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PHYSIOLOGICAL RESPONSE OF JEW'S MALLOW (*Corchorus olitrorus* L.) PLANT TO DIFFERENT SOURCES OF NITROGEN AND POTASSIUM FERTILIZERS

Ahmed, A.A.; M.M. H. Abd El-Baky; Z. F. Fawzy and A.M. Shaheen
Vegetable Research Dept. , National Research Centre, Dokki,Cairo, Egypt

ABSTRACT

Two field experiments were carried out the two successive summer seasons of 2002 and 2003 to investigate the performance of Jew's mallow plant (*Corchorus olitorus* L.) cv. Balady in relation to some different nitrogen sources (ammonium sulphate, urea, calcium nitrate and ammonium nitrate) and potassium sources (potassium chloride and potassium sulphate) on the vegetative growth characters, foliage yield and its some chemical properties.

The important results could be summarized as follows:

1. Fertilization with ammonium nitrate (33.5% N) gave the best values of vegetative growth characters expressed as plant length, leaves number/plant , leaves area/plant, fresh and dry weights of leaves weights/plant and whole plant as well as total foliage yield and N, P. and K contents in leaves tissues compared with other nitrogen sources.

   On the other hand, addition of ammonium sulphate (20.6% N) gave the lowest values of the above mentioned plant growth characters.
2. Addition of potassium sulphate enhanced vegetative growth characters as well as total foliage yield compared to potassium chloride.
3. The vigor vegetative plant growth and the heaviest total foliage yield were associated with application of ammonium nitrate (33.5% N) and potassium sulphate (48%K_2O).

INTRODUCTION

Jew's mallow (*Corchorus olitorus* L.) is one of the most popular leafy vegetables grown in Egypt. It is represent a good source of vitamins A and B as well as some minerals such as iron, phosphorus, calcium, potassium, sodium and manganese. It is consumed as a fresh leafy vegetable crop also as dried leaves could be used as well.

It is known that nitrogen is one of the major fertilizer elements required for good production. Nitrogen is highly effective on plant vegetative growth and its yield.

Jew's mallow plant as a leafy vegetable crop is influenced by nitrogen fertilizer.

Terashima and Evans (1988) on spinach, reported that photosynthesis decreased with insufficient nitrogen supply.

Bould *et al.* (1983) and Yagodin (1984) found that nitrogen deficiency led to much lower contents of protein and especially non-protein nitrogen compounds.

Hanafy Ahmed (1991b) reported that the total free amino acids concentration in the shoot and root of spinach plants were depressed by deprivation of nitrogen.

Hanafy Ahmed (1991 a) assumed that the low nitrogen fertilizer supply propably decreased the not assimilation rate by reducing the rate of photosynthesis per unit leaf area and/or further by increasing respiration rate.

Growth and yield were affected by different nitrogen sources (El-Fadaly and Mishrky (1990) on spnach; Shafsak *et al.* (1990) on lettuce ; Kheir *et al.* (1991) on Jew's mallow, lettuce; Ansary (1998)on spinach and lettuce; Abd El-Rahaman *et al.* (2001 on spinach ; Ahmed (2003) on spinach; Ahmed *et al.* (2004 on lettuce They reported that plants fertilizers with NO_3-N source were higher in their yield rather than plants fertilized with NH_4-N.

Moreover, some investigators mentioned that application of ammonium-N increased the yield compared with other nitrate-N (Goh and Vityakon (1986) on spinach; Myczkowski *et al.* (1991)on lettuce; Shehata *et al.* (2001) on spinach and Shehata (2002) on spinach. Some results revealed that there were no differences in the plant growth and its yield as a result of using different sources of minerals-N Bakr *et al.* (1970) on spinach ; Gardner and Pew (1979) on lettuce; El-Araby (1988) on spinach; Shafshak and Abo-Sedera (1990) on lettuce ; Walworth *et al.* (1992) on lettuce..

Contra-results Farag and Abdel-Aal (1989) reported that nitrogen applied in the form of urea increased leaf number and average fresh weight of leaves per plant compared to other nitrogen i.e. ammonium soluphtae and ammonium nitrate.

