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EFFECT OF SOME NITROGEN SOURCES AND POTASSIUM LEVELS ON YIELD, QUALITY AND NITRATE ACCUMULATION IN LETTUCE LEAVES

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ABSTRACT

To study the influence of nitrogen sources and potassium levels on growth, yield and chemical constituents of lettuce plants, cv. Balady, two experiments were conducted at Experimental Farm of Barramoon, Dakahlia Governorate during the winter seasons of 1999/2000 and 2000/2001. twelve treatments representing all possible combinations of three N sources (Urea, ammonium nitrate and ammonium sulphate) and four K doses (0, 20, 40 and 60 kg K_2O / fed.) were used in split plots design with four replicates.

The obtained results can be summarized as follows:-

Vegetative growth and yield:

1. Effect of N-sources:

Urea followed by ammonium nitrate were significantly increased growth and yield parameters (plant height, No. of outer and inner leaves, fresh and dry weight of outer and inner leaves, fresh weight / plant and total yield, ton/fed.) with no considerable differences among them in most cases. Ammonium sulphate was of the significant least effect.

2. Effect of K levels:

Increasing K-levels from 0 up to 60 kg K_2O/fed. considerably increased all the studied growth and yield parameters, 60 kg K_2O level was the most superior one.

3. Effect of interaction:

Interaction significantly affected growth and yield of lettuce plant, NH_4NO_3 x 60 kg K_2O/fed followed by urea x 60 kg K_2O/fed were the most superior treatments in their effect with no significant differences among them in most cases. K level (0 K_2O/fed) x all N-sources used were the treatments of the significant least effect.

Chemical constituents

1. Effect of N-sources:

Both urea and ammonium nitrate were significantly improved N, P and K content of lettuce plant relative to ammonium sulphate with no considerable differences among them in most cases in the two seasons of study. On the other hand, urea was of the least NO_3 content in their plant leaves. Ammonium nitrate was of the significant highest NO_3 content in both seasons.

2. Effect of K-levels:

N, P and K content considerably increased along with increasing the supplied K from 0 up to 60 Kg K_2O/fed. NO_3 accumulation was increased with increasing K from 0 to 40 kg K_2O/fed, then decreased at 60 kg level.

3. Effect of interaction:

K 0 level with all N-sources were the treatments of the lowest N, P, K and NO_3 content relative to other treatments. NO_3NH_4 and urea x 60 kg K_2O/fed were the treatment of the highest N, P and K, meanwhile, urea x 60 Kg K_2O was of low NO_3 content.

Finally, it could be concluded that ammonium nitrate and/or urea each with 60 kg K_2O/fed were the best treatments for maximizing the growth and yield of lettuce plant. Urea with 60 kg K_2O/fed was the treatment of best yield and low NO_3 content of leaves. So, it concluded as best treatment on basis of yield and NO_3 safety level for human nutrition.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is one of the most important leafy vegetables of a high nutritional value (Vitamin A, B_1, B_2 and C), as well as calcium and iron. Nitrogen represents an important element in leafy plants fertilization. There are several N fertilizer sources could be used but each vegetable crop favourate certain N source for the best growth, yield and quality. Numerous researchers carried out various experiments to show the effect of nitrogen source on vegetative growth of leafy vegetables. Farrag and Abd El-Aal (1989) reported that the maximum yield of spinach was obtained when urea was applied to soil at 200 kg N/fed.

Kheir *et al*. (1991) showed that the highest yield of spinach and lettuce was obtained by 25 kg N/fed from ammonium nitrate or urea.

On the other hand, Shafshak (1987) found that ammonium sulphate produced the highest fresh and dry weight of spinach leaves followed by calcium nitrate, ammonium sulphate also increased number of spinach leaves / plant as compared with calcium nitrate.

Mills *et al*. (1979) reported that spinach plants fertilized with NO_3-N was larger than these received NH_4-N. Hartman (1982) found that nitrogen applied as calcium nitrate gave a higher spinach yield than N as $(NH_4)_2SO_4$ (ammonium sulphate).

Gardner and Pew (1979) on lettuce reported that nitrogen source (ammonium sulphate and ammonium nitrate) did not affect total NO_3 accumulation. Likewise, Castro and Farrag (1998), on lettuce found that leaf NO_3 accumulation was not affected by N source (ammonium nitrate and urea). Arce *et al*. (1996) on lettuce indicated that application of ammonium nitrate resulted in significant higher leaf NO_3 concentration than application a manure or urea. Shafshak and Abo-Sedra (1990) also found that nitrate concentration of lettuce leaves was more with ammonium nitrate than calcium nitrate and the lowest level of nitrate accumulation was in plants received ammonium sulphate.

