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EFFECT OF BIO–FERTILIZER, NITROGEN SOURCES AND THEIR INTERACTION ON PLANT GROWTH, YIELD AND QUALITY OF LETTUCE.

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ABSTRACT

Two field experiments were carried out during the two successive winter seasons of 2000-2001 and 2001- 2002 at the Agriculture Experimental Station Faculty of Agriculture – Cairo university at Giza to study the effect of using bio fertilizer and nitrogen sources as well as their interaction on vegetative growth characteristics, yield and quality of Lettuce cv. Balady. Obtained results show that bio – fertilization increased the plant growth of Lettuce plants expressed as plant height, leaves number, chlorophyll reading and total nitrogen, phosphorus and potassium content in the leaves as well as average fresh head weight and total yield. However, it decreased the nitrate content of Lettuce leaves. The highest plant growth expressed as plant height, leaves numbers. chlorophyll reading and N, P and K content in the leaves, total yield and lowest the nitrate content of Lettuce leaves. were obtained by 50% compost + 50% mineral fertilizer followed by 50% cattle manure +50% mineral fertilizer. The lower values of plant growth were obtained by using 100% mineral fertilizer. On the other hand, the highest content of N, P and K and nitrate content of Lettuce leaves were obtained by the same treatments. The combined effect of bio – fertilizer and nitrogen sources did not reflect any statistical increase in all studied growth trails, chlorophyll reading and N, P and K content in the leaves and total yield. While The lowest N, P and K as well as nitrate content of leaves were obtained by using 100% cattle manure followed by 100% compost.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is an important popular leafy vegetable crop grown in Egypt. It is considered as a source of minerals and vitamins as it consumed as fresh green salad. A crop with such promising potentialities for local markets would necessitate much attention to improve its productivity and quality. One of the ways to reduce soil pollution is the use of biofertilizers which have been recommended by several investigators to substitute chemical fertilizers, Agwah and Shahaby (1993) conducted a field experiment to study the effect of *Azospirillum* on lettuce growth and its contents of vitamin C, chlorophyll. They found that there is a significant increase in dry weight and vitamin C while *Azospirillum* had no significant effect on chlorophyll a, chlorophyll b in leaves and yield. On the other hand Talaat (1995) Found that using biofertilizers (*Azotobacter chroococcum* and *A. vinelandii*) increased plant height and number of leaves and fresh and dry weight of lettuce plants.

Effective microorganisms (EM) are microbial inoculants (Hsieh *et al.*, 1995) on extracts of living organisms (nitrogen-fixing, phosphate-dissolving and photosynthetic microorganisms. Sangakkara *et al.*, (1992) reported that application of EM with chemical fertilizers gave good yields under conditions of adequate irrigation. EM applied alone increased yields Hsieh *et al.*, (1995) showed that the addition of microorganism EM appeared to have no significant effect on cabbage yield. However, the increases in cabbage yields in the organic plots compared with chemical plots were greater, especially when the microorganism EM was included in the manures.. Abdel-Ati, *et al.*, (1996); Hammad and Abdel-Ati, (1998) found that the addition of microorganism EM increased tomatoes, phaseolus, capsicum and aubergines yield. El-Banna and Tolba, (2000) found that using biofertilizers increased plant height and number of branches/plant in potato plants. El-Sharkawy, *et al.*, (2003) show that the highest values of plant height were recorded in the plants from plots inoculated with bio-fertilizer nitrobein. Nguyen and Trinh, (2003) and Zaki and Salama, (2006) reported that the use of EM positively affected the growth of cucumber compared with untreated plant, also improved the soil chemical properties by decreasing the electrical conductivity; pH and calcium carbonate content. Also, EM increased soil organic matter and decreased the N, P and K concentrations in soil due to the increasing of nutrients uptake by plants. Nitrogen is highly effective on growth and yield. Alt and Full (1988), Eid and Abo- Sedera (1989) and Shafshak and Abo-Sedera (1990) found that plant height and number of leaves and fresh and dry weight as well as total yield in lettuce plants were significantly increased by increasing nitrogen levels up to 60 or 90 kg N /fed.

