ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 46(3): Ho. 373-384, (2008).

RESPONSE OF LETTUCE (*Lactuca sativa* L.) CV. BALADY PLANTS TO SOME FERTILIZATION TREATMENTS

BY

Abd El-All, H.M. and Seham M. Aly
Vegetables Res. Depts., Hort. Res. Inst. Res., Dokki, Giza, Egypt.

ABSTRACT

Two field experiments were consummated at El-Kanater Experimental Farm, Qalyoubia Governorate, Egypt during the two successive winter seasons of 2006 and 2007 to study the effect of nitrobien biofertilizer (added once at the rate of 2 kg/fed mixed with about 25 kg of the soil at two weeks after transplanting), three sources of N-fertilizers, namely urea (46.5% N), ammonium nitrate (33.5% N) and ammonium sulphate (20.5% N) at the rates of 25, 50 and 75 kg/fed added as two equal batches; after transplanting by two weeks and after three weeks later, as well as their interactions on growth, quality, yield and chemical composition of lettuce (*Lactuca sativa* L.) cv. Balady plants.

The obtained results indicated that application of nitrobien significantly improved all the studied vegetative growth parameters, total yield, chlorophjyll a, b and total chlorophyll content, as well as the percentage of N, P and K, but to somewhat decreased the concentration of nitrate. Among the three used N-sources, ammonium sulphate, especially at the rates of 25 or 50 kg/fed were the most effective and favorite N-sources for improving all measured growth characteristics. Moreover, all combined treatments between the biofertilizer; (nitrobien) and the various levels of the studied N-fertilizers sources were markedly improved all vegetative growth traits, total yield and chemical constituents in treated plants, with the mastery of a combination between nitrobien at 2 kg/fed and ammonium sulphate at 25kg/fed., which attained the best growth, greening and total yield accompanied with the lowest concentration of nitrate.

Thus, under the conditions of this work, it could be recommended to fertilize lettuce cv. Balady plants with the combination of 2kg/fed of nitrobien biofertilizer and 25 kg/fed of ammonium sulphate for best growth and high quality.

INTRODUCTION

From the nutritional point of view, lettuce (*Lactuca sativa* L.), which belongs to Fam: Compositae is considered a valuable source of roughage, minerals and vitamins. It ranks first among leafy vegetable crops in value and in popularity (Bailey, 1976).

Plant nutrients are very important for production of crops and healthy food for the world's expanding population. Increasing crop production largely depends on the type of fertilizers used to supplement essential nutrients for plants. The nature and characteristics of nutrients release from chemical, organic and biofertilizers are different, and each type of fertilizer has its advantages and disadvantages regarding plant growth and soil fertility (Chen, 2006). Using chemical fertilizers may result in leaching, pollution of water resources, destruction of microorganisms, crop susceptibility to disease attack, acidification or alkalization of the soil or reduction in soil fertility. Thus, causing irreparable damage to the overall system (Bokhtiar and Sakurai, 2005). They reduce the colonization of plant roots with mycorrhizae and inhibit symbiotic N-fixation by rhizobia due to high N fertilization (Dutta *et al.,* 2003). On the other hand, biofertilizers play a significant role in regulating the dynamics of organic matter decomposition and increasing the availability of some nutrients such as N, P and S, so, chemical fertilizers doses can be lowered, while more nutrients can be gained from the soil itself, and that leads finally to reduce water and soil pollution (Chen, 2006). In addition, biofertilizers differ from chemical and organic fertilizers in the sense that they don't directly supply any nutrients to plants and are cultures of special bacteria and fungi. The production technology of biofertilizers is relatively simple and installation cost is very low compared to chemical fertilizers (Young *et al.,* 2003). In this concern, Chen (2006) reported that rhizobium can fix 50-300 kg N/ha for legumes, while azotobacters can fix 15-20 kg N/ha per year. Phosphobacterins, however increased soluble P_2O_5 to about 200-500 kg/ha, and thus 50 kg of superphosphate can be saved.