Similarity, Moustafa *et al.* (1992) on cabbage, reported that application of urea fertilizer increased fresh weight of stem, number and weight of the inner and total leaves /plant and weight of edible and whole head/plant and area, followed by ammonium fertilizer as compared with ammonium nitrate fertilizers which had the lowest record.

In respect to potassium fertilizer, Mengel and Kirkby (1979) reported that potassium is considered the third element of major importance in plant growth by effecting the synthesis of simple sugars and starch, the translocation of carbohydrate, the reduction of nitrates and synthesis of protein, particularly in meristemic tissues and the normal cell division. Also, they reported that potassium not only influence crop production by enhancing growth and synthetic processes, it is also highly important in raising the disease resistance of many crop species.

Moreover, Agwah and Mahmoud (1994) mentioned that potassium significantly increased carbohydrate concentration in tomato leaves.

The purpose of this investigation was to study the effect of different sources of nitrogen and potassium fertilizers on the growth, yield and some chemical composition of Jew's mallow plant.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive summer seasons of 2002 and 2003 at the Experimental Station of the National Research Centre, in Shalakan (Kalubia Governorate). The physical and chemical properties of the experimental soil are shown in Table (1). This work aims to study the effect of some different nitrogen and potassium sources on the growth and yield of Jew's mallow plant.

Each experiment contained 8 treatments, which were the simple combination between 4 forms of nitrogen (ammonium sulphate (20.6%N), urea (46%N), calcium nitrate (15.5%N) and ammonium nitrate (33.5%N) and 2 forms of potassium (potassium sulphate (48% K_2O) and potassium chloride (52 %K_2O). Whereas the chemical fertilizers were applied as follows : 23.25 Kg of P_2O_5 ; 41.25 kg of N-units as well as K_2O at rate of 48 units/fed. whereas phosphorus were added during soil preparation, but nitrogen and potassium were divided at 4 equal quantity and added 30 days after seeding then once 15 days after each cutting.

Jew's mallow (*Corchorus olitorus* L.) seeds cv. Balady were sown on the 2nd week of March 2002 and 2003 seasons. The normal agricultural practices took place whenever it was necessary according to the recommendations of the Egyptian Ministry of Agriculture.

The experimental design used in the two successive seasons was randomized complete block design with three replicates. Each plot area was 8.4m^2 consisted of three ridges each was 0.7 m in width and 4 m in length. Samples of plants were harvested at 45 days old. Vegetative growth characters, i.e., plant length, leaves number/plant, leaves area/plant, fresh and dry weights of whole plant and its leaves were recorded. Yield and total foliage yield as kg/m2 (4 cuts) of 4 weeks intervals or as ton/fed. were calculated for each treatment The chemical composition in leaf tissues such as total nitrogen, phosphorus and potassium were analysed in dry matter according to the methods of Black (1983), Trough and Mayer (1939) and Brown and Lilleland (1946), respectively.

Table (1): Physical and chemical analysis of the experimental soil during the seasons of 2002 and 2003

Physical properties		**2002**	**2003**
Soil texture		Clay	Clay
Clay	(%)	47.40	47.60
Silt	(%)	28.10	28.50
Fine sand	(%)	21.32	21.62
Coarse sand	(%)	2.75	2.68
Chemical analysis			
Available (K (mg/100 g soil)		0.59	0.60
Available (P) (mg/100g soil)		6.10	5.37
Total nitrogen (mg/100 g soil)		137.68	140.80
CL (meq/L.)		1.70	1.78
CO_3 (meq/L.)		4.88	4.95
Na_2CO_3 (meq/L.)		3.70	3.79
$CaCO_3$ (meq/L.)		1.69	1.70
Organic matter (%)		2.19	1.85
SO_4 (ppm)		90.82	90.61
EC (mmhos/cm/25ºC		2.20	2.41
pH		7.7	7.6

RESULTS AND DISCUSSION

A- Vegetative growth characters .

1. Effect of nitrogen sources.

The obtained results in Table (2) showed that vegetative growth characters of Jew's mallow plant were significantly affected by nitrogen fertilizer sources. Results indicated that using the nitrogen fertilizer in the form of ammonium nitrate (33.5%N) gave the best values of vegetative growth characters expressed as plant length, leaves number/plant, leaves area/plant, fresh and dry weight of leaves/plant and whole plant, followed in descending order by that plants which received calcium nitrate (15.5%N).