Many researchers have reported that increasing potassium fertilization rates increased vegetative growth and yield of some vegetable crops (El-Gazzar *et al*., 1990 and El-Sawy *et al*., 2000b). In addition, nitrate accumulation within plant tissues found to be affected by K levels and nitrate reductase activity (Maynard *et al*., 1976 and El-Sawy *et al*., 2000a).

This research was conducted to study the effect of N sources (urea, 46% N, ammonium sulphate, 21.5% N and ammonium nitrate, 33.5% N), different K levels and their combinations on lettuce vegetative growth, yield and chemical composition.

MATERIALS AND METHODS

Two field experiments were conducted at Baramoon Experimental Farm, Dakahlia Governorate during the winter seasons of 1999/2000 and 2000/2001 on lettuce cv. Balady to evaluate the effect of nitrogen sources and potassium levels on growth, yield and chemical constituents of lettuce.

The experiment includes three nitrogen sources (ammonium sulphate, $(NH_4)_2SO_4$, ammonium nitrate, NH_4NO_3 and urea $Co(NH_2)_2$), and 4 levels of potassium (from K_2SO_4, 48%), 0, 20, 40 and 60 kg K_2O/fed. The experimental design was split-plot with three replicates. N-sources in main and K levels were in sub-plot. The area of each plot was 9.6 m^2 and consisted of four ridges 4 m long and 0.6 m width. Lettuce seedlings of 40 days-old were transplanted on both sides of the ridges 10 cm apart on the first week of December on both seasons.

Plants were fertilized with 60 kg N/fed from each N-source and 200 kg/fed calcium superphosphate. All fertilizers N and K were added after 21 and 35 days from transplanting in two equal doses. The usual agricultural practices were done as usually followed in the commercial lettuce production. The lettuce plant were harvested 75 days after transplanting. Each sub-plot was harvested for recording fresh yield (ton/fed). Five lettuce plants were taken randomly from each sub-plot in which plant height, No. of leaves (Outer and inner), fresh and dry weight of outer and inner leaves (g/plant) and the whole fresh weight (g).

Leaf samples taken for N and K determination. Those were digested with sulphuric - perchloric acids mixture. Nitrogen was estimated by microkjeldahl method (Pipper, 1997). Phosphorus was estimated colourimetrically (King, 1951). Potassium was estimated using flame photometer (Jackson, 1967). NO_3 was estimated as ppm in dry weight according to Cataldo *et al*. (1975).

All data were statistically analyzed using ANOVA test according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth and yield:

Data in Tables (1 and 2) showed the effect of $(NH_4)_2 SO_4$, NH_4NO_3 and $Co(NH_2)_2$ on vegetative growth of lettuce plants. Such data revealed that urea followed by ammonium nitrate were significantly increased number, fresh and dry weight of outer and inner leaves, whole plant fresh weight and yield (ton/fed), while no considerable differences among them in most cases. The significant lowest growth and yield was of ammonium sulphate fertilizer at the two seasons. Similar results were obtained by Farag and Abd El-Aal (1989) on spinach and Kheir *et al*. (1991).

The pronounced superiority of urea and/or ammonium nitrate as favorite sources of N dealing with their best effect on lettuce growth and yield could be expected under present work condition, since they were

considerably improved mineral content of lettuce leaves, i.e. N, P and K (Tables 3 and 4). Those which known to be closely associated with the main internal physiological and metabolical status of plant as chlorophyll, enzymes, amino acids, sugars, ATP, nucleic acid and etc. synthesis.

In contrary $(NH_4)_2 SO_4$ induce the least growth and yield of lettuce plant, this could be due to its similar effect on the uptake and content of minerals, i.e. N, P and K (Tables, 3 and 4).

Both NO^-_3 and NH^+_4 can be taken up and metabolized by plants, NO_3 is often a preferential source for growth and yield. Also, the undesirable effect of $(NH_4)_2 SO_4$ relative to the other N-sources might be due to that NH_4-N rapidly depleted carbohydrate and carbon skeleton reserves of plant in amino acid, and protein assimilation. Such metabolical status resulted in free toxic NH_3 and amides. NH_3 (aq.) can be toxic because it can traverse cell membranes, uncoupling photophosphorylation at the membrane of the chloroplast inhibits respiration and depress the absorption of K, Ca and other cations (Gibbs and Calo, 1959, Heber *et al*., 1974 and Vines and Wedding, 1990).