Increased attention is now being paid to developing an integrated plant nutrition system that maintains and enhances soil productivity through balanced use of all nutrients sources including chemical, organic and biofertilizers. Such manner was emphasized by Shafshak and Abo-Sedera (1990) who found that increasing N level up to 60 or 90 kg/fed led to a gradual increase in growth, total yield as well as N, P and K contents in the leaves of lettuce plants. Moreover, ammonium sulphate proved to be the most suitable N-source to lettuce to avoid excess amounts of nitrate (NO_3). Agwoh and Shahaby (1993) indicated that Azospirillum significantly increased total dry weight and vitamin C in lettuce. Likwise, Talaat (1995) demonstrated that inoculation of lettuce seedlings with *Azotobacter chroococcum* or *A. vinelandii* greatly raised plant height, number of leaves and fresh and dry weights, whereas nitrate accumulation in the outer and inner midribs was markedly decreased compared to the untreated seedlings. On *Lactuca sativa* cv. Dark green, Hanafy *et al.,* (2002) noticed that a significant increase in shoot height, number of leaves, fresh and dry weights and yield was observed when plants were only treated with nitrobien biofertilizer with ammonium sulphate at 100 kg/fed. whereas a significant decrease in nitrate accumulation was recorded by plants drenched with rhizobacterin, nitrobien, microbien and biogien. On the contrary, content of phosphorus, total sugars, total free amino acids and soluble phenols was detected by plants treated with the different biofertilizers. Moreover, Menezes *et al.,* (2002) demonstrated the necessity of minerals for complementation of organic solution for the best production of lettuce under NFT culture. Likewise, Wang and Kale (2004) postulated that lettuce responded better to biofertilizers (Azotobacter and Azospirillum) at higher levels of N (150kg/ha). Recently, Hassan (2006) on lettuce cv. Balady, mentioned that biofertilization increased plant height, number of leaves, chlorophyll, N, P and K content in the leaves, as well as average fresh head weight and total yield, but it decreased the NO_3 – N content in the leaves. In addition, the highest records in all previous characters, however were obtained by 50% compost+50% mineral fertilizers (at 50 kgN/fed.). the combined effect of biofertilizer and N-sources did not reflect any statistical increase in all the studied traits.

Similarly, Hsieh *et al.* (1995) on cabbage, Hammad and Abdel-Ati (1998) and El-Banna and Tolba (2000) on potato, El-Sharkawy *et al.,* (2003) on Jerusalem artichoke, Abou El-Magd *et al.,* (2004) on onion. Sharma *et al.,* (2005) on cabbage and Zaki and Salama (2006) on cucumber obtained similar results on tested crops.

This work, however aims to study the effect of the different N-levels and sources, alone or in combination with biofertilizer on vegetative growth, yield, nitrate accumulation and chemical composition of lettuce cv. Balady.

MATERIALS AND METHODS

Two field experiments were conducted at El-Kanater Experimental Farm for Hort. Crops, Qalyoubia Governorate, Egypt during the two successive winter seasons of

2005/2006 and 2006/2007 years to fined out the response of lettuce plants to the various levels and sources of N-fertilizers, when added in the presence or absence of bio-fertilizer.

So, seeds of lettuce (*Lactuca sativa* L.) cv. Balady was sown in the nursery on September, 15th for both seasons. Seeds were successfully germinated in the proper time. After germination by about 45 days (on November, 1st), seedlings (8-10 cm long) were transplanted into experimental plots with area of about 10.5m^2 (each plot contained 5 rows with length of 3.5 m and width of 0.6 m) at 20 cm in between on both sides of the ridges, which were 60 cm apart. During preparation the soil for planting. All treatments were fertilized with Ca-Superphosphate (15.5% P_2O_5) at 200kg/fed., and potassium sulphate (48%K_2O) at 50 kg/fed., were added as two doses. Some physical and chemical properties of the soil used in the two seasons are shown in Table (a) according to Jakson (1973).

Table (a) Some physical and chemical properties of the soil used in the two seasons.

Particle size distribution (%)					E.C. ds/m^2	pH	Organic matter (%)
Coarse sand	Fine sand	Silt	Clay	Texture			
7.54	22.28	30.35	39.83	Clay	0.68	7.60	1.7

$CaCo_3$ (%)	Total N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (ppm)	Mn (ppm)	Cu (ppm)
2.1	1.56	0.60	1.50	2.7	1.2	0.82	0.57	0.48

In both seasons, the layout of the experiments was split-split plots design with three replicates. The main plots were devoted for the biofertilizer treatments as follows:

1-No biofertilizer (0.00 kg/fed) referred to as control.

2-Nitrobien (a biofertilizer contains a specific strain of *Azotobacter chroococcum* bacteria) was added once as a soil drench at the rate of 2 kg/fed after the mixing it with about 25 kg soil at two weeks after transplanting.

The sub-plots were conducted for the three nitrogen levels, which were 25, 50 and 75 kg/fed for the three N-sources, namely urea (46.5% N), ammonium nitrate (33.5% N) and ammonium sulphate (20.5% N) that were used as the sub-sub-plots. The amounts of each N-fertilizer under the three employed levels were divided into two equal batches, the first one was added two weeks after transplanting, while the second one was added three weeks later. Other agricultural practices were done as commonly followed in such plantation.

Besides, there are many interaction treatments were originated among the three factors employed in the present study as followes:

a- The interaction between biofertilizer and N-level, as each treatment of nitrobien was combined with each level of N to form 6 interaction treatments.

b- The interaction between biofertilizer and N-source, as each treatment of nitrobien was conjuncted with each type of N-fertilizer to crate 6 interaction treatments.

c- The interaction between N-level and N-source, as each level of N joined with each N-fertilizer type to make 9 interaction treatments.

d- The interaction between biofertilizer, N-level and N-source, as each treatment of nitrobien was binded to each level and each source of N to formalize 18 interactions.

At marketable stage (on December, 31st), a random sample of five plants was taken from each experimental plot to determine: plant height (cm), number of leaves/ plant and total fresh weight/plant (g). In addition, plants of each plot were harvested and weighed to calculate total yield average per feddan in tons.