Organic manures play a direct role in plant growth as they are the source of all necessary macro-and micro-nutrients in available forms during mineralization. They also improve agrochemical, physical and physiochemical properties of the soil. They improve air and water regimes of the soil, where heavy soils become less compact, while light soil acquire higher moisture and exchange capacities. Thus, growth of most vegetable crops improved by applying different forms of organic fertilizers in this regard, (Dahama, 1999) and El-Desuki *et al.* (2001) found that plant height and leaves number of sweet fennel were significantly increased by increasing the level of organic fertilizer (compost) to 12 ton/feddan. Ouda (2000) pointed out that adding chicken manure at the rate of $15m^3$/fed to tomato plants produced fruit yield similar to that obtained from plants which received mineral fertilizer at 120Kg N+ 45 kg P_2O_5 + 96Kg K_2O/fed). Abd El-Rahman and Hosny (2001) on eggplant indicated that chicken and cattle manure gave significantly greater early yield, marketable and total yield than mineral fertilizers. Youssef *et al.*, (2001) reported that chicken manure had a favorable effect on plant height, However, the lowest early and total yield of tomatoes was recorded due to using 100% chicken manure but adding 25% organic manure + 75% mineral fertilizers increased early and total yield of tomato.

Lettuce as a leafy vegetable crop can accumulate large amounts of nitrate Talaat (1995) mentioned that inoculation of lettuce seedling with (*Azotobacter chroococcum* and *A. vinelandii*) decreased nitrate accumulation in outer and inner midribs compared with untreated plants.

Many investigators found that the different nitrogen sources affected nitrate accumulation. In this respect, , Shafshak and Abo- Sedera (1989), Talaat (1995), Kowalska (1997), Hanafy *et al.*, (2000) and Abou EL- Magd *et al.*, (2005).

This work aimed to study the effect of commercial bio-fertilizers alone or combined with different N sources and their interaction on vegetative growth, yield and its components as well as chemical measurements of Lettuce (cv. Balady.)

MATERIALS AND METHODS

Two experiments were carried out at the Agricultural Experimental station, Faculty of Agriculture, Cairo university, during the winter seasons of 2000/2001 and 2001/2002. The soil of the experimental field was clay in texture with pH 7.69, the chemical analysis of soil samples and used organic manure (chicken manure and compost) was carried out at laboratories of soil and water Research. Inst. Agric. Res. Center according to the methods described by Jakson (1965) and the results of those analyses were presented in Tables (1 and 2).

Table (1): Some chemical properties of the used soil.

Year	pH	EC (dS/m)	Anions mg/1			Cations mg/1				Mineral nutrients mg/kg soil		
			HCO_3^-	Cl^-	so_4^{2-}	Mg	Na	Ca	K	N	P	K
2000/2001	7.79	1.61	1.40	3.60	2.55	1.09	3.20	3.25	0.41	3.0	2.5	20
2001/2002	7.58	1.59	1.26	4.99	4.75	1.38	5.10	4.00	0.58	4.0	2.4	25

Table (2): Chemical analysis of the used organic manure.

Characters \ Organic manures		Compost		Cattle	
		2000/2001	2001/2002	2000/2001	2001/2002
O.C%		33.26	23.28	12.00	23.28
O.M%		57.35	40.31	20.70	20.30
C/N ratio		17.17	11.52	7.19	8.31
PH		8.14	8.30	7.98	8.60
E.C.(ds/m)		4.38	4.10	4.70	4.65
Macro Elements %	N	1.68	1.75	1.44	1.22
	P	0.47	0.45	0.28	0.30
	K	1.23	1.82	2.42	2.90
	Ca	0.1647	0.1725	0.1576	0.1611
	Mg	0.7341	0.7514	0.6211	0.6012
Micro Element s ppm	Zn	28	80	56	70
	Fe	1021	1025	1620	1720
	Mn	111	216	444	446
	Cu	180	175	66	54
Humidity %		20.0	24.80	19.80	17.60
Weight of m^3 (kg)		600	575	750	720

In both seasons the experimental design was split plot design with 3 replicates. The main plots were devoted for nitrogen sources as follows:

1- 100% organic manure (cattle manure)
2- 100% organic manure (compost)
3- 100% mineral fertilizer (ammonium sulphate)
4- 50% organic manure (cattle manure) + 50% mineral fertilizer
5- 50% organic manure (compost)+ 50% mineral fertilizer.