As regard to K levels, data in Tables (1 and 2) revealed that increasing K levels from 0 to 60 kg K_2O/fed significantly increased all vegetative parameters and yield at the two seasons of study. Similar results were obtained by El-Sowy *et al*. (2000b).

The beneficial effect of increasing K levels on growth and yield of lettuce plants could be due to its stimulatory effect on the uptake of N, P and K (Tables 3 and 4). Also K known to be stimulated CO_2 assimilation (Peoples and Koch, 1979), and enhances the translocation of photosynthesis (carbohydrates and proteins, Koch and Mengel, 1977 and Secer, 1978). K also stimulated ATP synthesis (Hartt, 1972) thereby indirectly promote the synthesis of various organic compounds, such as proteins, sugar and polysaccharides.

Herein, it must be focus on the beneficial effect of K at the highest level (60 kg K_2O/fed) on the accumulation of dry matter of outer and inner leaves, plant weight and total yield (ton/fed) relative to other K levels. Meanwhile, this effect was accompanied with pronounced reduction in NO_3 content of leaves. NO^-_3 translocated upwards in xylem sap along with K^+ ions originally acting as the counter ions for the downward movement of malate. Otherwise K^+ ions affect NO^-_3 uptake, translocation and assimilation (Kirkby and Armstrong, 1980).

Generally, reducing of NO_3 content specially in leafy crops along with high yield considered as best establishment associated with safety and healthy nutrition of human.

So, it could be concluded with fertilizing lettuce plants with the highest K level (60 kg K_2O/fed) for the highest yield and quality (low NO_3 content).

Concerning interaction between N-sources and K-levels, data in Tables (1 and 2) show that all vegetative parameters and yield of lettuce plants were significantly affected by interaction in both seasons of study. NH_4NO_3 x 60 K_2O/fed followed by urea x 60 kg K_2O/fed were the most superior treatments in their effect with no significant differences among them in most cases. K-level (0 K_2O/fed) x all N-sources used were the treatments of the significant least effect.

It was known that NO^-_3 and K^+ ions absorbed together as a complelementry ions. On the other hand, K^+ and NH^+_4 had an antagonistic and competitive effect among them on root absorption sites. In addition, the applied N is only fully utilized for crop production when K supply is adequate (Heathcote, 1972).

Chemical constituents:

Data in Tables (3 and 4) indicated that fertilization lettuce plant with NH_4NO_3 significantly increased N% and NO^-_3 accumulation in leaves compared with urea and $(NH_4)_2\ SO_4$ in both seasons of study. Similar results were obtained by Shafshak and Abo-Sedra (1990). The lowest N content and NO_3 accumulation were found in plants supplied with ammonium sulphate. Some data indicated that P and K content were significantly increased by urea source relative to others. Similar results were obtained by Shafshak (1987), who reported that, the highest P and K content were found in spinach leaves fertilized with urea.

Table 3. Chemical constituents in lettuce leaves as affected by N-sources, K-levels and their interaction during the winter season (1999/2000).

Characters / Treatments	N (%)	P (%)	K (%)	NO_3 (ppm)
N-sources (A):				
$(NH_4)_2\ SO_4$	3.12	0.59	5.24	197.57
$NH_4\ NO_3$	3.23	0.63	5.25	201.23
Co $(NH_2)_2$	3.17	0.67	5.46	193.39
LSD at 5%	0.04	0.03	0.08	0.86
K_2 Levels (Kg/fed) (B):				
0	2.85	0.43	4.10	159.46
20	3.17	0.47	4.72	204.25
40	3.58	0.65	5.77	214.91
60	3.11	0.97	6.67	210.37
LSD at 5%	0.02	0.03	0.05	2.08
Interaction (A x B):				
$(NH_4)_2\ SO_4$ 0	2.81	0.42	4.16	156.80
20	3.04	0.45	4.69	203.20
40	3.47	0.64	5.88	217.31
60	3.17	0.87	6.22	212.95
$(NH_4\ NO_3$ 0	2.95	0.40	4.11	166.79
20	3.25	0.47	4.58	207.36
40	3.66	0.68	5.59	217.13
60	3.05	0.96	6.72	213.64
$(Co(NH_2)_2$ 0	2.78	0.46	4.04	154.79
20	3.20	0.48	4.87	204.00
40	3.60	0.64	5.85	210.28
60	3.12	1.09	7.08	204.51
LSD at 5%	0.04	0.05	0.09	3.65

Table 4. Chemical constituents in lettuce leaves as affected by N-sources, K-levels and their interaction during the winter season (2000/2001).