In fresh leaf samples, however chlorophyll a, b and their total content was determine as ppm according to the method described by Moran (1982), while in dry leaf samples, the percentage of total nitrogen was assayed by micro-Kjeldahle method indicated by Pregl, 1945, phosphorus was determined as described by Jackson, 1973, potassium was measured using the flamephotometer set and nitrate was assayed by method mentioned by Cafado *et al.*, 1975).

Data were then tabulated and subjected to analysis of variance using SAS program (1994) and Duncan's Multiple Range Test (1955) to compare among means of the various treatments.

RESULTS AND DISCUSSION

Effect of different fertilization treatments on:

1- Vegetative growth parameters:

Data in Table (1 and 2) show that application of biofertilizer at the rate of 2 kg/fed significantly increased plant height (cm), number of leaves/plant, total fresh weight/plant (g) and total yield (ton/fed) of treated plants in most cases of both seasons comparing with the untreated ones. That would be reasonable since biofertilizers may fix the air nitrogen, mobilizing phosphate and micronutrients through the production of organic acids lowering soil pH (Saber, 1993), and some of them can secrete growth promoting substance, e.g. auxins, cytokinins and gibberellins (Chen, 2006). In this regard, El-Sharkawy *et al.*, (2003) stated that nitrobien biofertilizer resulted in the tallest Jerusalem artichoke plants with the highest number of scales.

Addition of N-fertilizer in the form of ammonium sulphate gave, in general the highest records in all previous characters in the two seasons, especially when added at the level of 50 kg/fed, which followed by the level of 25 kg/fed. this may be due to the action of (NH_4) SO_4 in reducing soil pH and subsequently enhancing the availability and uptaking of nutrients. In this connection, Shafshak and Abo-Sedera (1990) pointed out that growth and yield of lettuce plants fertilized with ammonium sulphate seemed to be better than those of plants dressed with calcium or ammonium nitrate, that were quickly leached with drainage water.

Regarding the different interaction effects, data reveal that all combinations applied in this trial improved growth and yield of treated plants with various significance levels when compared to the untreated ones in both seasons. However, the superiority was found due to the combined treatment between 2 kg/fed of biofertilizer and 25 kg/fed of ammonium sulphate, as such combination generally registered the utmost high means of vegetative growth and yield in comparison to all other treatments and combinations. This may be attributed to lump the beneficial effects of both nitrobien (as a biofertilizer that fixes the air nitrogen and secrets some growth promoting substances) and ammonium sulphate (as a fertilizer that supplies the plants with N and decreases the soil pH, which produces more available nutrients), and this may be finally lead to maximizing the supply with all macrô- and micro – nutrients necessary for good growth and high yield. On the same line, were those results attained on lettuce varieties by Talaat (1995), Hanafy *et al.*, (2002), Wang and Kale (2004) and Hassan (2006).

2. Chemical composition:

a. Chlorophylls content:

It is obvious from data in Tables (3 and 4) that chlorophyll b content (ppm) was the only pigment that significantly increased in the leaves of plants fertilized with nitrobien compared to the unfertilized ones in both seasons. The increment in chlorophyll a and total chlorophylls a + b content, however was non-significant. This may explained the role of biofertilizer in fixing the atmospheric N, that is considered a main component necessary for stoma lamella and grana development (Chen, 2006). Moreover, using ammonium sulphate as a source for N-fertilization at the rate of 50 kg/fed recorded the highest and significant values in all previous pigments relative to the other sources and levels in the two seasons.

This may be reasonable, due to the role of N-nutrition in activating the vital processes including the formation of photosynthetic pigments. As for the effect of the interactions, data in the same Tables reveal that the highest contet of chlorophyll a, b and total chlorophyll (ppm) was gained by the combination of nitrobien at 2 kg/fed + ammonium sulphate at 25 kg/fed, as this combined treatment recorded means completely surpassed all other means scored by all other treatments and combinations. This may indicate the synergistic effect of both bio-and chemical-fertilizers on promoting chlorophylls synthesis. These results are in accordance with those postulated on lettuce by Menezes *et al.*, (2002) and Hassan (2006). Likewise, Sharma *et al.*, (2005) reported that the combined use of 60 kg. N/fed and Azospirillum was the most effective treatment for enhancement the content of pigments in cabbage leaves.

b- Macro-nutrients content:

According to data presented in Tables (5 and 6), it could be concluded that soil inoculation with nitrobien at the level of 2 kg/fed caused a significant increment in the percentage of N, P and K content in the leaves of treated plants compared to those of untreated ones in both seasons, except for N and K content in the second season, which was increased with non-significant differences relative to their content in the leaves of control plants. With regard to the effect of N-source and level, data in Table (6) show that ammonium sulphate is suitable N- source for improving thses nutrients content in dressed plants in the two seasons, especially when added at the rate of 50 kg/fed, as this rate registered the highest values comparing with the other levels in both seasons. In general, all interactions between the biofertilizer and the different levels of chemical ones hastened the content of previously stated nutrients with various significant levels in comparison to the control means in the two seasons. However, the prevalence in most cases of both seasons was found ascribed to the combined treatment between nitrobien at 2 kg/fed and ammonium sulphate at either 25 or 50 kg/fed. this means that application of biofertilizer usually leads to decrease the amount of chemical fertilizers must be added.