Table (2): Effect of different sources of nitrogen fertilizers on the vegetative growth characters of Jew's mallow plant during 2002 and 2003 seasons.

1st season

Nitrogen sources	Leaves / plant					Whole plant	
	Plant length	Number	Area	Fresh weight	Dry weight	Fresh weight	Dry weight
	(cm)		(cm^2)	(g)	(g)	(g)	(g)
Ammonium sulphate	28.5	23.4	307.1	15.5	2.0	19.6	3.8
Urea	30.7	28.1	342.3	17.3	2.5	21.3	4.4
Calcium nitrate	33.7	34.7	356.4	18.3	3.1	23.0	5.6
Ammonium nitrate	36.3	38.3	388.6	19.3	3.3	27.2	6.7
LSD at 5%	0.3	0.4	6.0	0.4	0.1	0.3	0.1
2nd season							
Ammonium sulphate	28.8	18.4	253.4	14.1	1.9	18.9	3.1
Urea	30.3	24.7	278.8	14.8	2.2	20.8	4.3
Calcium nitrate	31.6	29.7	303.2	16.1	2.4	22.2	5.1
Ammonium nitrate	33.1	32.7	310.5	17.0	2.7	23.4	5.7
LSD at 5%	0.2	0.4	1.7	0.2	0.1	0.5	0.3

On the other hand, addition of nitrogen fertilizer in the form of ammonium sulphate (20.6%N) gave the poorest values of the above mentioned plant growth characters. The above mentioned finding were true in both experiment. The statistical analysis of the obtained data revealed that the differences among the different nitrogen sources in both seasons were enough to reach the 5% were of significant. These were true for all plant growth parameters.

It could be concluded that , addition of ammonium nitrate or calcium nitrate fertilizers resulted in the vigor plant growth if compared with applying other nitrogen sources. This superiority of Jew's mallow plants which received ammonium nitrate or calcium nitrate might be due to growth of plants creates a demand for nitrogen in two ways: a) a demand for nitrate as precursor of protein synthesis and b) a demand for nitrate as vacular osmoticum; and nitrate taken up by the roots has to be divided between structural growth, reflected in organic nitrogen content and osmotic adjustment, reflected in the nitrate concentration of the cell sap. The osmotic compounds in the cell sap are important in order to allow cell enlargement

and to maintain turgor by water uptake and there was a strong correlation between nitrate uptake and fresh weight production of palnts (Blom-Zandstra *et al.*, 1988).

The obtained results are in good accordance with other investigators El-Fadaly and Mishriky (1990) on spinach ; Abd El-Moneim *et al.* (1996) on lettuce; Ansary (1998) on spinach and lettuce; Abd El-Rahman *et al.* (2001) on spinach; Ahmed (2003) on spinach and Ahmed *et al.* (2004) on lettuce..

2. Effect of potassium sources

Data of Table (3) illustrated that using potassium fertilizer in the form of potassium sulphate resulted in higher values of vegetative growth characters of Jew's mallow plant. Plant length, leaves number/plant, leaves area/plant, fresh and dry weights of leaves and whole plant were significantly enhanced by using potassium sulphate compared with using potassium chloride. These results held good in the two experimental seasons.

Table (3): Effect of different sources of potassium fertilizers on the vegetative growth characters of Jew's mallow plant during 2002 and 2003 seasons.

1st season

Potassium sources	Leaves / plant					Whole plant	
	Plant length	Number	Area	Fresh weight	Dry weigh	Fresh weight	Dry weigh
	(cm)		(cm_2)	(g)	(g)	(g)	(g)
Potassium chloride	31.7	30.3	335.3	17.3	2.5	21.9	4.7
Potassium sulphate	32.9	32.0	361.8	18.0	2.9	23.6	5.6
LSD at 5% level	0.2	0.3	4.2	0.3	0.1	0.2	0.1
2nd season							
Potassium chloride	30.4	25.4	265.2	15.0	2.0	20.5	3.9
Potassium sulphate	31.5	27.3	307.7	15.9	2.6	22.1	5.2
LSD at 5% level	0.1	0.3	1.2	0.1	0.1	0.3	0.2

Enhancement of vegetative growth of Jew's mallow plant as a result of using potassium sulphate may by due to a positive effect of sulphate which in turn lower soil pH and increased the availability of certain plant nutrients (Abd El-Fattah *et al.* (1985),(1990), (1996) and Hilal and Salem (1985).

