CROPS GROWTH AS A FUNCTION OF UREAFORM APPLICATION UNDER DRIP IRRIGATION

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ABSTRACT: *A field experiment was conducted at the experimental station, Fac. Agric., Al-Azhar Univ, Assuit Governorate, during three consecutive growing seasons (2001/02-2002/03) under drip irrigation system to evaluate function of ureaform on the growing crops (onion, soybean and turnip). The soil treated by ureaform (UF) as a slow release nitrogen fertilizer (SRNF) at three rates (60, 90 and 120 kg/fed) and by urea (Ur) as a normal nitrogen fertilizer at the recommended rate (120 kg/fed) as well as control treatment.*

Nitrogen source affected the onion partitioning into grade groups. UF increased the percentage of marketable and exportable grades whereas urea increased cull percentage (non marketable). In the second (soybean) and third season (turnip), UF gave higher yield than that of urea.

There were consistent differences in onion yield quality due to N-source. UF increased the pungency, total free amino acids and total sugar amounts. Also, it improved storability by preserving the yield quality almost unchanged after three months storage. Also, UF treatments increased protein content in the soybean seed by about 3 times compared with urea treatment. UF increased the macro and micronutrients taken up by each crop, while it decreased their content of nitrate ion.

Nitrogen depleted and nitrogen-undetected of UF treatments amounted 82 and 18% respectively against those of urea which amounted 33 and 67% in the same order. Application of UF has secured some of environment protection considerations and clean plant product potentials. In another words, UF application as a nitrogen fertilizer minimized N-losses, which would have decisively led to contaminate the groundwater by nitrate.

Key words: *Ureaform, urea, nitrogen use efficiency, onion, soybean, turnip.*

INTRODUCTION

Slow-release fertilizers are excellent alternatives to soluble fertilizers (Guertal, 2000). Because nutrients are released at a slower rate throughout the season, plants are able to take up most of the nutrients without waste by leaching. A slow-release fertilizer is more convenient, since less frequent application is required. Fertilizer burn is not a problem with slow-release fertilizers even at high rates of application; however, it is still important to follow application recommendations. Slow-release fertilizers may be more expensive than soluble types, but their benefits outweigh their disadvantages (Brown et al., 1988; Abbady et al., 1997; Jensen and Sanders, 2001; Abbady et al., 2003).

Ureaform (synthetic organic compound) consists of short or long chain of polymethelynurea. Its nature, chemical components, advantages and application were reviewed by Alexander and Helm (1990). It can cover nitrogen requirements for more than one crop. Therefore three successive crops (onion, soybean and turnip) were cultivated and monitored their response for ureaform under this study.

Onion bulb is a priority commercial crop that can generate progressive and viable markets. With effectively managed production and successful marketing, onions can be a profitable crop. However, there are many obstacles facing the growers that need especial nitrogen fertilizer and water management to get an optimum yield or quality. The amounts, specific fertilizer elements applied and times of application are critical to successful production. Any can lead to a dramatic loss in yield or could render the onions unmarketable. If too little nitrogen is available, onions can be severely stunted and more susceptible to diseases. High nitrogen application rates produce a succulent plant that is more susceptible to winter injury disease and to the production of flower stalks. Onions highly fertilized with nitrogen do not store well. Excess N applications can result in late maturity, causes doubling, large necks that are difficult to cure, soft bulbs and poor storage quality (Brewster, 1994; Brown, 2000; Drost & Koenig, 2001 and Halvorson et al., 2002).

Soybeans need a high level of fertility to produce top yields. They contain a large amount of nitrogen in the form of protein. Soybean, in general, is able to fix atmospheric nitrogen and take enough from the soil to meet its need. It has been shown that soybean is a net remover of nitrogen from the soil and does not add nitrogen to it such as a forage legume does. Soybean is able to use fertilizer N and residual N in the soil at the expense of fixing N due to fewer and smaller nodules. Situations where soybean might response to fertilizer N are failure to nodulate, ineffective nodules, prolonged wet conditions or a very low soil organic matter. Whether higher yielding soybean in the future will respond to fertilizer N is speculative (Wilcox, 1987 and Upfold & Olechowski, 2002).