In this concern, Chen (2006) declared that biofertilizers regulate organic matter decomposition and increase the availability of some nutrients from the soil itself. So, chemical fertilizers doses can be lowered, and that of course, protect the environment from chemical pollution. Such findings, however are in parallel with those recorded on lettuce by Shafshak and Abo-Sedera (1990), Hanafy *et al.*, (2002) and Hassan (2006).

c. Nitrate (NO_3-N) content:

Nitrate accumulation is considered the most serious problem facing lettuce production. It occurs in plants as a result of nitrate accumulation in the soil due to the activity of soil nitrification organisms, which mainly results from the intensive application of N-fertilizers carried out by Egyptian farmers. That results in imbalancing nutriational status of the plants, and consequently high nitrate accumulation and soil pollution (Hanafy *et al.*, 2002). Nitrite (NO_2) may be formed from NO_3 after ingestion causing methaemolobinemia (Wright and Davison, 1964). Presence of NO_2 in blood may also result in the formation of nitroseamines, which are carcinogenic (Craddock, 1983). So, reduce nitrate accumulation in lettuce tissues is considered one of the most important objecttives in modern agriculture.

From data illustrated in Tables (5 and 6), it is obvious that supplying plants with nitrobien significantly decreased NO_3 concentration in the leaves relative to plants do not receive such biofertilizer in the two seasons. Ammonium sulphate, however was the only N-source that greatly declined NO_3 accumulation, especially when added at the rate of 25kg/fed in the presence of nitrobien biofertilizer, as this combined treatment gave in general the least means, which were 0.75 and 0.79% in the first and second seasons, respectively. Increasing level of N-fertilization (irrespective the N-source). On the other hand, resulted a pronounced accumulation of nitrate, even under biofertilization treatments, indicating that lowering the application rate of N-fertilizer is the most effective factor in reducing nitrate concentration.

Table (1): Effect of biofertilizer and its interaction with nitrogen level and source on some vegetative growth parameters and total yield of *Lactuca sativa* L. cv Balady plant during 2005 and 2006 seasons.

Biofert. Treat. (Kg/fed)	N. fert. Level (Kg/fed)	Plant height (cm.)				No. of leaves/plant				Total fresh weight/plant (g)				Total yield (ton/fed)			
		u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean
		First season: 2005															
0.00	25	24.00 k	29.00 ij	32.00 hi	28.33 d	23.00 f	24.00 f	25.00 e	24.00 d	388.0f	415.0ef	466.0e	423.0c	17.07 i	17.85 i	19.58 h	18.17 d
	50	30.00 ij	36.00 fg	44.00 ab	36.67 b	31.00 d	36.00 cb	39.00 ba	35.33 b	625. 0bc	641.0bc	689.0ab	651.7a	25.02 e	25.81 de	27.51 bc	26.11 b
	75	32.00 hi	37.00 fg	40.00 cd	36.33 b	29.00 ed	31.00 d	34.00 c	31.33 c	551.0 d	536.7d	541.7d	543.1b	22.81 fg	23.29 f	23.70 f	23.27 c
Mean		28.67 e	34.00 c	38.67 b	33.78 b	27.67 d	30.33 c	32.67 bc	30.22 b	521.3c	530.0bc	565.6b	539.3b	21.63 f	22.32 e	23.60 d	22.52 b
2.00	25	37.00 ef	41.00 bc	47.00 a	41.67 a	34.00 c	37.00 b	42.00 a	37.67 a	650.0abc	690.0ab	725.0a	688.3a	26.28 d	27.98 ab	28.73 a	27.66 a
	50	32.00 hi	39.00 de	43.00 bc	38.00 b	32.00 dc	34.00 c	39.00 ba	35.00 b	672.0ab	668.0ab	690.0ab	676.7a	26.55 cd	26.79 cd	28.53 a	27.29 a
	75	27.00 j	34.00 gh	36.00 fg	32.33 c	29.00 ed	30.00 de	32.00 dc	30.33 dc	534.0d	548.0d	589.0cd	557.0b	22.24 g	23.05 fg	23.85 f	23.05 c
Mean		32.00 d	38.00 b	42.00 a	37.33 a	31.67 cb	33.67 b	37.67 a	34.33 a	618.07ab	635.3a	668.0a	640.7a	25.02 c	25.94 b	27.04 a	26.00 a
		Second season: 2006															
0.00	25	26.00 j	28.00 hi	34.00 ef	29.33 e	22.00 f	23.00 f	26.00 e	23.67 d	403.0 l	412.0 l	430.0k	415.0d	17.71 i	18.09 i	18.70 i	18.17 e
	50	33.00 ef	38.00 cd	42.00 ab	37.67 b	32.00 dc	36.00 cb	39.00 ba	35.67 b	591.0f	623.0e	667.0c	627.0b	24.48 ef	25.23 de	26.76 bc	25.49 b
	75	30.00 gh	36.00 de	40.00 bc	35.33 c	28.00 ed	31.08 dc	35.00 c	31.33 c	413.0 l	549.0h	578.0g	512.3c	21.62 h	2305 g	23.46 fg	22.71 c
Mean		29.67 d	34.00 c	38.67 a	34.11 a	27.33 d	30.00 c	33.33 bc	30.22 b	469.0d	527.0c	558.3cb	518.1b	21.27 e	22.12 d	22.97 c	22.12 b
0.00	25	35.00 de	40.00 bc	44.00 a	39.67 a	34.00 c	38.00 b	43.00 a	38.33 a	659.0d	681.0b	700.0a	676.7a	26.82 bc	27.37 ab	28.19 a	27.46 a
	50	33.00 ef	38.00 cd	41.33 ab	37.44 b	31.00 dc	36.00 cb	38.00 b	35.00 b	643.0d	679.0bc	702.0a	674.7a	26.38 c	27.20 ab	27.91 ab	27.16 a
	75	29.00 hi	31.00 fg	35.00 de	31.67 d	28.00 ed	30.00 d	31.00 dc	29.67 dc	491.0j	503.0j	524.0i	506.0c	20.43 h	21.52 h	21.47 h	21.14 d
Mean		32.33 c	36.33 b	40.11 a	36.26 a	31.00 c	34.67 b	37.33 a	34.33 a	594.3b	621.0a	642.0a	619.1a	24.54 b	25.36 a	25.86 a	25.25 a