3. Effect of the interaction.

It is obvious from the data of Table (4) that using both ammonium nitrate (33.5% N) and potassium sulphat (46%K_2O) resulted in the highest values of vegetative growth characters expressed as plant length, leaves number/plant leaves area/plant, fresh and dry weights of leaves /plant and whole plant.

On the other contrary, the lowest values of the above mentioned plant growth characters were recorded with that Jew's mallow plant supplied with ammonium sulphate and potassium chloride.

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These vigoristy of plant growth characters as resulted with using ammonium nitrate and potassium sulphate could be attributed to the combination beneficial effects of nitrate, potassium and SO_4^{2-} on plant growth and soil.

In this respect, Haeder and Mengel (1969) found that the uptake and transport of K^+ to younger leaves was favoured in plants well supplied with N.

Similarly , Silva Junior (1991) on cabbage, mentioned that using N+K fertilizers increased leaves number of plants.

B- Yield and its some chemical composition .

1. Effect of nitrogen sources.

the obtained results in Table (5) of the two experimental seasons showed that yield as Kg/m^2 and or ton/fed. significantly affected by applying different nitrogen fertilizer sources. Whereas using nitrogen fertilizer in the form of ammonium nitrate gave the highest yield . By other means, plants which received ammonium nitrate yielded 15.768 and 15.440 ton/fed. in the 1st and 2nd seasons respectively. On the other hand, plants which received nitrogen fertilizer as form of ammonium sulphate yielded 14.716 and 12.216 font/fed. of the same respect.

Table (5): Effect of different sources of nitrogen fertilizers on the foliage yield and its some chemical composition of Jew's mallow plant during 2002 and 2003 seasons.

Nitrogen sources	Foliage yield (4 cuts)		%		
	(kg/m²)	(Ton/fed.)	N	P	K
1st season					
Ammonium sulphate	3.554	14.716	2.438	1.125	2.714
Urea	3.744	14.976	2.603	1.220	2.834
Calcium nitrate	3.860	15.440	2.772	1.298	2.955
Ammonium nitrate	3.942	15.768	3.175	1.531	3.007
LSD at 5% level	0.009	0.016	0.026	0.016	0.003
2nd season					
Ammonium sulphate	3.054	12.216	2.763	1.274	2.840
Urea	3.390	13.560	2.928	1.364	2.969
Calcium nitrate	3.704	14.816	3.097	1.454	3.095
Ammonium nitrate	3.860	15.440	3.500	1.681	3.132
LSD at 5% level	0.031	0.017	0.051	0.015	0.013

Concerning the content of N, P and K of leaves tissues, the presented data in Table (5) showed that their contents were significantly affected by using different nitrogen fertilizer sources. Whereas, addition of NH_4NO_3 gave the highest values of N, P and K contents in leaves tissues followed in descending order by $Ca(NO_3)_2$. These finding are in good similar in both two seasons.

The obtained results are in harmony with those reported by many investigators such as El-Fadaly and Mishriky (1990) on spinach; Shehata *et al.* (1990) on lettuce; Kheir *et al.* (1991) on Jew's mallow, lettuce, spinach; Abd El-Moniem *et al.* (1996) on lettuce; Ansary (1998) on lettuce, spinach ;

Abd El-Rahman *et al.* (2001) on spinach; Ahmed (2003)on spinach and Ahmed *et al.* (2004) on lettuce.

Generally these differences in the yield and some nutritional values (N,P and K) of Jew's mallow plant might be attributed to the variation in both of the uptake processes and assimilation of nitrogen forms in Jew's mallow plant (Abd El-Rahman, *et al.* 2001).

2. Effect of potassium sources.

Data presented in Table (6) indicated that yield as Kg/m^2 or as ton/fed. of Jew's mallow plant significantly responsed to addition of potassium sulphate rather than potassium chloride. Whereas, the yield as Kg/m^2 or as ton/fed. of Jew's mallow plants were higher by using potassium sulphate in both seasons.

Similarly, N, P and K contents of leaves tissues were affected by using different potassium sources. Whereas, N,P and contents of leaves tissue were increased as a result of using potassium sulphate compared to potassium chloride.

