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A COMPARISON BETWEEN CONTROLLED RELEASE AND SOLUBLE N-FERTILIZERS ON YIELD AND QUALITY OF TWO SUBSEQUENT VEGETABLE CROPS.

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ABSTRACT

With increasing nitrogen unit price, the growers are begining to search about new methods for increasing nitrogen use efficiency. Consequently, this study was carried out to evaluate the efficiency of slow release nitrogen fertilizers on yield quantity and quality of two consecutive crops i.e., lettuce (*Lactuca sativa* L.) and jew's mallow (*Corchorus olitorus* L.) under furrow irrigation system.

Two filed experiments were conducted at Kaha Hort. Res. Station, Kalyoubia Governorate, during two consecutive growing seasons (winter and summer seasons) 2007/2008 and 2008/2009.

Results showed that sulfur coated urea (SCU) caused an increase in plant fresh weight and dry weight, yield as well as nitrogen and nitrate content of lettuce plants as compared with Ureaformaldehyde (UF) and traditional urea. The residual effect for Ureaformaldehyde increased the plant growth parameters, yield, nitrogen and nitrate content for jew's mallow. But, nitrate content in both crops did not exceed the critical concentration tolerated for human. On the other hand, the results show generally that increasing N-level from 30 to 90 kg/ fed. caused a marked increase in parameters under study for the two crops

It can be concluded to use sulfur coated urea at 90 kg N/fed. is recommended to obtain the optimum yield with highest quality for lettuce plant. Also, the residual effect for this fertilizer was sufficient to obtain the optimum yield and quality of jew's mallow.

INTRODUCTION

Recently, with increasing nitrogen unit price, vegetable growers are begining to think about reducing nitrogen application rates. Growers are weighing decisions to reduce nitrogen rates along with the potential for N losses that may occur due to the form of N used, method of application and weather conditions. In the past, growers may have increased N application rates to offset the potential for N losses and subsequent yield loss. This practice was considered to be inexpensive insurance largely because the cost of the extra N fertilizer was inexpensive. Nowadays, the economical situation, in addition to the restrict procedures against N-pollution let to change the former attitude of N fertilization. Meanwhile, the using of slow release nitrogen fertilizers to protect against N loss is recommended.

The use of coating is a novel approach to reduce nitrate losses and increase the N-efficiency.

Most crops especially leafy vegetables require a continuous supply of N for maximum yield, quality and appearance. With conventional fertilizer, these sources are accomplished by supplementing basic application with one

or more sidedressing. Slow release N fertilizers may result in greater recovery of applied nutrients, reduction of N luxury consumption and nitrate accumulation, decreased leaching of N from soils, and longer N supply, thus requiring fewer application (Sharma *et al.*, 1976, El-Asdoudi, 1993, El- Aila, 1994, and Mikkelsen *et al.*, 1994).
Substantial benefits of slow release fertilizers have been documented. The advantages are less nutrient losses, longer lasting supply of nutrients and labour savings (Allen, 1984).

On the other hand, residual nitrogen from slow release nitrogen fertilizer was able to supply the next crop with its N-requirements (Regis (2002) and Abbady et al., 2003). Raun and Johnson, (1999) found that approximately 80% of the applied fertilizer N was accounted for in either aboveground plant parts or in the soil (measured as total N) to a depth of 180 cm. This level of fertilizer N recovery is very high in relation to common levels measured (50 lbs. N/acre). Silvertooth, *et al.*, (2002) pointed out that plant took up approximately 40%, and the remaining 60% was found in the soil in the Arizona studies. Over 90% of the fertilizer N recovered in the soil was found in the top 30 cm.

The present study aims to evaluate the performance of coating urea fertilizer and its effectiveness as a regulator nitrogen release on yield and yield quality of two consecutive crops i.e., lettuce (*Lactuca sativa* L.) and jew's mallow (*Corchorus olitorus* L.) under furrow irrigation system

MATERIALS AND METHODS

Two filed experiments were conducted at Kaha Hort. Res. Station, Kalyoubia Governorate, during two consecutive growing seasons (winter and summer seasons) 2007/2008 and 2008/2009 under furrow irrigation system to evaluate some controlled release fertilizers (Ureaformaldehyde and sulfur coated urea) and soluble N-fertilizer (traditional urea 46% N) within three levels 30, 60 and 90 kg N/fed. on yield, quality and N-use efficiency of two subsequent vegetable crops (lettuce and jew's mellow).