* Biofert: biofertilizer, N-fert.: nitrogen fertilizer, u: urea, A.N.: ammonium nitrate and A.S.: ammonium sulphate.

* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 0.05 level

Table (2): Effect of nitrogen level and source and their interaction on some vegetative growth parameters and total yield of *Lactuca sativa* L. cv Balady plant during 2005 and 2006 seasons.

N. fert. Level (Kg/fed)	Plant height (cm.)				No. leaves/plant				Total fresh weight/plant (g)				Total yield (ton/fed)			
	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean
	First season: 2005															
25	30.50 e	35.00 d	39.50 b	35.00 b	28.50 d	30.50 cd	33.50 bc	30.80 b	519.0e	552.5d	595.5c	555.7b	21.7f	22.9e	24.2c	22.9b
50	31.00 e	37.50 bc	43.50 a	37.33 a	31.50 c	35.00 b	39.00 a	35.20 a	648.5b	654.5b	689.5a	664.2a	25.8b	26.3b	28.0 a	26.7a
75	29.50 e	35.5 cd	38.00 b	34.33 b	29.00 d	30.50 cd	33.00 cb	30.80 b	542.5de	542.4de	565.4dc	550.1b	22.5e	23.2de	23.7cd	23.1b
Mean	30.33 c	36.00 b	40.33 a		29.70 c	32.00 b	35.20 a		570.0c	583.1b	616.8a		23.3c	24.1b	25.3a	
	Second season: 2006															
25	30.50 d	34.0 c	39.00 b	34.50 b	28.00 e	30.50 d	34.50 cb	31.00 b	526.0f	546.5e	565.0d	545.8 b	22.3d	22.7cd	23.4c	22.8b
50	33.00 c	38.0 b	41.67 a	37.56 a	31.50 dc	36.00 b	38.50 a	35.30 a	617.0c	651.0b	684.5a	650.8a	25.4b	26.2b	27.3a	26.3a
75	19.50 d	33.5 c	37.50 b	33.50 c	28.00 e	30.50 d	33.00 c	30.50 b	452.0g	524.5f	550.5e	509.0c	21.0e	22.3d	22.0d	21.8c
Mean	31.0 c	35.17 b	39.39 a		29.20 c	32.30 b	35.30 a		531.7c	574.0b	600.0a		22.9b	23.7a	24.3a	

* Biofert: biofertilizer, N-fert.: nitrogen fertilizer, u: urea, A.N.: ammonium nitrate and A.S.: ammonium sulphate.

* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 0.05 level

Table (3): Effect of biofertilizer and its interaction with nitrogen level and source on chlorophyll contents in the leaves of *Lactuca sativa* L. cv Balady plant during 2005 and 2006 seasons.