Turnip is a good source of vitamins A and C, potassium and small amount of other nutrients as well as it consumes low amount of nitrogen. It can withstand dry periods if some soil moisture is available. An excess of water reduces turnip growth. Cracking of the root may occur with a fast growth rate brought on by excessive fertilization, wide spacing and hot humid weather. Sometimes these growth cracks become infected with soft rot bacteria (Motes et al., 1996; Shattuck & Mayberry, 1998).

Irrigation water management is essential for profitable yields. Drip irrigation provides the most efficient irrigation in terms of the amount of water required for a crop. Small amounts of water can be delivered at frequent intervals as needed by the plants, and water losses to evaporation are less than with sprinklers. Also, water is delivered at or below ground level, so that wetting of the foliage is not a problem, as with sprinklers. Drip irrigation allows great flexibility in both water and N management. Water and N are the two inputs to irrigated cropping systems that have the most impact on agronomic, economic and environmental outcomes. Irrigation water management can save 30 to 50 percent of water and energy. Over irrigation can result in leaching of fertilizers to the groundwater and reduces the efficiency of N fertilizers (Thompson et al., 2000 & 2002; Assouline, 2002 and Halvorson et al., 2002).

The current study aims to evaluate the achievement of ureaform (UF) and determine suitable rate which give optimum yield for each crop in suggested cropping consecution comparing to urea fertilizer under drip irrigation system.

MATERIALS AND METHODS

A field experiment was conducted at the experimental station, Fac. Agric., Al-Azhar Univ, Assuit Governorate, during three consecutive growing seasons (2001/02-2002/03) under drip irrigation system. The field experiment was a complete randomized design with three replicates. Each plot had an area of 1/168 Fedden (5x5m) and was bounded by buffer strips 1.5m wide.

Urea fertilizer (Ur) as a soluble form was applied at a rate of 120 Kg N/feddan (official recommended rate for onion crop. Ureaform fertilizer as a slow release nitrogen fertilizer (prepared by Abbady et al., 1992) was used at rates of 60, 90 and 120 kg N/fedden (UF1, UF2 and UF3) side banding in one dose, prior to planting. For comparison, a control treatment (C) without N fertilizer was purposed. The main soil properties of the experimental field were determined according to Klute (1986) and presented in table (1). Available macronutrients (N, P and K) were determined according to Page (1982) and available micronutrients (Fe, Zn and Mn) were extracted by DTPA and determined using atomic absorption.

Table (1): Main soil properties of the studied soil.

Property		Soil depth (0 – 60) cm
O.M.%		0.80
$CaCO_3$ %		1.65
Sand %		25.00
Silt %		40.00
Clay %		35.00
Texture class		Clay loam
pH (1 : 2.5 soil : water)		7.90
EC_e (dS/m)		2.15
Soluble ions (meq./l)	CO_3	0.00
	HCO_3	2.34
	Cl	8.13
	SO_4	10.23
	Ca	10.38
	Mg	5.12
	Na	4.89
	K	0.31
Available (ppm)	NH_4	49.00
	NO_3	84.00
	P	9.40
	K	441.00
	Zn	2.30
	Fe	9.50
	Mn	4.10

Onion cultivar (Giza 6) was cultivated in November 2001 as a first crop. To test the residual effect of used fertilizers (urea and ureaform) Soybean cultivar (Clark) and turnip cultivar (Soltany) were cultivated in June 2002 (as a summer crop) and November 2002 (as a winter crop), respectively. The yield and yield quality of each crop were determined and tested by measuring some agronomic traits. The plant samples were dried at 70 °C. Total macronutrients (N, P and K) and NO_3 content were determined according to Klute (1986). Micronutrients (Fe, Mn and Zn) were determined using atomic absorption. At harvesting and after 3 months storage, chemical components of onion were determined such as pungency (Schwimmer & Weston, 1961), free amino acids (Rosen, 1957) and total sugar (Thomas & Dutcher, 1924). Nitrogen recovery and nitrogen use efficiency (NUE) of added

N was calculated according to Dilz (1988). Statistical analysis was carried out according to the procedures outlined by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

I- Yield and its component

a) Onion

Data in Fig. (1) show the bulb yield and its grades as affected by ureaform rates. Total, marketable and exportable yield had highly significant affected by applied nitrogen fertilizer rates or forms compared to control treatment. The marketable and total yield followed the descending order of Ur > UF3 > UF2 > UF1 > C treatment. The recorded exportable yield followed the descending order of UF3 > Ur > UF2 > UF1 > C treatment.

