table (3) indicated that treating pepper plants with bio- fertilizer led to significant increases in average yield / plant and average fruit weight in both seasons, as well as number of fruits / plant in the second season only, while fruit dry weight was not significantly affected in fruit the two seasons.

According to the comparison among the two types of bio-fertilizer, both of them achieved significant increment in average yield/ plant and average fruit weight in both seasons, also number of fruits/ plant in the second season only, when, the differences among them not significant, but microbin type accomplished the highest values of the recorded data.

These results are in agreement with those obtained by Berova et al., (2010), they indicated that treated wheat and tomato plants with Azotobacter simulated both growth and yield, also, El- Ghibihi and Abdel El-Fattah (2001) on taro plants, Gentiti and Jumpponen (2006) and El – Zeiny et al., (2001) on tomato plants.

Table 2. Vegetative growth of pepper plants as affected by microbin, blue - green algae, nitrogen levels and their interactions during 2012 and 2013 seasons

Treatments	Characters	Foliage fresh weight/plant (gm)		Foliage dry weight/ plant (gm)		Plant height (cm)		No. of main stems/plant	
		2012	2013	2012	2013	2012	2013	2012	2013
N- levels, (Kg/Fed)	0	340	600	47.36	64.90	61.42	76.62	3.42	4.76
	60	399	642	51.02	68.60	67.17	80.50	4.50	4.88
	120	438	748	55.01	73.50	72.17	91.66	4.92	4.83
	180	447	755	57.05	76.00	73.00	90.16	4.62	4.52
L.S.D. at 5%		12.03	79.0	3.5	10.94	4.64	8.1	N.S.	N.S.
Microbin	0	383	719	48.62	69.30	68.33	79.92	3.90	5.00
	60	429	789	55.95	77.23	69.67	82.66	4.10	5.33
	120	460	831	65.50	81.10	73.33	95.66	5.10	5.73
	180	463	823	66.14	82.74	74.33	96.66	5.23	5.80
L.S.D. at 5%		16.5	13.4	4.3	3.0	3.1	2.5	N.S.	N.S.
Blue-green	0	374	713	42.41	59.81	67.30	78.34	4.56	5.01
	60	412	757	49.98	62.31	68.30	81.65	4.80	5.22
	120	444	817	55.13	70.52	69.90	83.41	4.90	5.30
	180	446	820	57.34	72.89	71.80	84.61	4.80	5.50
L.S.D. at 5%		17.02	83.2	8.70	8.60	N.S.	N.S.	N.S.	N.S.

*N.S. not significant

Table 3. Yield and its components of pepper plants as affected by microbin, blue-green algae, nitrogen levels and their interactions during 2012 and 2013 seasons

Treatments \ Characters		Average fruit weight (gm)		Yield / plant (gm)		No. of fruits / plant		Fruit dry weight (%)	
		2012	2013	2012	2013	2012	2013	2012	2013
N- levels Kg. Fed^{-1}	0	11.51	12.45	432	674	9.19	9.73	6.01	7.23
	60	12.34	13.84	480	787	9.23	10.37	6.31	7.31
	120	14.62	15.91	586	771	9.22	10.91	6.33	7.85
	180	13.56	15.95	526	793	9.31	10.16	5.97	8.22
L.S.D. at 5%		1.77	1.86	74.5	82.12	N.S.	1.17	N.S.	N.S.
Microbin	0	14.52	15.33	489	711	9.70	11.00	6.09	7.91
	60	15.32	17.25	643	1036	9.80	11.96	6.36	8.08
	120	14.65	16.77	686	866	9.74	10.75	6.32	7.82
	180	13.25	15.72	608	731	9.41	10.83	5.88	8.06
L.S.D at 5%		1.1	0.5	78.9	71.4	N.S.	0.6	N.S.	N.S.
Blue- green	0	13.23	14.25	451	715	9.21	10.21	6.11	8.12
	60	14.34	15.63	595	999	9.65	11.11	6.47	8.15
	120	13.63	15.53	645	876	9.62	11.21	6.43	7.95
	180	13.99	14.61	604	633	9.31	10.96	5.85	8.15
L.S.D. at 5%		0.51	0.44	89.5	78.4	*N.S.	1.65	N.S.	N.S.