The considerable enhancement in the yield and elemental composition of Jew's mallow plant could be attributed to sulphate at potassium sulphate which in turn lower soil pH and increased the availability of certain plant nutrients (Hilal and Salem, 1985; Abd El-Fattah *et al.*, 1985, 1990, 1996).

Table (6): Effect of different sources of potassium fertilizers on the foliage yield and its some chemical composition of Jew's mallow plant during 2002 and 2003 seasons.

1st season

Potassium sources	Foliage yield (4 cuts)		%		
	(kg/m^2)	(Ton/fed.)	N	P	K
Potassium chloride	3.730	14.920	2.667	1.240	2.864
Potassium sulphate	3.820	15.530	2.828	1.347	2.890
LSD at 5% level	0.007	0.011	0.018	0.012	0.002
2nd season					
Potassium chloride	3.351	13.404	2.992	1.393	2.997
Potassium sulphate	3.653	14.612	3.153	1.494	3.021
LSD at 5% level	0.022	0.012	0.036	0.010	0.009

3. Effect of the interaction.

It is clear from data in Table (7) that there were significant differences concerning to the effect of interaction treatments of nitrogen and potassium sources on the yield as Kg/m^2 or as ton/fed. as well as some nutritional values of leaves tissues. Whereas, the heaviest yield and the highest nutrient elements content of Jew's mallow plant were obtained with that plants which received ammonium nitrate and potassium sulphat.

Whereas, plants which fertilized with ammonium nitrate combined with potassium sulphate yielded 15.920 and 15.776 ton/fed. in the 1st and 2nd seasons respectively.

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On the other hand, the lowest values were recorded with that plants which supplied with ammonium sulphate combined with potassium chloride. These findings were true in both two seasons.

The beneficial effect of ammonium nitrate combined with potassium sulphate rather than ammonium sulphate combined with potassium chloride could be attributed to effect of ammonium nitrate on Jew's mallow plant could be expected.

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الاستجابة الفسيولوجية لنبات الملوخية لمصادر مختلفة للتسميد الآزوتى والبوتاسى

أحمد عبد النبى أحمد، محمود محمد حامد عبد الباقى، زكريا فؤاد فوزى و عبد المعطى محمد شاهين
قسم بحوث الخضر – المركز القومى للبحوث – الدقى – القاهرة

أجريت تجربتان حقليتان بمزرعة المركز القومى للبحوث بشلقان – محافظة القليوبية فى موسمين متتاليين ٢٠٠٢، ٢٠٠٣ لدراسة استجابة نبات الملوخية لمصادر مختلفة من التسميد النيتروجينى (سلفات نشادر، يوريا، نترات كالسيوم، نترات أمونيوم) والتسميد البوتاسى (سلفات بوتاسيوم، كلوريد بوتاسيوم) وتأثير ذلك على النمو الخضرى والمحصول وبعض الصفات الكيميائية (نيتروجين، فوسفور، بوتاسيوم) لنبات الملوخية.

وتتلخص أهم النتائج المتحصل عليها فيما يلى :

١- أدى التسميد الآزوتى فى صورة نترات الامونيوم (٣٣,٥% نيتروجين) إلى زيادة فى قيم صفات النمو الخضرى لنبات الملوخية متمثلة فى طول النبات، عدد الأوراق/نبات، مساحة الأوراق/نبات، الوزن الغض والجاف لكلا من الأوراق /نبات، والنبات الكلى وكذلك المحصول (محصول الأوراق والمحصول الكلى) بالاضافة إلى زيادة محتوى الأوراق من العناصر المعدنية (نيتروجين، فوسفور، بوتاسيوم) مقارنة ببقية مصادر التسميد النيتروجين الأخرى .

٢- أدى استخدام التسميد البوتاسى فى صورة سلفات بوتاسيوم (٤٨% بو٢ أ) إلى تحسن صفات النمو الخضرى وكذلك المحصول مقارنة بالتسميد بكلوريد البوتاسيوم (٥٢% بو٢ أ).