Ureaformaldehyde (UF) contain 41.27 % N of commercial names in Egypt as ureaform was taken from General Organization Equalization Fund (GOAEF), Ministry of Agriculture, Egypt. A commercial sulphur-coated urea (SCU) contain 29% N was supplied by the Soil Fertility and Plant Nutrition Research Section, Soils and Water Res. Inst. A.R.C.

The Experiments of this study were executed in a split plots system in randomized complete block design with three replicates. Regulator release nitrogen were randomly distributed in the main plots. The sub-plots were assigned for nitrogen rates. Each sub plot consisted of five rows within 3-meter-long. The distance between the rows was 0.6 meter.

Lettuce seedlings cv. Dark Green were transplanted when they were six weeks old on 15^{th} and 20^{th} November in first and second season, respectively. On one side of the ridge with a space of 20 cm between plants. Each treatment was separated by two guard ridges.

Before transplanting, slow release nitrogen fertilizer was broadcast in the soil surface and incorporated with 5cm depth of soil. While conventional nitrogen fertilizer (urea) was applied after three weeks of seedling and incorporated with soil before irrigation. Each rate was applied as one dose. Calcium superphosphate (15.5 % P_2O_5) and potassium sulphate (48.5 % K_2O) were applied at 100 and 50 kg/fed., during soil preparation, respectively.

After lettuce harvest, rows were hoed to remove plant waste and weeds. Then, Seeds of jew's mellow cv. Balady were sown on same rows of lettuce without tillage, at a rate of 10 kg /fed. Sowing dates were 5th and 3rd March for the first and second season, respectively. No nitrogen fertilizer was added to jew's mellow plants. Other agricultural practices were carried out as recommended for the commercial production field for lettuce and jew's mellow.

Before planting and at harvesting, soil samples of the experimental site were collected from a surface layer (0-30 cm) of different sites in the two years of study. Some physical and chemical properties of the used soil were estimated by the method described by Page *et al.*, (1982) and presented in (Table 1).

Table 1: Some physical and chemical properties of the experimental soil (at the depth of 0-30) before planting during 2007/08 and 2008/09 seasons.

Soil physical and chemical properties					
	2007/08	2008/09		2007/08	2008/09
Organic matter%	0.80	0.85	Ca^{++}	6.48	6.51
CaCO3%	1.65	1.60	Mg^{++}	3.13	3.11
Sand%	25	25	Na^{+}	5.92	5.91
Silt%	40	41	K^{+}	0.28	0.25
Clay%	35	34	NH_4	45.00	41.75
Soil texture	Clay	Clay	NO_3	77.35	65.71
pH (1:2.5 soil suspension)	7.9	7.95	P	11.21	11.18
ECe(dSm^{-1})	2.15	2.17	K	321	317

A random sample of five plants from each sub plot were taken at harvesting time to determine plant fresh and dry weight. All plants for each treatment were weight to calculate the total yield per feddan. Total nitrogen, was determined in leaves according to the method described by Chapman and Pratt (1982). Nitrate was determined in dry matter according to Singh (1988).

Data obtained were subjected to statistical analysis by the technique of analysis of variance (ANOVA) for split plot design according to Snedecor and Cochran (1982). Comparisons among means of treatments were tested using Duncan's Multiple Range Test (Duncan, 1965), and L.S.D values at 5% level.

RESULTS AND DISCUSSION

Primary effect of slow release fertilizers and traditional urea on lettuce:

All modified urea increased the fresh and dry weight of lettuce leaves compared with traditional urea treatment. Results show that a modified urea products gave a highly significant increase in growth data, in both seasons (Table 2).

Regarding to the effect on interaction between nitrogen sources and levels, data in Table (2) indicate clearly that the slow release urea with 90 kg N/fed. gave the best results for plant growth parameters compared with traditional urea. Yield was significantly higher in the SCU and UF treatments than traditional urea. The total yield obtained by the UF was less than SCU. The good yield in slow release fertilizers was in line with higher levels of nitrogen in the soil profile (Table 4)

Regarding to the effect of nitrogen levels, data in Table (2) show that the high nitrogen level gave the best yield compared with low levels (30 and 60 kg N/fed). The differences were reached to the level of significantly in both seasons.