*N.S. not significant

Also, the results revealed that, increasing nitrogen levels up to 120 kg N/fed caused significant increases in average yield/plant and average fruit weight in the two seasons whereas further nitrogen increase up to 180 kg N/fed caused no significant effect. Number of fruits/ plan in the first season only and fruit dry weight in the two seasons were not significantly affected. The highest fruit yield / plant was obtained with 120 kg N/fed, when, the values of increases were achieved compared with zero N level in the two seasons.

These results might be due to the increase in vegetative growth, since nitrogen is an important constituent of chlorophyll which increases photosynthesis, resulting in assimilation of more carbohydrates and their translocation to the fruits (Chaurasia and Singh, 1995). Similar results were obtained by (Vender and Cremaschi, 1980; Sharma, 1985; Walther and Maoz, 1990 and El- Zeiny et al., 2001). The results in the same table show that there was significant effect due to the interactions between bio-fertilizer and nitrogen levels in fruit yield/plant and average weight of fruits in the two seasons, as well as number of fruit/plant in the second seasons only. No significant change was found in fruit dry weight in the two seasons. Data revealed that treating pepper plants with bio-fertilizer and 60 kg N//fed increased fruit yield/plant compared with untreated treatments also, the comparison among the two types of bio-fertilizer, data showed that there is no significant effect among them in the two seasons.

N, P and K concentrations.

Data in Table (4) showed the effect of the two types of bio-fertilizer i.e.; microbin, blue-green algae, nitrogen levels and their interactions on N, P and K concentrations (%) in both foliage and pepper fruits. The results indicated that application of microbin or blue-green significantly increased the nitrogen concentration in the foliage and fruits in the two seasons. However, no significant effect occurred in phosphorus and potassium concentrations in both foliage and fruits in the two seasons.

Concerning the effects of nitrogen levels on N, P and K concentrations, data in the same table showed that nitrogen concentration (%) in foliage and fruits increased with increasing nitrogen levels in the two seasons, but the differences in nitrogen concentration were not always significant. Phosphorus and potassium concentrations in the foliage and fruits were not significantly affected by nitrogen levels in both seasons. The increase in nitrogen concentration with increasing nitrogen levels due to the fact that nitrogen is an important element for building cells and reproduction.

Constituent of protein and chlorophyll improves the vegetative growth, which led to more absorption of nitrogen (Chaurasia and Singh, 1995). These results are in agreement with those obtained by (Talley, 1983; Furvnes, 1990; Walther and Maoz, 1990). The interactions between bio- fertilizer (microbin or blue-green) and nitrogen levels had no significant effect on N, P and K concentrations in both foliage and fruits in the two seasons.

Table 4. N, P and K concentration in foliage and pepper fruits as affected by microbin, blue-green algae, nitrogen levels and their interactions during 2012 and 2013 seasons

Characters / Treatments		N %				P %				K %			
		Foliage		Fruit		Foliage		Fruit		Foliage		Fruit	
Treatments		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
N- levels Kg/Fed	0	2.12	1.69	1.28	1.00	0.37	0.21	0.43	0.33	3.16	3.76	2.41	2.98
	60	2.94	2.47	1.56	1.22	0.38	0.31	0.57	0.39	3.30	4.04	2.88	3.35
	120	3.50	2.72	2.17	1.49	0.38	0.26	0.51	0.30	3.37	3.39	2.73	3.14
	180	3.67	3.02	2.58	1.50	0.39	0.27	0.55	0.33	3.52	4.15	2.68	3.22
L.S.D. at 5%		0.79	0.65	0.88	0.52	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Microbin	0	2.16	2.06	1.49	1.03	0.53	0.41	0.61	0.48	3.28	3.89	2.60	3.17
	60	2.46	2.52	1.83	1.58	0.55	0.49	0.78	0.62	3.16	4.25	2.81	3.52
	120	2.60	2.81	2.31	1.97	0.63	0.48	0.65	0.49	3.43	3.86	2.78	2.78
	180	2.63	2.85	2.71	1.65	0.63	0.49	0.90	0.63	3.39	4.28	2.89	3.34
L.S.D. at 5%		0.35	o.33	0.34	0.32	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
Blue-green	0	2.41	2.15	1.51	1.21	0.61	0.40	0.59	0.50	3.30	3.54	2.71	3.11
	60	2.51	2.25	1.81	1.61	0.59	0.41	0.79	0.64	3.21	3.99	2.66	3.61
	120	2.60	2.31	1.92	1.88	0.61	0.45	0.59	0.51	3.11	3.73	2.50	2.65
	180	2.62	2.41	2.13	1.71	0.60	0.42	0.89	0.62	3.01	4.10	2.49	3.41
L.S.D. at 5%		0.1	0.1	0.31	0.21	*N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