The sub plot were conducted for bio-fertilizer treatments i.e., 1- control (without bio-fertilizer). 2- Immersing seedling roots in EM for 2 minutes before transplanting. The Effective microorganisms (EM) stock solution that used in the study has been produced and available at Ministry of Agriculture, Egypt. EM content different of beneficial Effective microorganisms about 80 species as reported by Higa and Parr (1994). The main species included in EM are as follows:-(Lactic acid bacteria, Photosynthetic bacteria, Yeasts, Fungi).. Seedling roots 40 days old were immersed in (EM) stock solution for 20 minutes before planting. Seeds of lettuce (*Lactuca sative* L.) cv. Balady. Seeds were sown on October 26th- and November 2nd- for the seasons of 2000/2001 and 2001/2002, respectively. Seedlings were transplanting after 40 days from seed sowing at 25cm a part, on both sides of ridges, 70 cm wide and 4 m long. Amount of each manure to be added were determined on the basis of its N-content (Table 2) and the recommended amount were incorporated into the soil at soil preparation at about 30-40 cm. depth, two week before transplanting transplants. The inorganic N was applied at different rates (0,50 and 100 Kg N/fed.),using ammonium sulphate (20.5%N). All nitrogen amounts were divided into three equal parts. and applied (3,6 and 2 weeks after transplanting as side dressing. All treatments were fertilized with calcium super phosphate (15% P_2O_5) at 200 Kg/fed., and potassium sulphate (48% K_2O) at 50 Kg/fed.

Data recorded

Random sample of five plants from each experimental plot were chosen at 12 weeks (at harvest) after transplanting in the two seasons and the following measurements were recorded:

1- Plant height (cm):

The height of plants was measured from the soil surface up to the tip of the height leaf.

2- Number of leaves / plant.
3- Foliage fresh and dry weight (g).
4- Total yield (ton/fed.).

Chemical measurements:

1) Chlorophyll was determined by the method described in A.O.A.C., (1965).
2) Determination of N, P and K in leaves were assayed according to Kock and Mc Meckin (1924) for N, Jakson (1973) for P and Brown and Lilleland (1946) for K.
3) Determination of Nitrates in leaves at the harvest time was estimated according to Salicylic acid method Cafado *et al.* (1975).

Statistical analysis:

The data were exposed to proper Statistical analysis of variance of randomized complete block design by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1-Plant growth and yield:

Data on the effect of bio-fertilizer, different nitrogen sources and their interaction on plant growth characters i.e., plant height, number of leaves per plant, dry weight, fresh head weight and total yield per feddan of lettuce plants were presented in Tables (3 and 4).

1.1- Plant height:

Such data in Tables (3 and 4) indicate that bio-fertilizer treatment recorded the highest and significant increases in plant height in both seasons compared to the untreated plants. In this respect, plant height was significantly increased by all tested nitrogen fertilizer treatments compared with the treatment of 100% mineral fertilizer(control) in both seasons. In this regard, the highest values of plant height were recorded in case of using 50% compost + 50% mineral fertilizer. As for the effect of the interaction, the some data in Tables (3 and 4) reveal that the interaction between Bio-fertilizer and nitrogen sources significantly increased plant height. The tallest significant lettuce plants were obtained by the combined effect of bio-fertilizer and 50% compost + 50% mineral fertilizer followed by bio-fertilizer and 50% cattle manure + 50% mineral fertilization. On the other hand, the lower values of plant height were obtained by the combined effect of 100% mineral fertilizer without bio-fertilizer.

1.2- Number of leaves/plant:

The same data in Tables (3 and 4) show clearly that bio-fertilizer caused statistical increases in the number of leaves per plant compared with the untreated plants. These results were similar in the two seasons.

Concerning the effect of nitrogen sources, such data indicate that the highest leaves number per plant was obtained by using 50% compost + 50% mineral fertilizer. Values of leaves number of the other treatments ranged between those (50% cattle + 50% mineral) and 100% compost fertilizing. The lowest number of leaves was obtained in case of 100% mineral fertilization. These results are nearly similar in the two seasons of study.

Regarding the interaction effect between bio-fertilizer and nitrogen sources, it is obvious that such interaction significantly increased number of leaves per plant. The highest number of leaves per plants was obtained by combined effect of bio-fertilizer and 50% compost+ 50% mineral fertilizer. In addition, the lowest number of leaves per plants was obtained by 100% mineral without bio-fertilizer.