The affect of yield by the interaction between nitrogen sources and levels were presented in Table (2). The result show that the application of 90 kg N/fed applied as SCU or UF were superior than 30 and 60 kg N/fed. This difference among different treatments was significant in the two years. Result could be explained as the regulation of nutrient release would be used more efficiently by plants than uncoated fertilizers and subsequently reducing-N leaching losses and providing a constant supply of nutrients to the roots (EL-Aila and Abou Seeda 1996b).

Table (2): Effect of different nitrogen sources and levels on fresh and dry weight, yield, nitrogen and nitrate content in leaves of lettuce plant during the two season of 2007/2008 and 2008/2009.

Treat-ment	Fresh weight g/ plant		Dry weight g/ plant		Yield ton /fed.		Nitrogen content %		Nitrate content (ppm)	
	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
sources										
Urea	526.22c	587.46b	35.9c	43.7b	15.79c	15.84c	2.72c	2.87c	64.67c	68.86c
UF	562.93b	621.57a	39.2b	48.5a	18.01b	16.86b	3.45b	3.33b	69.19b	76.39b
SCU	587.54a	621.06a	42.4a	49.5a	20.20a	18.50a	3.64a	3.64a	71.24a	77.96a
Levels										
30	497.42c	552.92c	34.7c	42.9c	17.02b	15.08c	3.01c	2.95c	61.13c	67.95c
60	549.35b	595.87b	37.9b	45.6b	18.36a	17.27b	3.28b	3.27b	67.51b	73.23b
90	629.91a	681.29a	45.0a	53.2a	18.63a	18.85a	3.52a	3.62a	76.46a	82.03a
Urea										
30	450.9g	510.54f	30.5f	39.2f	14.32f	14.39f	2.43f	2.66f	55.41f	62.74f
60	522.05f	583.92e	34.8e	42.9e	16.47e	16.45e	2.82e	2.89e	64.15e	71.7de
90	605.71c	667.93b	42.4c	49.1b	16.59e	16.68e	2.91e	3.06d	74.43b	72.08d
UF										
30	517.56f	574.07e	35.2e	44.7e	17.59d	14.16f	3.21d	3.01d	63.60e	70.55e
60	550.11e	591.96d	37.8d	46.2d	18.02d	17.10d	3.48bc	3.29c	67.60b	72.75d
90	621.14b	698.67a	44.8b	54.5a	18.43c	19.34b	3.66b	3.67b	76.33b	85.86b
SCU										
30	523.81f	574.15e	38.3e	44.7e	18.81b	16.50e	3.38cd	3.18c	64.37e	70.56e
60	575.90d	611.74c	40.9d	47.7c	20.58a	18.26c	3.54bc	3.61b	70.78c	75.18c
90	662.89a	717.27a	47.9a	55.9a	20.86a	20.54a	3.98a	4.13a	78.56a	88.14a

Means in the same column and same group having the same letter are not significantly different at 0.05 level by Duncan's.

Respecting N and NO3 leaf content, data presented in Table (2) reveal that significant differences between different sources and levels of nitrogen used treatments. The highest values were recorded by SCU and UF compared with traditional urea. However, the effect of interaction between sources and levels of nitrogen on both N and NO3 in lettuce leaves content were significantly increased with 90 kg N/fed. from SCU treatment in comparison with other treatments in both years. Similar results were obtained by Gioacchini, et al., (2006). who reported that the accumulation of N content resulted form slow-release was higher than traditional fertilizers. In addition nitrate content did not exceed the critical concentration tolerated for human (250 ppm) as reported by Fritz and Venter (1978) in fresh stem of kohlrabi plant.

Residual effect of slow release fertilizers and traditional urea on jew's mallow subsequent to lettuce:

The residual effect of SCU and UF on jew's mallow as a subsequent crop after lettuce grown on the same plots of lettuce had caused positive results over control (urea treatment), however, the residual effect of urea treatment was less than slow release urea in most determined values; plant fresh and dry weight as well as total yield (Table3).