*N.S. not significant

CONCLUSION

The previous results showed that treating pepper plants with bio-fertilizer (microbin or blue-green algae) under 60 kg N/fed gave the highest values of fruit yield/plant compared with 120 kg N/fed which is used by Egyptian farmers. The obtained results explained that microbin achieved more values than blue-green algae, but, these values were not significant. Therefore, the application by any of the two bio-fertilizers will save considerable amount of nitrogen and will decrease the pollution of environment.

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الملخص العربي

تقييم تأثير نوعين من السماد الحيوي (بكتيري ومستخلص الطحالب البحرية) تحت مستويات مختلفة من التسميد النيتروجيني على نباتات الفلفل النامية تحت ظروف مناخية متحكم فيها في الصوب الزراعية

دعاء محمد مصطفي أحمد، جابر داهش محمد يوسف، طارق ياقوت رمضان

أجريت تجربتان على نباتات الفلفل (الصنف الأسباني) تحت ظروف مناخية متحكم فيها في الصوب الزراعية خلال موسمي الزراعة ٢٠١٣،٢٠١٢ وذلك لدراسة تأثير نوعين مختلفين من السماد الحيوي أحدهما بكتيري(ميكروبين) والآخر مستخاص طحالب بحرية(بلو-جرين) ومستويات مختلفة من السماد الأزوتي (صفر، ١٨٠،٦٠،١٢٠ كجم ن/فدان) بالإضافة إلى تفاعلاتهما على النمو الخضري للنبات والمحصول الكلي للثمار ومكوناته وكذلك تركيز النتروجين والفوسفور والبوتاسيوم في كل من الأوراق والثمار.

أدت معاملة نباتات الفلفل بالسماد الحيوي(أي من النوعين المذكورين) إلى حدوث زيادات معنوية على الوزن الطازج والجاف للمجموع الخضري، ارتفاع النبات، المحصول الكلي للثمار، ومتوسط وزن الثمار للنبات كما زاد أيضا تركيز النيتروجين في كل من الأوراق والثمار في موسمي الدراسة.

ولم يكن هناك تأثير واضح على كل من عدد السيقان الرئيسية والوزن الجاف للثمار في كل من الموسمين بالإضافة إلى عدد الثمار للنبات في الموسم الأول فقط.

أدت زيادة معدل النيتروجين المستخدم حتى ١٢٠ كجم ن / فدان إلى حدوث زيادات معنوية في ارتفاع النبات وكل من الوزن الطازج والجاف للنمو الخضري للنبات، ومحصول الثمار الكلي ومتوسط وزن الثمار للنبات، كما زاد أيضا تركيز النيتروجين في كل من الأوراق والثمار.

وقد أظهر التفاعل بين استخدام التسميد الحيوي (كلا من النوعين) والنيتروجين تأثيرات معنوية على الحصول الكلي للثمار ووزن الثمار للنبات وكذلك تركيز النيتروجين في كل من الأوراق والثمار.

وبصفة عامة أدت معاملة نباتات الفلفل باستخدام الميكروبين بمعدل ٢ كجم/ فدان أوالبلو-جرين بمعدل ٢ لتر / فدان مع استعمال ٦٠ كجم نيتروجين/ فدان إلى الحصول على أعلى محصول من الثمار في كل من موسمي الزراعة.