In contradict, Ur and C treatments realized amount of spoiled grades much higher than those of ureaform treatments. This tendency illustrated that UF treatments preferably offer high yield quality since their marketable and exportable grades (expressed as a percent of total yield) were higher than those of Ur or C treatments (table 2). While, the culls or spoiled grade percentages were much less in ureaform treatments (UF1, UF2 or UF3) compared to those of Ur or C indicating again good yield quality. These results are in good agreement with those obtained by Brown et al. (1988) who stated that if too little nitrogen is available, onions could be severely stunted and more susceptible to disease. High nitrogen application rates produce a succulent plant which more susceptible to water injury disease and to the production of doubling. They also, added that using excessive nitrogen could adversely affect growth, especially if it was urea. The good yield quality refers to UF fertilizer application may explain on basis that it ensures available nitrogen supply at regular rate (Abbady et al., 1997).

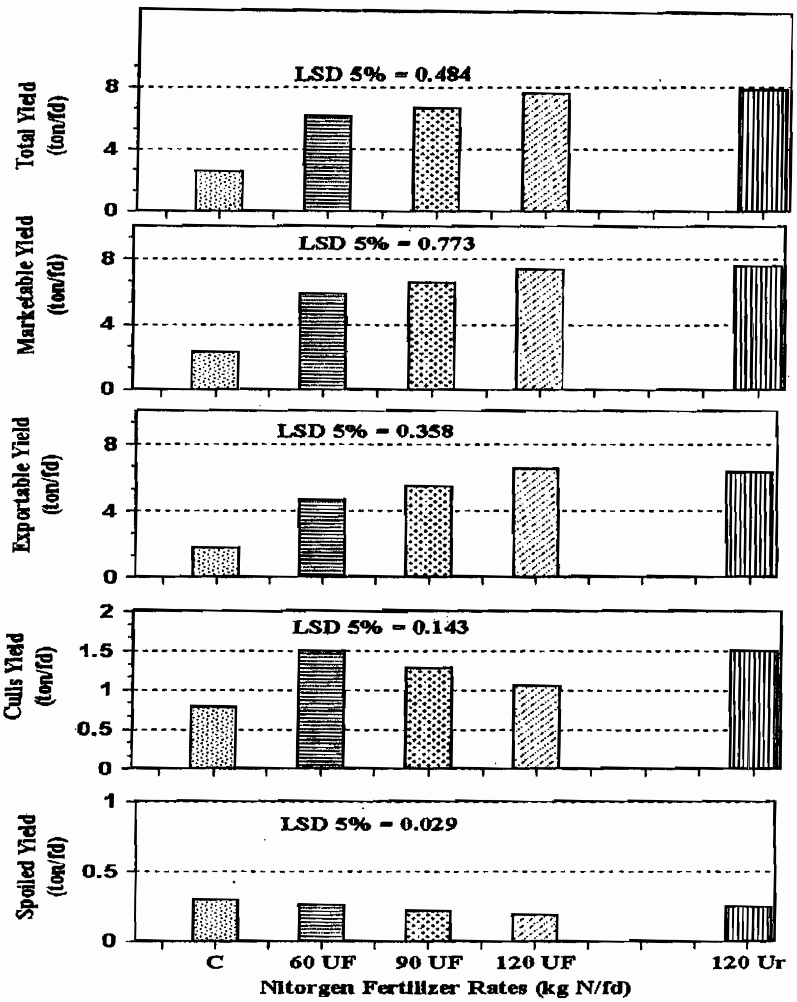

Fig (1). Onion yield and its grades as affected by ureaform rates.

b) Soybean

Yield and its traits as affected by ureaform rates are presented in Fig. (2). Data revealed that there are significant differences between N-treatments as a whole and control one. Total yield, weight of 100 seeds, pod No./plant, pod length and plant height followed the descending order of UF3 > UF2 > UF1> Ur > C treatment. It is obvious in the second growing season that, the UF treatments were superior to other treatments (Ur and C). These findings confirm that a good yield quality may obtain from UF treatments, which sustain a slow release of nitrogen ready for plant consumption at adequate amount in time as needed.