Data in Table (3) show also that gradual increases in values of fresh weight, dry weight of leaves /plant as well as total yield per feddan were obtained with each increase in N level. This result was true in the two years of study. These results might be attributed to the stimulated effect of nitrogen on the meristmatic activity of plant tissues, since nitrogen is a constituent of proteins, nucleic acid and many other important substances of plant cell (Yagodin, 1984). Several investigators came to similar conclusion, for instance, Abo-Sedera *et al.*, (1989) and Richard *et al.*, (1985).

The results show also that application of 90 kg /fed applied as UF was superior than 30 and 45 kg N/fed. This difference among different treatments was significant in the two years. However, the residual amounts from UF and SCU application at the rates of 90 kg N/ fed were as preferable to total yield. This result was true in the two years of study. Result could be explained by the regulation of nutrient release to be used more efficiently by plants with SCU and UF than uncoated fertilizers and subsequently reducing-N leaching losses and providing a constant supply of nutrients to the roots (EL-Aila and Abou Seeda 1996b).

The same data in Table (3) show that the UF at 90 kg N/fed. gave significant N and NO3 content in jew's mellow leaves than other treatments in both years. These results were in agreement with that of Abbady *et al.*, (2003)

The cumulative amounts of N forms NH_4^+-N and NO_3^--N at the end of experiments are listed in Table 4 and fig. 1, 2, 3 and 4 . It is seen that the amounts of NH_4^+-N and NO_3^--N were tended to increase in the order: UF > SCU > Urea. And increased gradually within increasing N levels. These results are in agreement with Shaji, *et al.*, (1991) who mentioned that the rate of N dissolution from Urea Coated was high at early growth stages of corn plant, but gradually decreased with time. Same results were illustrated by Merhaut et al., (2006). The cumulative N release reached about 80% of the total N content of the fertilizer. Westerman and Kurtz (1972) found that 22 to 26% of the initial fertilizer N applied to sorghum-sudan grass was present as residual soil N after two cropping seasons. So that, a better understanding of residual N and mineralization potentials would also benefit in fertilization management and improved efficiencies for many crops, (Raun *et al.*, 1998). Concerning with increasing nitrogen available in the second season, may be due to mineralization of nitrogen from residual plants.

Table (3): Effect of different nitrogen sources and levels (as residual) on fresh and dry weight, yield, nitrogen and nitrate content in leaves of jew's mellow plant during the two season of 2007/08 and 2008/09.

Treatment	Fresh weight g/ plant		Dry weight g/ plant		Yield ton /fed.		Nitrogen content %		Nitrate content (ppm)	
	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09	2007/08	2008/09
Sources										
Urea	11.80c	11.35c	2.76c	3.12c	3.94c	3.79c	2.78c	2.53c	31.24c	33.05c
UF	15.39a	15.97a	3.53a	3.97a	5.68a	5.38a	3.21a	3.14a	40.48a	42.19a
SCU	12.95b	13.98b	3.04b	3.48b	4.77b	4.90b	2.89b	2.73b	32.99b	36.48b
Levels										
30	10.08c	10.92c	2.41c	2.72c	3.76c	3.98c	2.72c	2.41c	26.20c	28.86c
60	14.18b	14.73b	3.19b	3.75b	4.78b	4.69b	2.91b	2.77b	37.43b	39.28b
90	15.87a	15.65a	3.72a	4.11a	5.86a	5.39a	3.26a	3.22a	41.09a	43.57a
Urea										
30	8.40h	9.46h	2.10f	2.35g	3.11e	3.54f	2.64f	2.37e	21.85h	25.60f
60	12.36f	11.95f	2.74e	3.22e	4.01d	3.68f	2.66f	2.50d	33.53e	33.67e
90	14.62d	12.19f	3.43c	3.78d	4.72c	4.14e	3.02d	2.70c	38.00c	39.50d
UF										
30	12.22f	12.86e	2.88e	3.20e	4.13d	4.39d	2.77e	2.42de	31.77f	33.43e
60	16.46b	17.09b	3.62b	4.25b	5.58b	5.20c	3.26b	3.11b	42.79b	44.43b
90	17.47a	17.96a	4.10a	4.46a	7.34a	6.54a	3.60a	3.88a	46.88a	48.69a
SCU										
30	9.61g	10.45g	2.25g	2.59f	4.04d	4.01e	2.72ef	2.43de	24.97g	27.18f
60	13.70e	15.16d	3.21d	3.80d	4.75c	5.19c	2.82e	2.69c	35.95d	39.74d
90	15.52c	16.35c	3.64b	4.07c	5.52b	5.49b	3.14c	3.06b	38.36c	42.51c

Means in the same column and same group having the same letter are not significantly different at 0.05 level by Duncan's.