Characters / Treatments	N (%)	P (%)	K (%)	NO_3 (ppm)
N-sources (A):				
$(NH_4)_2\ SO_4$	3.08	0.58	5.09	196.44
$NH_4\ NO_3$	3.21	0.61	5.17	199.76
Co $(NH_2)_2$	3.16	0.66	5.42	192.53
LSD at 5%	0.06	0.02	0.09	0.83
K_2 Levels (Kg/fed) (B):				

0	2.82	0.42	4.06	158.02
20	3.15	0.47	4.63	203.88
40	3.52	0.64	5.60	213.65
60	3.11	0.94	6.62	209.42
LSD at 5%	0.06	0.03	0.04	2.00
Interaction (A x B):				
$(NH_4)_2 SO_4$ 0	2.75	0.40	4.10	155.73
20	3.06	0.44	4.51	202.01
40	3.36	0.63	5.59	216.01
60	3.14	0.84	6.14	212.01
$(NH_4 NO_3$ 0	2.95	0.40	4.03	164.75
20	3.21	0.46	4.56	206.42
40	3.62	0.66	5.48	215.72
60	3.06	0.92	6.62	212.15
$(Co(NH_2)_2$ 0	2.77	0.45	4.04	153.56
20	3.17	0.50	4.80	203.22
40	3.57	0.63	5.74	209.23
60	3.12	1.07	7.08	204.10
LSD at 5%	0.09	0.05	0.07	3.47

As regard to K levels, data in Tables (3 and 4) indicated that fertilization lettuce plants with K significantly increased N, P, K and NO_3 content of lettuce leaves compared with unfertilized plants.

Increasing K level from 20 upto 60 kg K_2O/fed significantly increased P, and K content. The highest values of N and NO^-_3 were found in plants of 40 kg K_2O/fed treatment. Similar results were obtained by El-Sawy *et al*. (2000a), on potato.

Concerning interaction between N-sources and K levels, data in Tables (3 and 4) show that N, P, K and NO^-_3 contents were significantly affected by interaction in both seasons of study. Fertilization lettuce plants with NH_4NO_3 and 40 kg K_2O/fed gave the highest values of N and NO^-_3 content, whereas plants supplied with NH_4NO_3 and 60 kg K_2O/fed gave the highest values of P and K contents. The lowest values of N, P, K and NO_3 were obtained from plants fertilized with ammonium sulphate and 0 K_2O/fed in both seasons of study.

Finally, it could be concluded that ammonium nitrate and/or urea each with 60 kg K_2O/fed were the best treatments for maximizing the growth and yield of lettuce plant. Urea with 60 kg K_2O/fed was the treatment of best yield and low NO_3 content of leaves. So, it concluded as best treatment on basis of yield and NO_3 safety level for human nutrition.

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تأثير بعض مصادر النتروجين ومستويات التسميد البوتاسى على المحصول والجودة وتراكم النترات فى أوراق الخس٠

محمد السعيد أبو النصر

مركز البحوث الزراعية - معهد بحوث البساتين - القاهرة٠

أجريت تجربتان حقليتان بمحطة بحوث البساتين بالمنصورة (البرامون) - محافظة الدقهلية على محصول الخس (الصنف البلدى) أثناء موسمى الزراعة ١٩٩٩ / ٢٠٠٠ م ، ٢٠٠٠ / ٢٠٠١ م وذلك لدراسة تأثير صور النتروجين المختلفة (سلفات النشادر ٢١,٥% أزوت ونترات الأمونيوم ٣٣,٥% أزوت واليوريا ٤٦% أزوت)٠ وكذلك التسميد البوتاسى ٤٨% بو٢أ وذلك بأربع مستويات (صفر ، ٢٠ ، ٤٠ ، ٦٠ كجم بو٢أ للفدان ودراسة التفاعل بينهما وأثر ذلك على محصول الخس والتركيب الكيماوى للأوراق٠

ويمكن تلخيص أهم النتائج كالآتى:

١- النمو الخضرى والمحصول: أدى التسميد باليوريا إلى زيادة النمو الخضرى والمحصول زيادة معنوية وخصوصاً طول النبات وعدد الأوراق الداخلية والخارجية ومتوسط الوزن الجاف للأوراق والمحصول بالطن للفدان ، ولم توجد إختلافات معنوية بين اليوريا والنترات فى عدد الأوراق الداخلية والخارجية ومتوسط وزن الأوراق الداخلية والوزن الطازج للنبات٠ أدى التسميد بسلفات الأمونيوم إلى الحصول على أقل قيم للمحصول والنمو الخضرى٠

أدى التسميد بـ ٤٠ كجم بو٢أ إلى زيادة طول النبات وعدد الأوراق الداخلية والخارجية ومتوسط وزن الأوراق الداخلية والخارجية ، بينما أدى التسميد بـ ٦٠ كجم بو٢أ إلى زيادة الوزن الجاف للأوراق وكذلك متوسط وزن النبات والمحصول للفدان٠

بالنسبة لدراسة التفاعل بين صور النتروجين ومستويات البوتاسيوم ، أدى التسميد بنترات الأمونيوم و ٤٠ كجم بو٢أ/ فدان إلى زيادة طول النبات وعدد الأوراق الداخلية والخارجية ومتوسط وزن الأوراق الخارجية والوزن الجاف للأوراق الخارجية بينما التسميد بنترات الأمونيوم و ٦٠ كجم بو٢أ للفدان أدى لزيادة متوسط وزن الأوراق الداخلية والوزن الجاف للأوراق الخارجية والوزن الطازج للنبات كما أدى إلى زيادة وزن المحصول٠

٢- المحتوى الكيماوى:

أدى التسميد بنترات الأمونيوم إلى زيادة محتوى الأوراق من النتروجين والنترات فى أوراق الخس بينما التسميد باليوريا أدى إلى زيادة محتوى الأوراق من البوتاسيوم والفوسفور وذلك فى كلا الموسمين٠

أدى التسميد بـ ٤٠ كجم بو٢أ للفدان إلى زيادة محتوى الأوراق من النتروجين والنترات بينما أدى التسميد بـ ٦٠ كجم بو٢أ للفدان إلى زيادة محتوى الأوراق من الفوسفور والبوتاسيوم٠

بالنسبة للتفاعل بين صور النتروجين ومستويات البوتاسيوم ، أدى تسميد نباتات الخس بنترات الأمونيوم والمستوى ٤٠ كجم بو٢أ للفدان إلى زيادة محتوى الأوراق من النتروجين والنترات ، بينما التسميد بنترات الأمونيوم والمستوى ٦٠ كجم بو٢أ للفدان إلى زيادة محتوى الأوراق من الفوسفور والبوتاسيوم٠

توصى الدراسة بإستخدام اليوريا (٦٠ كجم أزوت للفدان) مع سلفات البوتاسيوم (٦٠ كجم بو٢أ) كأفضل معاملة لإعطاء أعلى نمو ومحصول وأفضل تركيب معدنى وأقل محتوى من النترات لنباتات الخس ولمحتوى النترات المنخفضة أهمية كبيرة فى نحقيق تغذية آمنة وصحية٠

Table 1. Growth and yield traits of lettuce as affected by N-sources, K-levels and their interaction during the winter season (1999/2000).