1.3- Fresh and dry weight per plant:

Response of the fresh and dry weight per plant to bio-fertilizer was illustrated in Tables (3 and 4). The results indicate that applying bio-fertilizer had

significant effect on fresh and dry weight per plant compared with untreated plants. These results are true in the two seasons of growth. In addition, the same results presented in Tables (3 and 4) show that fresh and dry weight per plant were significantly affected by applying different sources of organic and inorganic manure during the growth stages of lettuce plant for the two experimental seasons. Data show that the lowest value of fresh and dry weight per plant were obtained with the control plants (100% mineral fertilizer) in the two seasons. While, the highest value was obtained by 100% cattle manure. The results in Tables (3 and 4) reveal also there is synergistic affect due to the combining between organic manure with inorganic manure compared to using mineral fertilizer only.

Table (3): Effect of bio- fertilizer and nitrogen sources as well as their interactions on vegetative growth of lettuce plants during the seasons of (2000-2001).

Characters / Treatment		Plant height (cm.)	No. of leaves per plant	Head fresh weight (g.)	Head dry Weight (g.)	Total yield (Ton/ fed.)
Control		35.67	30.87	367.3	34.00	11.33
EM		40.87	41.27	492.7	40.93	13.51
L.S.D at 0.05		1.47	2.76	34.2	2.11	1.05
100% Recom. NPK		30.00	19.33	280.0	27.17	9.567
100% Recom.Cattel M.		35.00	26.33	366.7	33.83	11.52
100% Recom. Compost		39.00	37.00	380.0	34.83	11.48
50% Recom. NPK+ 50% Recom. Cattel M.		41.5	43.83	473.3	42.67	13.08
50% Recom. NPK + 50% Recom. Compost		45.83	53.83	650.0	48.83	16.45
L.S.D at 0.05		2.32	4.36	54.01	3.34	1.66
Without	100% Recom. NPK	27.00	18.00	210.0	22.67	8.900
	100% Recom.Cattel M.	31.00	19.67	300.0	29.00	10.60
	100% Recom. Compost	37.00	31.33	336.7	32.67	10.63
	50% Recom. NPK+ 50% Recom. Cattel M.	39.67	37.33	413.3	40.67	12.50
	50% Recom. NPK + 50% Recom. Compost	45.83	53.83	650.0	48.83	16.45
EM	100% Recom. NPK	33.00	20.67	350.0	31.67	10.23
	100% Recom.Cattel M.	39.00	33.00	433.3	38.67	12.43
	100% Recom. Compost	41.00	42.67	423.3	37.00	12.33
	50% Recom. NPK+ 50% Recom. Cattel M.	43.33	50.33	533.3	44.67	13.67
	50% Recom. NPK + 50% Recom. Compost	48.00	59.67	723.3	52.67	18.87
	L.S.D at 0.05	3.28	6.16	76.38	4.72	2.35

Table (4): Effect of bio- fertilizer and nitrogen sources as well as their interactions on vegetative growth of lettuce plants during the seasons of (2002-2003).

Characters / Treatment		Plant height (cm,)	No. of leaves per plant	Head fresh weight (g.)	Head dry Weight (g.)	Total yield (Ton/ fed.)
Control		39.07	40.13	396.7	35.20	12.15
EM		43.60	47.27	543.3	44.53	14.28
L.S.D at 0.05		1.78	5.17	38.2	2.69	1.00
100% Recom. NPK		33.67	24.67	303.3	30.33	9.683
100% Recom.Cattel M.		38.17	34.67	386.7	35.00	11.68
100% Recom. Compost		41.17	43.17	416.7	37.67	12.98
50% Recom. NPK+ 50% Recom. Cattel M.		44.67	52.83	550.0	45.00	14.32
50% Recom. NPK + 50% Recom. Compost		49.00	63.17	693.3	51.33	17.42
L.S.D at 0.05		2.81	8.17	60.3	4.25	1.58
Without	100% Recom. NPK	31.33	19.67	243.3	22.33	9.633
	100% Recom.Cattel M.	34.67	32.33	320.3	27.33	10.60
	100% Recom. Compost	39.67	39.33	363.3	35.00	11.97
	50% Recom. NPK+ 50% Recom. Cattel M.	43.33	49.33	453.3	43.67	12.93
	50% Recom. NPK + 50% Recom. Compost	46.33	60.00	603.3	47.67	15.63
EM	100% Recom. NPK	36.00	29.67	363.3	38.33	9.733
	100% Recom.Cattel M.	41.67	37.00	453.3	42.67	12.77
	100% Recom. Compost	42.67	47.00	470.0	40.33	14.00
	50% Recom. NPK+ 50% Recom. Cattel M.	46.00	56.33	646.7	46.33	15.70
	50% Recom. NPK + 50% Recom. Compost	51.67	66.33	783.3	55.00	19.20
	L.S.D at 0.05	3.97	11.56	85.3	6.02	2.24