Table (2): Grades percentage of total onion yield as affected by ureaform rates

Treatment	Exportable yield %	Marketable yield %	Culls yield %	Spoiled yield %
C	69.41	88.45	30.59	11.55
UF1	80.86	96.82	19.14	3.18
UF2	81.06 (82.66)*	96.82 (97.04)*	18.94 (17.34)*	3.18 (2.96)*
UF3	86.06	97.49	13.94	2.51
Ur	75.65	95.77	24.35	4.23

* The average value of UF treatments.
Total yield = exportable + culls   Marketable yield =exportable + pickles + doubling
Culls yield = pickles + doubling + spoiled yield   Spoiled yield = bolters + damage

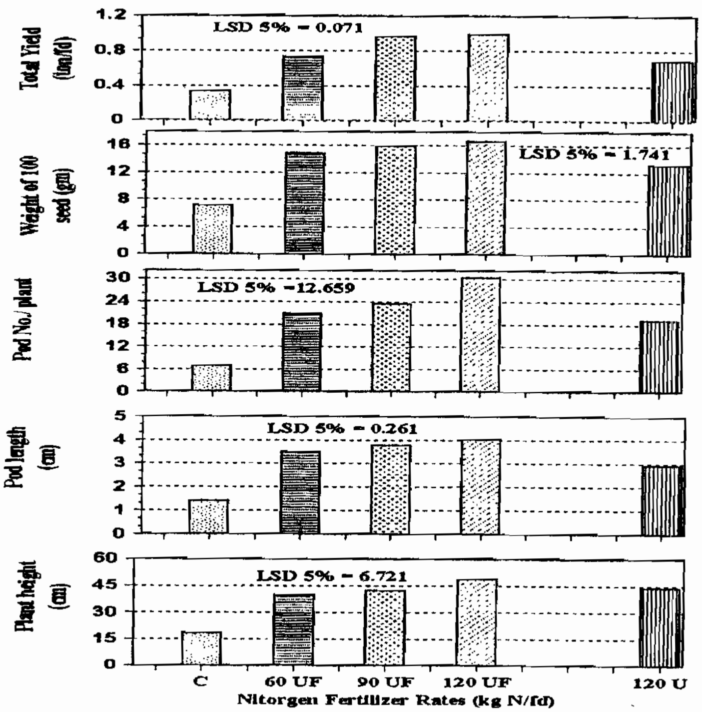

Fig (2). Soybean yield and its traits as affected by uraform rates.

c) Turnip

In the third growing season, it is anticipated that the previous crops take up most nitrogen that storage in the soil so, coming crop may face insufficient amount of nitrogen. Therefore, Turnip was selected as a third crop in suggested cropping succession. Tested turnip traits show that UF treatments realized significant positive effect superior to other treatments (Ur and C), especially UF3 (Fig. 3). This may be due to the remained nitrogen comes from UF fertilizer that has a slow release nature and low gaseous N-losses. It could be mentioned that high rate of ureaform may authorize cultivating a third crop that consumptive low nitrogen amount (Motes et al., 1996 and Shattuck & Mayberry, 1998).