Biofert. Treat. (Kg/fed)	N. fert. Level (Kg/fed)	Chlorophyll a (ppm)				Chlorophyll b (ppm)				Chlorophyll a + b (ppm)			
		u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean
		First season: 2005											
0.00	25	102.3 h	109.3gh	114.9 fg	108.8 e	43.20 i	45.10i	46.30i	44.87e	145.5h	154.4gh	161.2g	157.3e
	50	162.1 cd	169.2bc	188.3a	173.2ab	57.10 ef	62.80abc	64.90ab	61.60ab	219.2d	232.0bc	253.1a	234.8ab
	75	154.0 d	157.3d	161.4cd	157.6c	53.80gh	60.10cde	60.90cd	58.27c	207.8e	217.4de	222.3cd	215.8c
Mean		139.5d	145.3c	154.9b	146.5a	51.37c	56.00cd	57.37c	54.91b	190.8d	201.3c	212.2b	201.4a
2.00	25	161.3cd	177.1b	192.6a	177.0a	57.90de	63.30ab	66.10a	62.43a	219.2d	240.4b	258.7a	239.4a
	50	158.1d	169.3bc	179.3ab	168.9bc	54.50gh	61.60bc	64.90ab	60.33b	212.6de	230.9bc	235.2b	226.2b
	75	120.9ef	122.3ef	125.7e	123.0d	53.30h	53.40h	55.10fg	53.93d	174.2f	175.7f	180.8 f	176.9d
Mean		146.8c	156.2b	165.9a	156.3a	55.23 d	59.43b	62.03a	58.90a	202.0c	215.7b	224.9a	214.2a
		Second season: 2006											
0.00	25	104.0f	110.0ef	115.7ef	109.9c	45.36i	47.38i	49.16ih	47.30d	149.4h	157.4gh	164.9fg	157.2d
	50	166.4cd	170.3bc	190.9ab	175.9ab	59.85de	65.93ab	68.21a	64.66a	226.3de	236.2cd	259.1ab	240.7a
	75	156.7dc	161.2cd	168.3cb	162.1b	55.70fg	63.10abc	64.03ba	60.94b	212.4bc	224.3de	232.3cd	223.0b
Mean		142.4b	147.2b	158.3ab	149.3a	53.64e	58.80cd	60.47b	57.63b	196.0c	206.0bc	218.8b	207.0a
0.00	25	163.1cd	179.2ab	199.3a	180.5a	58.70de	64.18ba	67.00a	63.29a	221.8de	243.4bc	266.3a	243.8a
	50	152.3d	163.1cd	172.9bc	162.8b	55.62fg	61.80bc	65.10ab	60.84b	207.9c	224.9de	238.0bc	223.6b
	75	119.8ef	121.4ef	127.2e	122.8c	53.50h	54.00gh	55.76fg	54.42c	173.3fg	175.4fg	183.0f	177.2c
Mean		145.1b	154.6ab	166.5a	155.4a	55.94 d	59.99c	62.62a	59.52a	201.0c	214.6b	229.1a	214.9a

Table (4): Effect of nitrogen level and source and their interaction on chlorophyll contents in the leaves of *Lactuca sativa* L. cv Balady plant during 2005 and 2006 seasons.

N. fert. Level (Kg/fed)	Chlorophyll a (ppm)				Chlorophyll b (ppm)				Chlorophyll a + b (ppm)			
	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean
	First season: 2005											
25	131.8e	143.2d	153.7c	142.9b	50.6f	54.2de	56.2cd	53.7c	182.4f	197.4 de	209.9c	196.6b
50	160.1c	169.3b	179.3a	169.5a	55.8cd	62.2b	64.9a	61.0a	215.9c	231.4 b	244.1a	230.5a
75	137.4dc	139.8d	143.6d	140.3b	53.6e	56.8c	58.0c	56.1b	191.0e	196.6de	201.6d	196.4b
Mean	143.1c	150.8b	158.9a		53.3c	57.7b	59.7a		196.4c	20.85b	218.6a	
	Second season: 2006											
25	133.6e	144.6de	157.5bc	145.2b	51.7d	55.6c	57.4bc	54.9b	185.2e	200.1cd	214.9bc	200.1b
50	159.3bc	166.7ab	181.9a	169.3a	55.0c	61.8a	64.3a	60.4a	214.3b	228.5b	246.1a	229.6a
75	155.2cb	141.3dc	145.8cd	147.4b	52.5d	56.3bc	58.1b	55.6b	207.7cd	197de	203.9cd	203.0b
Mean	149.4b	150.9b	161.7a		53.0c	57.9b	59.9a		202.4b	208.8b	221.6a	

* Biofert: biofertilizer, N-fert.: nitrogen fertilizer, u: urea, A.N.: ammonium nitrate and A.S.: ammonium sulphate.

* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 0.05 level

Table (5): Effect of biofertilizer and its interaction with nitrogen level and source on some constituents in the leaves of *Lactuca sativa* L. cv Balady plant during 2005 and 2006 seasons.