Concerning the interaction between bio-fertilizer and nitrogen source, the obtained results show that plants received bio-fertilizer with 50% compost + 50% mineral fertilizer were the heaviest in both fresh and dry weight. Similar results were recorded by Talaat (1995), Hammad and Abdel- Ati, (1998) and El-Banna and Tolba, (2000) Found that using biofertilizers increased plant height and number of branches/plant in potato plants. Nguyen and Trinh, (2003) reported that the use of EM positively affected the growth of cucumber compared with untreated plant El-Sharkawy, *et al.*, (2003) show that the highest values of plant height were recorded in the plants from plots inoculated with bio-fertilizer nitrobein. Dahama, (1999),El-Desuki *et al.* (2001) and Agamy (2004) found that plant height and leaves number of sweet fennel were significantly increased by increasing the level of organic fertilizer (compost) to 12 ton/feddan. Youssef *et al.*, (2001) Found that chicken manure had a favorable effect on tomato plant height.

1-4 Total yield

The effect of different studied treatments on yield is presented in Tables (3 and 4).Such data indicated the highest yield was obtained with using bio-fertilizer. On the contrarily, the lowest value was obtained without bio-fertilizer. These results are nearly similar in the two seasons. In this regard Gomaa (1989), Abdel- Ati, *et al.*, (1996); Saber (1996), Awad (1998), Abd allah *et al.*, (2001), Abou EL- Magd *et al.*, (2004), Agamy (2004) and Badawi *et al.*, (2005). reported similar results on studied vegetable crops.

The highest yield was obtained by using 50% compost + 50% mineral fertilizer. Values of yield of the other treatments ranged between those (50% cattle + 50% mineral) and 100% compost fertilizing. The lowest yield was those of 100% mineral fertilizer. Alt and Full (1988), Eid and Abo- Sedera (1989) and Shafshak and Abo- Sedera (1990) found that yield in lettuce plants was significantly increased by increasing nitrogen levels up to 60 or 90 kg N /fed. Ouda (2000)) on tomato plants, Abd El-Rahman and Hosny (2001)) on eggplant and Youssef *et al.*, (2001) reported that the lowest early and total yield of tomatoes was recorded due to using 100% chicken manure, but adding 25% organic manure + 75% mineral fertilizers increased early and total yield of tomato.

Data also showed that the interaction between the application of 50% compost + 50% mineral fertilizer with bio-fertilizer gave the highest yield compared with 100% mineral fertilizer and 100% cattle manure in both seasons. Without the application of bio-fertilizer. These results are in conformity with those reported by Sangakkara *et al.*, (1992), Hsieh *et al.*, (1995), Nguyen and Trinh, (2003), Abd allah *et al.*, (2001), Agamy (2004),Badawi *et al.*, (2005) and Zaki and Salama, (2006). reported similar results on studied vegetable crops.

2- Chemical constituents:

2.1- Chlorophyll content:

Data in Tables (5 and 6) show the effect of bio fertilizer and nitrogen sources as well as their interaction on chlorophyll a and chlorophyll b contents of leaves of lettuce plants during the winter seasons of 2001/2002 and 2002/2003.

In this regard, such data reveal that application of Bio-fertilizer to lettuce seedling resulted in increasing such pigments in the tissues of lettuce leaves. In this respect the highest value was obtained from (EM) bio-fertilizer.

It is obvious also from data in Tables (5 and 6) that chemical analysis for photosynthetic pigments in leaves of lettuce, i.e., chlorophyll a and chlorophyll b were significantly increased with different organic manure, i.e., compost and cattle manure compared with the mineral fertilizer. On the other hand, such photosynthetic pigments content was less in case of using organic sources compared with the treatments which received the mixture of mineral fertilizers and organic manures. Moreover, application of 50% compost + 50% mineral fertilizers gave the greatest values for photosynthetic pigments content in plant leaves during both seasons of this study.