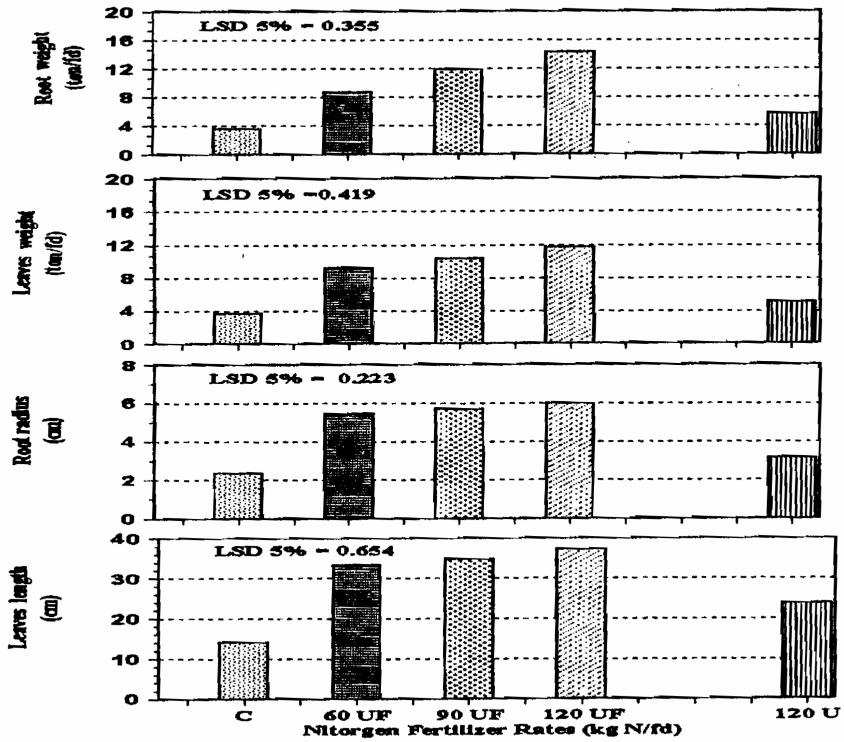

Fig (3). Turnip yield and its traits as affected by ureaform rates.

II - Yields Quality

Pungency, total free amino acids and total sugar of onion yield as affected by ureaform rates and storability status are shown in Fig. (4). In general, the values of such components increased as UF fertilizer increased either at harvesting time or after three months storage. Regarding storability, the pungency values for all treatments including control, after storage, were slightly higher than that at harvesting time. These results agree with those obtained by Kopsell et al., (1999) who found that pungency as measured by enzymatically formed pyruvic acid (EPY) increased or decreased during storage for some cultivars or remained unchanged in others. Since this change is related to inheritance factors.

The storage reduced total free amino acids and total sugar in all treatments including control. This is may be due to their consumption during biological processes as an enzymatical conversion. This result agrees with that found by Brown et al., (1988) who stated that storage or excess nitrogen fertilizer might reduce bulb yield and bulb grade or quality, maturity, storability and disease resistance. They added that if the nitrate produced from speed nitrification of used urea is excessive when onion roots reach bed centers, i.e. at early growth stage, onion yield and storability might be adversely affected. Brewster (1994) illustrated that excessive nitrogen applications contributed to increase storage losses.

On the other hand, the results proved that using UF fertilizer would be the possible way to maximize bulb quality, this was in agreement with the work of Drost and Koening (2001) who reported that fertilization of onion with polyon coated urea, as a SRNF could increase onion bulb quality through better N use efficiency compared to urea.

Regarding protein content in soybean yield, the UF treatments realized higher protein percent than that of other treatments (Ur and C). The protein percent increased as the UF fertilizer increased. The protein percent was 6.61, 10.55 and 13.74 in UF1, UF2 and UF3, respectively. The protein percent was 3.36 and 5.7% in Ur and C treatments, respectively. This finding, again confirm and verify that ureaform fertilizer can give not only high production but also produce a good yield quality.

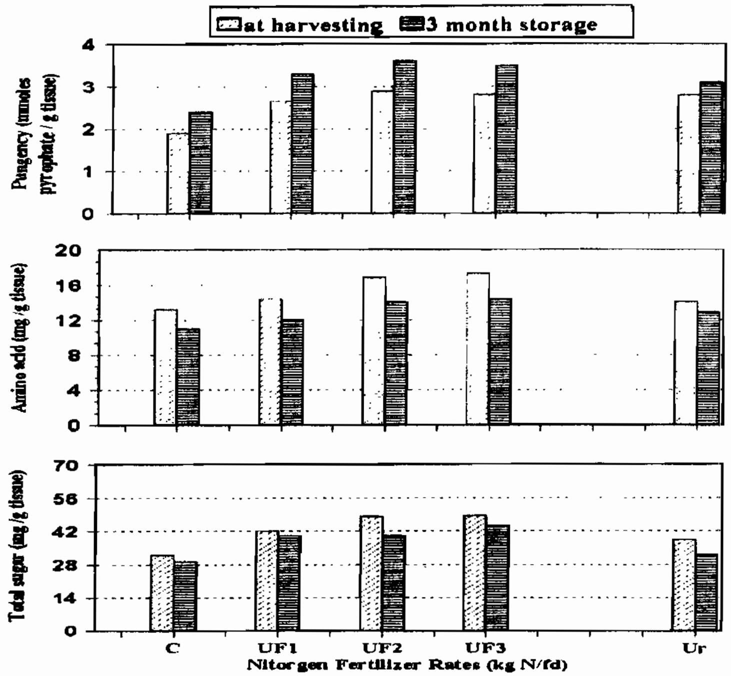

Fig. (4). Pungency, total free amino acid and total sugar as affected by uraform rates at harvesting time and after three month storage