Characters / Treatments	Plant height (cm)	No. of outer leaves / plant	No. of inner leaves ' plant	Fresh weight of outer leaves (g)	Fresh weight of inner leaves (g)	Dry weight of outer leaves (g)	Dry weight of inner leaves (g)	Plant fresh weight (g)	Yield (ton/fed)
N-sources (A):									
$(NH_4)_2 SO_4$	38.08	14.76	24.66	195.87	188.98	18.94	18.81	427.80	12.10
$NH_4 NO_3$	39.37	17.52	25.88	238.25	212.53	23.57	21.45	490.84	14.91
$Co (NH_2)_2$	39.31	19.13	26.76	242.56	212.63	24.20	21.40	492.09	15.07
LSD at 5%	0.24	0.72	0.78	3.46	2.52	0.29	0.52	4.63	0.25
K_2 Levels (Kg/fed) (B):									
0	35.45	13.72	21.63	175.53	149.92	15.10	14.67	363.93	11.06
20	37.73	16.81	26.12	206.94	206.69	19.59	20.06	457.84	14.09
40	40.65	18.31	26.16	259.11	239.16	26.38	23.21	524.13	15.83
60	41.84	19.71	29.15	260.65	233.07	26.97	24.27	535.08	16.32
LSD at 5%	0.20	0.66	0.60	2.90	2.20	0.23	0.43	8.33	0.29
Interaction (A x B):									
$(NH_4)_2 SO_4$ 0	35.10	12.57	20.38	150.83	137.27	13.70	13.44	321.95	9.77
20	37.02	15.51	24.33	179.96	181.87	16.83	17.68	411.98	12.64
40	39.22	15.59	26.73	226.30	218.08	22.78	21.83	488.05	14.77
60	40.98	16.38	27.18	226.39	218.69	22.91	22.28	489.23	14.80
$(NH_4 NO_3$ 0	36.01	13.25	21.07	169.02	150.62	15.44	14.72	363.47	10.93
20	36.14	15.52	25.97	206.18	214.19	19.78	20.74	469.30	14.69
40	41.26	20.47	26.36	287.58	239.08	29.47	23.81	557.20	16.79
60	44.07	20.84	30.13	290.19	246.21	29.58	26.53	573.39	17.23
$(Co(NH_2)_2$ 0	35.25	15.34	23.43	206.73	161.87	18.86	15.85	406.37	12.49
20	40.02	20.41	28.07	234.67	224.02	22.62	21.77	492.23	14.94
40	40.47	18.50	25.39	263.46	223.18	26.79	24.00	527.13	15.94
60	41.48	22.27	30.14	265.37	241.44	28.53	24.00	542.62	16.92
LSD at 5%	0.34	1.14	1.04	5.64	3.81	0.40	0.74	14.42	0.51

Table 2. Growth and yield traits of lettuce as affected by N-sources, K-levels and their interaction during the winter season (2000/2001).

Characters / Treatments	Plant height (cm)	No. of outer leaves / plant	No. of inner leaves ' plant	Fresh weight of outer leaves (g)	Fresh weight of inner leaves (g)	Dry weight of outer leaves (g)	Dry weight of inner leaves (g)	Plant fresh weight (g)	Yield (ton/fed)
N-sources (A):									
$(NH_4)_2 SO_4$	35.45	14.57	24.36	188.43	182.67	18.73	18.77	415.28	12.82
$NH_4 NO_3$	38.26	16.86	25.77	230.84	203.98	23.36	21.18	480.13	14.84
$Co (NH_2)_2$	39.42	18.76	26.43	232.52	205.12	24.25	21.42	480.18	15.15
LSD at 5%	1.10	0.98	0.58	7.26	3.50	0.41	0.61	7.14	0.38
K_2 Levels (Kg/fed) (B):									
0	33.12	13.40	21.12	168.19	143.87	15.97	14.56	550.93	11.07
20	36.97	16.39	25.98	200.38	199.16	19.41	19.98	447.49	13.98
40	40.01	17.95	26.05	248.12	221.06	26.33	22.91	513.65	15.73
60	40.75	19.18	28.92	252.36	224.93	26.73	24.36	522.65	16.03
LSD at 5%	1.08	0.61	0.57	3.17	2.98	0.31	0.33	8.41	0.29
Interaction (A x B):									
$(NH_4)_2 SO_4$ 0	31.01	12.22	20.17	140.93	132.43	13.47	13.70	303.92	9.41
20	35.00	14.19	24.09	177.74	176.35	16.18	17.64	402.62	12.44
40	37.27	15.68	26.38	216.07	209.29	22.33	21.300	476.90	14.56
60	38.51	16.16	26.80	218.96	212.62	22.92	22.43	477.66	14.88
$(NH_4 NO_3$ 0	32.75	12.92	20.83	164.60	143.27	15.34	14.53	353.22	11.15
20	36.44	15.24	26.15	201.79	202.82	19.56	20.39	460.01	14.59
40	40.94	19.54	26.08	272.73	230.31	28.86	23.29	546.83	16.57
60	42.91	19.75	30.01	284.25	239.51	29.67	26.49	560.46	17.07
$(Co(NH_2)_2$ 0	35.59	15.06	22.36	199.04	155.92	19.10	15.45	395.66	12.65
20	39.45	19.73	27.71	221.61	218.32	22.50	21.90	479.83	14.91
40	40.83	18.62	25.70	252.68	214.38	26.99	24.15	515.42	16.07
60	41.81	21.63	29.94	256.77	231.87	28.41	24.17	529.82	16.95
LSD at 5%	1.87	1.05	0.99	5.50	5.15	0.54	0.56	14.57	0.51