Table (5): Effect of bio- fertilizer and nitrogen sources as well as their interactions on total chlorophyll, N,P,Kand nitrates content in leaves of lettuce plants during the seasons of (2000-2001) .

Characters / Treatment		Chro. .(mg/100g.F.W.)		N. (mg/g.D.W.)		P. (mg/g.D.W.)		K. (mg/g.D.W.)		Nitrates .(ppm)	
		A	B	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner
Control		3.807	1.453	24.80	28.00	2.453	5.093	40.07	52.33	3872	2917
EM		4.540	2.153	28.53	32.47	2.740	5.580	42.73	57.53	3595	2753
L.S.D at 0.05		0.381	0.225	1.20	1.80	0.256	0.335	1.81	2.70	105	169
100% Recom. NPK		2.433	0.950	27.50	32.00	2.367	5.000	41.33	53.83	4660	3317
100% Recom.Cattel M.		3.567	1.333	21.25	23.50	2.017	4.833	39.50	50.00	3425	2675
100% Recom. Compost		4.100	1.867	23.17	26.50	1.550	4.117	35.50	40.83	3048	2317
50% Recom. NPK+ 50% Recom. Cattel M.		4.800	2.183	28.33	33.50	3.050	5.650	42.67	61.00	4048	3100
50% Recom. NPK .+ 50% Recom. Compost		5.967	2.683	32.83	35.67	4.000	7.083	48.00	69.00	3485	2767
L.S.D at 0.05		0.603	0.356	1.90	2.85	0.404	0.526	2.86	4.27	166	268
Without	100% Recom. NPK	2.433	0.950	26.33	28.67	2.367	4.800	40.33	51.33	4903	3500
	100% Recom. Cattel M.	3.367	0.900	21.25	23.50	1.550	4.117	35.50	40.83	3517	2717
	100% Recom. Compost	3.700	1.467	22.00	25.67	1.867	4. 633	37.33	48.67	3100	2350
	50% Recom. NPK+50% Recom. Cattel M.	4.500	1.733	26.67	30.33	2.900	5.467	42.33	56.67	4133	3183
	50% Recom. NPK + 50% Recom. compost	5.467	2.467	29.00	33.00	3.767	6.533	46.67	67.00	3707	2833
EM	100% Recom. NPK	2.867	1.200	28.67	35.33	2.367	5.200	42.33	56.33	4417	3133
	100% Recom.Cattel M.	3.767	1.767	23.00	24.67	1.733	4.200	37.33	43.67	3263	2700
	100% Recom. Compost	4.500	2.267	24.33	27.33	2.167	5.033	41.67	51.33	2997	2283
	50% Recom. NPK+50% Recom. Cattel M.	5.100	2.633	30.00	36.67	3.200	5.833	43.00	65.33	3963	3017
	50% Recom. NPK+50% Recom. compost	6.467	2.900	36.67	38.33	4.233	7.633	49.33	71.00	3333	2633
L.S.D at 0.05		0.852	0.501	2.68	5.53	0.571	0.188	5.57	6.03	235	379

Table (6): Effect of bio- fertilizer and nitrogen sources as well as their interactions on total chlorophyll, N,P,Kand nitrates content in leaves of lettuce plants during the seasons of (2001-2002).