III – Macro and Micronutrients

Data given in table (3) show the concentration of both macro and micronutrients taken up by onion, soybean and turnip as affected by ureaform rates. The results revealed that plants of UF treatments could gather higher amount of such nutrients than those of urea or control one. Such effect may be due to the chemical effectiveness of ureaform fertilizer on soil component which is strongly similar to the effect of decomposed organic matter, which reduced soil pH and made most nutrients more available for plant. Also, breaking downs of UF acts as a chelating substance that could retain nutrients to be ready for plant uptake. These findings are in agreement with those obtained by Awad et al., (1990), Abbady et al., 1999 and Awaad (2000).

Concerning nitrate ion in two seasons, plants in UF treatments showed lower content of nitrates (3.8 ppm) than those of urea one (8.4). It seems that ureaform fertilizer was useful not only in supplying adequate nitrogen for long term crop but also in offering clean plant product free from residues nitrogen which can meet world standard requirements that make it acceptable for export. These findings were in agreement with the work of Abbady et al., 1997; El-Mallah et al., 1998 and Jensen & Sanders 2001.

IV – N-recovery and N-use efficiency (NUE)

Data shown in table (4) represents the depleted-N by each crop and total N taken up by the studied crops (onion, soybean and turnip) as affected by ureaform rates. In general, the results showed several facts: (I): N-recovery and NUE of UF treatments were almost similar to those of urea only in the first season (for onion), (II) : N-recovery and NUE of UF treatments for soybean crop were about 3 times higher than of urea, (III): N-recovery and NUE of UF treatments for turnip crop were about 10 times higher than of urea, and (IV): total N-recovery and NUE of UF treatments for all crops were about 2 times higher than of urea.

Table (3): Contents of some nutrients in the studied crops as affected by Ureaform rates.

Treatment	Macro-nutrient (%)			Micro-nutrients (ppm)			NO_3 (ppm)
	N	P	K	Fe	Mn	Zn	
				Onion (first season)			
C	1.39	0.12	1.87	40.00	30.00	25.00	2.00
UF 1	1.66	0.13	1.71	43.00	35.00	24.00	2.00
UF 2	1.80	0.15	1.56	43.00	33.00	20.00	3.40
UF 3	1.82	0.14	1.68	44.00	35.00	25.00	3.90
Ur	1.69	0.14	1.7	40.00	33.00	27.00	9.50
				Soybean (second season)			
C	1.00	0.80	1.20	303.00	49.00	20.00	1.20
UF 1	3.85	0.82	1.44	410.00	76.20	21.31	4.10
UF 2	4.15	0.98	1.61	398.00	75.16	21.10	4.20
UF 3	4.46	0.95	1.70	445.00	52.66	25.80	5.20
Ur	2.89	0.96	1.80	342.00	53.15	20.48	7.30
				Turnip (third season)			
C	0.53	0.30	1.22	150.00	20.00	11.00	0.00
UF 1	0.55	0.36	3.03	250.00	18.00	15.00	0.00
UF 2	0.59	0.29	3.42	280.00	22.00	14.00	0.00
UF 3	0.65	0.24	3.00	220.00	28.00	16.00	0.00
Ur	0.55	0.33	2.92	190.00	22.00	16.00	0.00

Table (4): Nitrogen recovery (Kg/fed) and nitrogen use efficiency by crops as affected by ureaform rates.