٣- أدى استخدام كلاً من التسميد النيتروجينى فى صورة نترات الأمونيوم (٣٣,٥% نيتروجين) والتسميد البوتاسى فى صورة سلفات البوتاسيوم (٤٨% K_2O) إلى الحصول على أفضل النتائج لصفات النمو الخضرى والمحصول وكذلك محتوى الأوراق من العناصر الغذائية (النيتروجين والفوسفور، والبوتاسيوم) مقارنة بمعاملات التفاعل الأخرى.

Table (4): Effect of the interaction between different sources of nitrogen and potassium fertilizers on the vegetative growth characters of Jew's mallow plant during 2002 and 2003 seasons.

1st season

K-sources	N-sources	Leaves / plant					Whole plant	
		Plant length (cm)	Number	Area (cm^2)	Fresh weight (g)	Dry weigh (g)	Fresh weight (g)	Dry weight (g)
Potassium chloride	Ammonium sulphate	28.4	20.9	289.5	14.7	1.7	19.1	3.5
	Urea	30.4	27.8	338.8	17.0	2.2	20.7	3.9
	Calcium nitrate	32.1	34.1	354.7	18.5	2.9	22.9	5.3
	Ammonium nitrate	35.8	38.2	358.4	19.0	3.2	25.0.	5.9
Potassium Shulphate	Ammonium sulphate	28.5	25.8	324.7	16.4	2.2	20.0	4.1
	Urea	31.0	28.4	345.7	17.5	2.8	21.9	5.0
	Calcium nitrate	35.3	35.4	358.0	18.5	3.3	23.0	5.9
	Ammonium nitrate	36.8	38.4	418.9	19.5	3.5	29.4	7.2
LSD at 5% level		0.5	0.5	8.4	0.5	0.1	0.4	0.2
2nd season								
Potassium Chloride	Ammonium sulphate	28.0	17.5	240.3	13.8	1.6	17.7	2.8
	Urea	30.1	23.2	256.8	14.3	1.9	20.6	3.5
	Calcium nitrate	31.3	28.8	280.2	15.5	2.1	21.7	4.2
	Ammonium nitrate	32.2	32.2	283.5	16.5	2.2	22.1	5.1
Potassium Sulphate	Ammonium sulphate	29.6	19.3	266.5	14.3	2.3	20.1	3.3
	Urea	30.4	26.2	300.7	15.3	2.5	21.1	5.2
	Calcium nitrate	31.9	30.5	326.2	16.7	2.6	22.7	5.9
	Ammonium nitrate	34.1	33.2	337.5	17.4	3.1	24.6	0.4
LSD at 5% level		0.3	0.5	2.5	0.2	0.1	0.7	0.4

Table (7): Effect of the interaction between different sources of nitrogen and potassium fertilizers on the foliage yield and its some chemical composition of Jew' mallow plant during 2002 and 2003 seasons.

1st season

K-sources	N-sources	Foliage yield (4 cuts)			%	
		(Kg/m_2)	(Ton/fed.)	N	P	K
Potassium chloride	Ammonium sulphate	3.520	14.080	2.431	1.114	2.691
	Urea	3.672	14.688	2.600	1.153	2.826
	Calcium nitrate	3.824	15.296	2.711	1.276	2.947
	Ammonium nitrate	3.904	15.616	2.925	1.418	2.992
Potassium sulphate	Ammonium sulphate	3.588	15.352	2.444	1.137	2.736
	Urea	3.816	15.264	2.607	1.288	2.842
	Calcium nitrate	3.896	15.584	2.834	1.321	2.962
	Ammonium nitrate	3.980	15.920	3.426	1.643	3.022
LSD at 5% level		0.013	0.023	0.036	0.023	0.005
Second season						
Potassium chloride	Ammonium sulphate	2.908	11.632	2.756	1.262	2.816
	Urea	3.088	12.352	2.925	1.303	2.951
	Calcium nitrate	3.632	14.528	3.036	1.438	3.102
	Ammonium nitrate	3.776	15.104	3.250	1.568	3.117
Potassium Sulphatte	Ammonium sulphate	3.200	12.800	2.769	1.287	2.864
	Urea	3.692	14.768	2.932	1.426	2.987
	Calcium nitrate	3.776	15.104	3.159	1.471	3.087
	Ammonium nitrate	3.944	15.776	3.751	1.793	3.147
LSD at 5% level		0.044	0.024	0.072	0.021	0.018