Table (4): Effect of different nitrogen sources and levels on amounts of NH_4^+-N and NO_3^--N in soil at the end of jew's mellow season of 2007/08 and 2008/09.

Treatment		NH_4^+-N		NO_3^--N	
		2007/08	2008/09	2007/08	2008/09
Sources					
	Urea	39.47	33.04	46.09	53.05
	UF	44.26	38.47	54.22	58.95
	SCU	42.39	36.58	50.62	54.36
L.S.D ......(A)		0.78	1.67	1.74	0.67
Levels	30	39.47	31.76	44.16	50.81
	60	41.84	35.24	51.42	56.37
	90	44.52	41.87	55.36	59.19
L.S.D........(B)		0.78	1.67	1.74	0.67
L.S.D......(A x B)		1.36	2.89	3.01	1.16

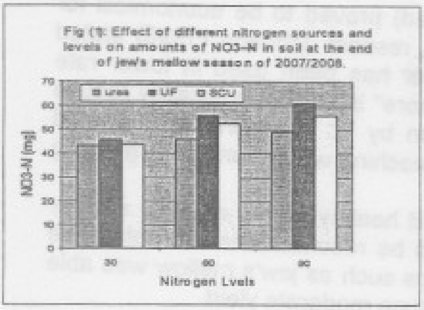

Fig (1): Effect of different nitrogen sources and levels on amounts of NO3-N in soil at the end of jew's mellow season of 2007/2008.

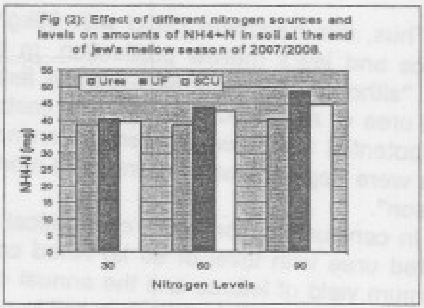

Fig (2): Effect of different nitrogen sources and levels on amounts of NH4+N in soil at the end of jew's mellow season of 2007/2008.

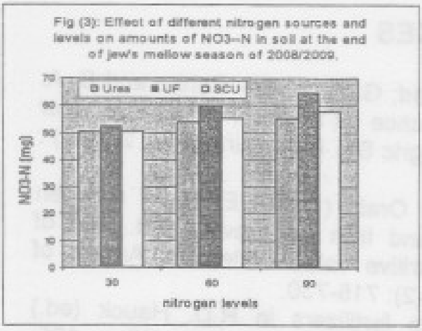

Fig (3): Effect of different nitrogen sources and levels on amounts of NO3--N in soil at the end of jew's mellow season of 2008/2009.

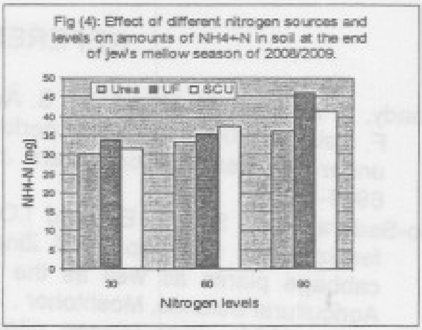

Fig (4): Effect of different nitrogen sources and levels on amounts of NH4+N in soil at the end of jew's mellow season of 2008/2009.

The results in Table 5 show that the highest return was obtained from slow release urea at the rate of 90kg N /fed especially with SCU compared with traditional urea at same level.

Table (5): Estimation of net return for all treatments of the interaction between nitrogen sources and levels as well as residual effect on lettuce and jew's mellow during the two subsequence season of 2007 and 2008.