Characters / Treatment		Chro. .(mg/100g.F.W.)		N. (mg/g.D.W.)		P. (mg/g.D.W.)		K. (mg/g.D.W.)		Nitrates .(ppm)	
		A	B	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner
Control		4.540	1.707	26.60	30.27	2.933	5.840	43.27	56.47	4065	3073
EM		5.053	2.333	29.80	34.47	3.020	6.260	45.53	61.67	3957	2983
L.S.D at 0.05		0.331	0.193	1.53	1.41	0.247	0.333	1.82	2.61	171	246
100% Recom. NPK		3.283	1.217	23.00	27.17	1.983	4.733	38.17	44.50	4660	3317
100% Recom.Cattel M.		4.150	1.533	25.50	30.17	2.383	5.583	42.00	55.17	3425	2675
100% Recom. Compost		4.933	2.067	30.17	34.50	3.500	6.400	46.33	63.50	3048	2317
50% Recom. NPK+50% Recom. Cattel M.		5.017	2.367	29.00	32.67	2.833	5.700	44.00	58.00	4048	3100
50% Recom. NPK + 50% Recom. Compost		6.600	2.917	33.33	37.33	4.183	7.833	51.50	74.17	3485	2767
L.S.D at 0.05		0.523	0.304	2.42	2.23	0.391	0.527	2.88	4.14	271	389
Without	**100% Recom. NPK**	2.967	0.9667	21.00	26.33	1.967	4.533	35.67	40.67	4903	3500
	100% Recom.Cattel M.	4.133	1.133	24.00	29.00	2.433	5.467	40.33	53.67	3517	2717
	100% Recom. Compost	4.567	2.000	28.33	28.67	2.700	5.367	43.33	54.67	3100	2350
	50% Recom. NPK+50% Recom. Cattel M.	4.800	1.867	29.00	31.33	3.367	6.233	45.67	60.67	4133	3183
	50% Recom. NPK + 50% Recom. compost	6.233	2.567	30.67	36.00	4.200	7.600	51.33	72.67	3707	2833
EM	**100% Recom. NPK**	3.600	1.467	25.00	28.00	2.000	4.933	40.67	48.33	4417	3133
	100% Recom.Cattel M.	4.167	1.933	27.00	31.33	2.333	5.700	43.67	56.67	3263	2700
	100% Recom. Compost	5.067	2.267	31.33	37.67	3.633	6.567	47.00	66.33	2997	2283
	50% Recom. NPK+50% Recom. Cattel M.	5.467	2.733	29.67	36.67	2.967	6.033	44.67	61.33	3963	3017
	50% Recom. NPK + 50% Recom. compost	6.967	3.267	36.00	38.67	4.167	8.067	51.67	75.67	3333	2633
L.S.D at 0.05		0.740	0.431	3.25	3.15	0.553	0.746	4.08	5.85	384	550

The interaction effect of bio-fertilizer by nitrogen sources on chlorophyll a and chlorophyll b in the two seasons of 2001/2002 and 2002/2003 are presented in Tables (5 and 6). The results show that there were a significant differences due to the interaction of bio-fertilizer and nitrogen sources on leaves chlorophyll a and chlorophyll b content in both seasons.

The results, generally, indicate that the best valuable combinations between the two investigated factors were the inoculation of lettuce seedling with the EM bio-fertilizer and application of 50% compost + 50% mineral fertilizer. The lowest chlorophyll and chlorophyll b content in leaves of plant was observed with the application of mineral fertilizer with and without bio fertilization.

Such increase in photosynthetic pigments of lettuce leaves as a result of bio- fertilizer and nitrogen sources application my be due to the main role of such fertilizers in increasing the concentration of macro and micro elements at rooting zone which consequently increased the uptake by plant which in turn contributed in the synthesis of chlorophyll a and chlorophyll b. These results agree with data obtained by Shafshak and Abo- Sedera (1990), Talaat (1995), Kowalska (1997), Hanafy *et al.*, (2000) and Badawi *et al.*, (2005).

2- Macro nutrients content:

The results of Tables (5 and 6) illustrate the effect of bio-fertilizer and nitrogen sources as well as their interaction on N,P and K contents of outer and inner leaves during the winter seasons of 2002/2003 and 2003/2004

Data presented in Tables (5 and 6) show that the influence of lettuce seedling with bio-fertilizer on N,P and K content in outer and inner lettuce leaves were significant, relative to untreated treatment in both seasons. Nguyen and Trinh, (2003) and Zaki and Salama, (2006) reported that the use of EM increased soil organic matter and decreased the N,P and K concentrations in soil due to the increasing of nutrients uptake by plants.

As for the affect of nitrogen sources the same data show that the influence of nitrogen sources on leaves N,P and K contents were significant and the trend was approximately similar in both seasons. The statistical comparisons among the different nitrogen sources show that using 50% compost + 50% mineral fertilizer followed by 50% cattle + 50% mineral fertilizer appeared to be sufficient for the plants to express the highest chemical constituents in leaves of lettuce.

Data in Tables (5 and 6) illustrate also that, N,P and K content of plant leaves were significantly affected with bio-fertilizer and nitrogen sources applications during both seasons of this work. In this concern, application of EM + 50% compost + 50 mineral fertilizer reflected the maximum increments of mineral content in plant leaves. These results may be attributed to the increase of mineral content in plant leaves. These results agree with data obtained by Shafshak and Abo- Sedera (1990) Agwah and Shahaby (1993), Talaat (1995), and Hanafy *et al.*, (2000).