Biofert. Treat. (Kg/fed)	N. fert. Level (Kg/fed)	N (%)				P (%)				K (%)				NO_3 (%)			
		u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean
		First season: 2005															
0.00	25	2.60 j	2.80 i	2.82 i	2.74 e	0.251 i	0.268 hi	0.295 gh	0.271 d	2.38 j	2.52 i	2.74 gh	2.55 c	1.29 g	1.35 f	1.14 i	1.26 d
	50	3.74 ef	3.90 cd	4.09 ab	3.91 b	0.328 ef	0.368 cd	0.396 ab	0.364 b	3.82 e	3.92 de	4.23 a	3.99 a	1.59 d	1.70 c	1.45 e	1.58 b
	75	3.59 g	3.70 fg	4.09 ab	3.79 c	0.331 ef	0.370 bc	0.381 bc	0.361 b	3.60 f	3.86 e	4.00 c	3.82 b	1.81 b	1.90 a	1.70 c	1.80 a
Mean		3.31 d	3.47 c	3.67 ab	3.48 b	0.303 d	0.335 c	0.357 b	0.332 b	3.27 c	3.43 b	3.66 a	3.45 b	1.56 b	1.65 a	1.43 c	1.55 a
2.00	25	3.81 de	3.98 bc	4.15 a	3.98 a	0.339 de	0.389 ab	0.410 a	0.379 a	3.91 de	3.99 cd	4.13 ab	4.01 a	0.80 l	0.86 k	0.75 l	0.80 f
	50	3.67 fg	3.82 de	4.02 ab	3.84 c	0.329 ef	0.378 bc	0.399 ab	0.369 b	3.62 f	3.84 e	4.03 bc	3.83 b	1.09 i	1.22 h	1.00 j	1.10 e
	75	2.79 i	2.98 h	3.02 h	2.93 d	0.292 gh	0.306 fg	0.316 ef	0.305 c	2.40 j	2.63 h	2.76 g	2.60 c	1.50 e	1.63 d	1.31 fg	1.48 c
Mean		3.42 i	3.59 b	3.73 a	3.58 a	0.320 cd	0.358 b	0.375 a	0.351 a	3.31 c	3.49 b	3.64 a	3.48	1.13 e	1.24 d	1.02 f	1.13 b
		Second season: 2006															
0.00	25	2.60 i	2.75 hi	2.80 gh	2.72 c	0.259 j	0.279 i	0.299 gh	0.279 d	2.40 i	2.43 i	2.61 h	2.48 c	120 h	1.39 g	1.05 i	1.21 d
	50	3.75 de	3.83 cd	3.98 ab	3.85 a	0.334 f	0.379 c	0.422 a	0.378 ab	3.79 ef	4.00 b	4.20 a	4.00 a	1.60 de	1.73 bc	1.42 fg	1.58 b
	75	3.62 f	3.85 cd	4.12 a	3.86 a	0.340 f	0.358 de	0.399 b	0.366 b	3.69 g	3.73 f	4.00 b	3.81 b	1.80 b	1.95 a	1.65 cd	1.80 a
Mean		3.32 f	3.48 b	3.63 a	3.48 a	0.311 e	0.339 c	0.373 b	0.341 b	3.29 d	3.39 c	3.60 b	3.43 a	1.53 b	1.69 a	1.37 c	1.53 a
0.00	25	3.71 ef	3.90 bc	4.06 ab	3.89 a	0.345 ef	0.396 b	0.422 a	0.388 a	3.90 cd	3.98 bc	4.24 a	4.04 a	0.82 k	0.90 jk	0.79 k	0.84 f
	50	3.63 f	3.78 de	4.00 ab	3.80 a	0.331 f	0.369 cd	0.409 ab	0.370 b	3.73 f	3.85 de	4.03 b	3.87 b	1.07 i	1.20 h	1.01 ij	1.09 e
	75	2.69 hi	2.81 gh	2.96 g	2.82 b	0.289 hi	0.397 b	0.309 g	0.332 c	2.31 j	2.43 i	2.70 h	2.48 c	1.51 ef	1.60 de	1.30 gh	1.47 c
Mean		3.34 c	3.50 b	3.67 a	3.50 a	0.322 d	0.387 a	0.388 ab	0.363 a	3.31 d	3.42 c	3.66 a	3.46 a	1.13 e	1.23 d	1.03 f	1.13 b

* Biofert: biofertilizer, N-fert.: nitrogen fertilizer, u: urea, A.N.: ammonium nitrate and A.S.: ammonium sulphate.

* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 0.05 level

Table (6): Effect of nitrogen level and source and their interaction on some constituents in the leaves of *Lactuca sativa* L. cv Balady plant during 2005 and 2006 seasons.

N. fert. Level (Kg/fed)	N (%)				P (%)				K (%)				NO_3 (%)			
	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean	u.	A.N.	A.S.	Mean
	First season: 2005															
25	3.21 g	3.39 ef	3.49 de	3.36 b	0.295 f	0.329 de	0.353 bc	0.325 c	3.15 f	3.26 e	3.43 d	3.28 b	1.04 h	1.11 g	0.94 i	1.03 c
50	3.71 c	3.86 b	3.06 a	3.87 a	0.329 de	0.373 b	0.397 a	0.366 a	3.72 c	3.88 b	4.13 a	3.91 a	1.34 e	1.46 d	1.23 f	1.34 b
75	3.19 g	3.34 f	3.56 d	3.36 b	0.312 ef	0.338 cd	0.349 cd	0.333 b	3.00 g	3.25 e	3.38 d	3.21 c	1.66 b	1.77 a	1.51 c	1.64 a
Mean	3.37 c	3.53 b	3.70 a		0.312 c	0.347 b	0.366 a		3.29 c	3.46 b	3.65 a		1.35 b	1.44 a	1.23 c	
	Second season: 2006															
25	3.16 e	3.32 d	3.43 cd	3.30 b	0.302 f	0.338 d	0.361 c	0.333 c	3.15 f	3.20 f	3.42 d	3.26 b	1.01 f	1.15 e	0.92 g	1.03 c
50	3.69 b	3.80 b	3.99 a	3.83 a	0.333 d	0.374 b	0.416 a	0.374 a	3.76 c	3.93 b	4.12 a	3.93 a	1.34 d	1.47 c	1.21 e	1.34 b
75	3.16 e	3.33 d	3.54 c	3.34 b	0.315 e	0.378 b	0.354 c	0.349 b	3.00 h	3.08 g	3.35 e	3.14 c	1.66 b	1.78 a	1.48 c	1.64 a
Mean	3.33 c	3.49 b	3.65 a		0.316 c	0.363 b	0.377 a		3.30 c	3.40 b	3.63 a		1.33 b	1.46 a	1.20 c	