Treatment	N cost (L.E./ fed.)	lettuce and Jew's mellow			
		Income (L.E./fed.)		Return (L.E./fed.)	
		2007/08	2008/09	2007/08	2008/09
Urea					
30	90	17434.1	17930.0	17344.1	17840.0
60	180	20477.9	20133.3	20297.9	19953.3
90	270	21313.2	20820.0	21043.2	20550.0
UF					
30	260	22723.8	23886.7	22463.8	23626.6
60	520	24934.6	26300.0	24414.6	25780.0
90	780	25770.7	26893.3	24990.7	26113.3
SCU					
30	100	22850.9	22813.3	22750.9	22713.3
60	200	25342.1	24590.0	25142.0	24390.0
90	300	26387.9	26500.0	26087.8	26200.0

* Income was estimated according to the following price: price of product at L.E. 1.0/kg for lettuce and jew's mellow

** Treatments cost was estimated according to the following prices: price of N at L.E. is 3.00, 8.60 and 3.33 for urea, Ureaformaldehyde and sulfur coated urea, respectively.

Thus, this treatment (SCU with 90kgN/fed) proved to be economical for lettuce and jew's mellow production. In this respect Johnson (1990) stated that, "although the controlled-release fertilizer has been used in lower rate than urea or ammonium nitrate, and costs more" it would significantly reduce the potential for ground water contamination by N. The benefits of coated urea were apparent when there were more leaching water during the growing season".

In conclusion, from both economical and healthy points of view, sulpher coated urea with level of 90 kg N/fed could be recommended to obtain the optimum yield of lettuce and the annual crops such as jew's mellow was able to utilize from resudial nitrogen in soil to produce moderate yield.

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مقارنة بين الأسمدة بطيئة الذوبان والأسمدة التقليدية على المحـصول والجـودة لمحصولين من الخضر المتعاقبة

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نظراً لارتفاع ثمن الأسمدة النيتروجينية في الآونة الأخيرة، وبالتالي زيادة تكاليف الوحدة من المنتج الزراعي، كان من الضروري البحث عن طرق جديدة تعمل على زيادة معدل الاستفادة من الأسمدة النيتروجينية خاصة وأنه لا توجد بدائل حقيقية للأسمدة النيتروجينية يمكن الاعتماد عليها كليا ، لذلك كان الهدف من هذا البحث هو دراسة تأثير اليوريا المغلفة بالكبريت واليوريافورمالدهيد مقارنة بسماد اليوريا العادية وذلك على محصول الخس ودراسة تأثير الأثـر المتبقـي مـن تلـك الأسمدة على محصول الملوخية ، كخضر ورقية متعاقبة تحتاج إلى كميات وفيرة من النيتـروجين للحصول على محصول مرتفع بصفات جودة مرتفعة.

لذلك أجريت تجربتان حقليتان بمزرعة قها للبحوث الزراعية – محافظة القليوبيـة خـلال موسمي ٢٠٠٧ / ٢٠٠٨ و ٢٠٠٨ /٢٠٠٩ تم خلالها زراعة محصول الخس في الموسم الشتوي يليه زراعة محصول الملوخية في الموسم الصيفي وذلك في ذات الوحدة التجريبية.

وكان أهم النتائج المتحصل عليها كما يلي:

- أدى إضافة اليوريا المغلفة بالكبريت إلى زيادة وزن النبات الطازج والجـاف والمحـصول وكذلك محتوى الأوراق من النيتروجين والنترات لنبات الخس مقارنة باليوريا العادية، بينمـا أدى إضافة اليوريافورمالهيد إلى تحسين النمو والمحصول ولكن بنسبة أقل من اليوريا المغلفة بالكبريت.
- كان للأثر المتبقي لسماد اليوريافورمالدهيد تأثير محسن على صفات النمو والمحصول لنبات الملوخية وزيادة محتوى الأوراق من النيتروجين وذلك بالمقارنـة بـسماد اليوريـا المغلفـة بالكبريت واليوريا العادية.
- أدى إضافة الأسمدة النيتروجينة بمعدل ٩٠ كجم للفدان إلى زيادة في قيم النمـو الخـضري والمحصول ومحتوى الأوراق من النيتروجين والنترات لكلا المحصولين.
- محتوى الأوراق من النترات في كلا المحصولين كان في الحدود الأمنة لصحة الإنسان

وتوصـي الدراسة بإضافة سماد اليوريا المغلفة بالكبريت بمعدل ٩٠ كجم ن/فـدان لتحـسين النمو والمحصول لنبات الخس ، كما يمكن الاستفادة من الأثر المتبقي منه في إنتاج محصول جيـد من نبات الملوخية وتوفير قدر كبير من الأسمدة النيتروجينية.

قام بتحكيم البحث

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