3- Nitrate content:

Data nitrate accumulation as affected by bio-fertilizers treatments are present in Tables (5 and 6). Bio-fertilizer treatment significantly decreased nitrate concentration in the outer and inner leaves of lettuce in both seasons, as compared to the control (untreated plants). These results are in harmony with those obtained by Agwah and Shahaby (1993), Talaat (1995) and Hanafy *et al.*, (2000) mentioned that inoculation of lettuce seedling with (*Azotobacter chroococcum* and *A. vinelandii*) decreased nitrate accumulation in outer and inner leaves of lettuce compared with untreated plants. Nitrate concentration in the outer and inner of lettuce leaves was decreased by all treatments except for 100% mineral fertilizer. Pechova and Prugar (1986) mentioned that FYM positively affected nitrification processes in the soil and nitrate accumulation in the lettuce crop. Similar results were recorded by many investigators found that the different nitrogen sources affected nitrate accumulation. In this respect, Shafshak and Abo-Sedera (1990), Talaat (1995), Kowalska (1997) and Abou EL- Magd *et al.*, (2005).

Data also showed that the interaction between Bio-fertilizer and nitrogen sources significantly decreased nitrate accumulation in outer and inner leaves of lettuce. The lowest significant nitrate concentration in the outer and inner leaves of lettuce were obtained by the combined effect of bio-fertilizer and 100% compost followed by bio-fertilizer and 100% cattle manure. Higher values of nitrate accumulation in outer and inner leaves of lettuce were obtained by the combined effect of without bio-fertilizer and 100% mineral fertilizer (control), 50% cattle + 50% mineral fertilizer and 50% compost+ 50% mineral fertilizer in a descending order.

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تأثير استخدام السماد الحيوى ومصادر النيتروجين العضوى أو المعدنى والتفاعل بينهما على النمو ومواصفات الجودة والمحصول لنباتات الخس

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تم إجراء تجربتين حقليتين في محطة التجارب الزراعية التابعة لكلية الزراعة جامعة القاهرة محافظة الجيزة في الموسمين الشتويين لعامي(٢٠٠٠-٢٠٠١) و(٢٠٠١- ٢٠٠٢) وذلك لدراسة تأثير استخدام الأسمدة الحيوية ومصادر النيتروجين والتفاعل بينهما على النمو والمحصول وصفات الجودة لنباتات الخس(الصنف البلدي). أوضحت النتائج أن استخدام التسميد الحيوي أدى إلى زيادة النمو النباتي لنباتات الخس معبرا عنة بارتفاع النبات وعدد الأوراق ومحتوى الكلوروفيل الكلى وزيادة محتوى الأوراق من عناصر النيتروجين والفسفور والبوتاسيوم والمحصول الكلى وكذلك انخفاض معدل تراكم النترات. وكذلك تم الحصول على أعلى زيادة في النمو النباتي لنباتات الخس معبرا عنة بارتفاع النبات وعدد الأوراق و محتوى الكلوروفيل الكلى وزيادة محتوى الأوراق من عناصر النيتروجين والفسفور والبوتاسيوم والوزن الطازج للرؤوس والمحصول الكلى وكذلك انخفاض معدل تراكم النترات وذلك بإضافة ٥٠% سماد الكمبوست +٥٠% السماد المعدني يليه ٥٠% سماد الماشية +٥٠% السماد المعدني.وتم الحصول على اقل قيم في النمو النباتي وكذلك تم الحصول على أعلى زيادة في محتوى الأوراق من عناصر النيتروجين والفسفور والبوتاسيوم والنترات بإضافة ١٠٠ % سماد معدني. وكذلك فقد حقق التأثير المتداخل للتسميد الحيوي ومصادر النيتروجين زيادة معنوية للنمو النباتي و محتوى الكلوروفيل الكلى وزيادة محتوى الأوراق من عناصر النيتروجين والفسفور والبوتاسيوم والوزن الطازج للرؤوس والمحصول الكلى وكذلك انخفاض محتوى الأوراق من عناصر النيتروجين والفسفور والبوتاسيوم ومعدل تراكم النترات وذلك بإضافة ١٠٠ % سماد الماشية يليه ١٠٠ % سماد الكمبوست.