* Biofert: biofertilizer, N-fert.: nitrogen fertilizer, u: urea, A.N.: ammonium nitrate and A.S.: ammonium sulphate.

* Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 0.05 level

These results are coincidence with those obtained by Shafshak and Abo-Sedera (1990), Talaat (1995), Hanafy *et al.,* (2002) and Hassan (2006), all of them on working lettuce. Similar gains were also recorded by Hsieh *et al.,* (1995) on cabbage, El-Banna and Tolba (2000) on potato, Abou El-Magd *et al.,* (2004) on onion and Zaki and Salama (2006) on cucumber.

According to the aforementioned results, it could be concluded that to score the best vegetative growth of lettuce cv. Balady, coupled with good quality and less accumulation of nitrate, it should be fertilized with the combination of nitrobien (added as soil drench at the rate of 2 kg/fed immediately after transplanting) and ammonium sulphate added at the rate of 25kg/fed in two equal batches, the first one could be added two weeks after transplanting, while the second after three weeks later.

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استجابة نباتات الخس البلدي لبعض معاملات التسميد

حاتم محمد عبد العال، سهام محمود علي
شعبة بحوث الخضر، معهد بحوث البساتين- الدقي- الجيزة- مصر

أجريت تجربتان بمحطة بحوث البساتين بالقناطر الخيرية، محافظة القليوبية، مصر خلال الموسم الشتوي لعامين ٢٠٠٥/٢٠٠٦، ٢٠٠٦/٢٠٠٧ وذلك لدراسة تأثير السماد الحيوي نيتروبين بمعدل ٢ كجم/فدان مضاف للتربة مرة واحدة بعد الشتل بأسبوعين، ثلاثة مصادر من الأسمدة الأزوتية هي: اليوريا (٤٦,٥ % أزوت)، نترات الأمونيوم (٥, ٣٣% أزوت) وسلفات الأمونيوم (٥, ٢٠ % أزوت) وذلك بمعدلات ٢٥، ٥٠، ٧٥ كجم/فدان تضاف على دفعتين، الأولى عقب الشتل بأسبوعين والثانية عقب الأولى بثلاثة أسابيع وكذلك التفاعلات بينهما على النمو والجودة والتركيب الكيميائي لنباتات الخس (*Lactuca sativa* L.) الصنف البلدي (cv. Balady).

ولقد أوضحت النتائج المتحصل عليها أن اضافة النيتروبين أحدثت زيادة معنوية في جميع قياسات النمو الخضري، المحصول الكلي، محتوى الأوراق من الكلوروفيل أ، ب والمحتوى الكلي منهما، وكذلك النسبة المئوية لعناصر النيتروجين، الفوسفور والبوتاسيوم، في الوقت الذي أدى فيه الى خفض تركيز النترات نسبياً. ومن بين مصادر الأزوت الثلاثة المستخدمة في هذه الدراسة أوضحت النتائج أن سلفات الأمونيوم، خاصة عند اضافتها بمعدل ٢٥ أو ٥٠ كجم/فدان كانت أكثر المصادر تحسيناً لجميع الصفات التي تم قياسها. أيضاً أحدثت جميع التوليفات المستخدمة بين السماد الحيوي والمستويات المختلفة لمصادر التسميد الأزوتي الثلاثة تحسناً ملحوظاً في جميع قياسات النموالحضري، المحصول الكلي والمحتوى الكيميائي للنباتات المعاملة، مع تفوق التوليفة التي جمعت بين النيتروبين (بمعدل ٢ كجم/فدان) وسلفات الأمونيوم (بمعدل ٢٥ كجم) والتي حققت أفضل معدل للنموأعلى محصول على الأطلاق مصحوباً بأقل تركيز للنترات في الأوراق.

وعليه، فانه طبقا لظروف هذه الدراسة، يمكن التوصية بتسميد نباتات الخس (الصنف البلدي) بكل من السماد الحيوي (نيتروبين) بمعدل ٢ كجم/فدان + سلفات الأمونيوم (كمصدر كيميائي للأزوت) بمعدل ٢٥ كجم/فدان للحصول على أفضل نموأعلى جودة للمحصول الناتج.