Treat ment	Onion		Soybean		Turnip		Total	
	N-recovery	NUE	N-Recovery	NUE	N-Recover	NUE	N-Recover	NUE
C	-	-	-	-	-	-	-	-
UF1	14.92	24.87	26.84	44.73	8.71	14.52	50.47	84.12
UF2	20.46	22.73	38.99	43.32	14.85	16.50	74.30	82.56
UF3	27.58	22.98	43.32	36.10	23.35	19.46	94.25	78.54
Ur	19.71	16.43	17.51	14.59	2.09	1.74	39.31	32.76

N-recovery/fed= N-uptaken by yield/fed – N-uptaken by control/fed
Nitrogen use efficiency (NUE) = (N-recovery/fed) ÷ (applied N-rate/fed) x 100

Fig. (5) shows the final position of applied nitrogen whether fast or slow release form. It was dramatically observed that NUE for UF treatments (on average) reached about 82 % while it was for Ur treatment about 33 %. The decrease in NUE of urea would reflect potential leaching or volatizing nitrogen losses. The undetected nitrogen may represent both fractions of N-remained in the soil and N-losses.

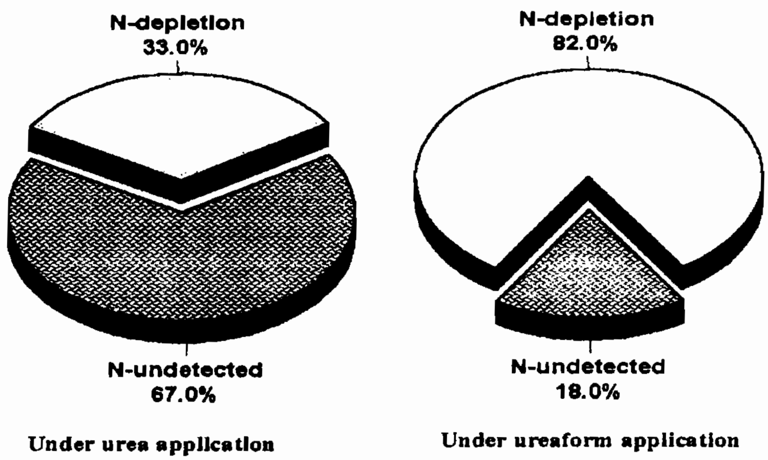

Fig. (5). The final position of both slow and fast release of nitrogen fertilizer.

In conclusion, application of ureaform under drip irrigation system led to enhancing the nitrogen use efficiency and obtaining good yields quality and quantity. Also, it led to determining optimum rate of ureaform for the studied cropping concussion; despite, more studies must be achieved. Also this work fulfils inclusively some of considerable environmental gains.

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نمو المحاصيل كدالة لإضافة اليوريافورم تحت نظام الري بالتنقيط

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الملخص العربي

أجريت تجربة حقلية بمحطة البحوث الزراعية، كلية الزراعة، جامعة الأزهر بأسيوط خلال ثلاث مواسم زراعية متعاقبة (٢٠٠١/٢٠٠٢ & ٢٠٠٢ & ٢٠٠٢/٢٠٠٣) تحت نظام الري بالتنقيط لتقييم تأثير اليوريافورم كسماد بطئ الذوبان مقارنة باليوريا العادية على نمو وجودة المحاصيل المتعاقبة (بصل، فول صويا، لفت). أضيفت اليوريافورم بثلاث معدلات (٦٠، ٩٠، ١٢٠ كجم / فدان) واليوريا بالمعدل الموصى به (١٢٠ كجم / فدان) بالإضافة إلى معاملة المقارنة.

أوضحت النتائج أن اليوريافورم أدت إلى زيادة إنتاجية محصول البصل التسويقي والتصديري بينما أدت اليوريا الى زيادة نسبة المحصول غير القابل للتسويق (المصاب، الهالك، الحنبوط). كما أدت اليوريافورم إلى زيادة إنتاجية بذور محصول فول الصويا وكذلك محصول اللفت في الموسم الثالث بالمقارنة بمعاملة اليوريا مما يؤيد فكرة الأثر المتبقي لليوريافورم وبقاءها من موسم إلى آخر دون أن يفقد نيتروجينها في قطاع التربة. بصفة عامة، اليوريافورم أدت إلى تحسين الصفات النوعية للمحاصيل المدروسة مقارنة باليوريا. حيث زادت كل من الحرافة والأحماض الأمينية والسكريات الكلية عن مثيلتها في معاملة اليوريا. وبالتخزين لمدة ثلاث شهور كان مقدار التغير بالزيادة بالنسبة للحرافة في معاملات اليوريافورم أكبر عنه في معاملة اليوريا. وكان مقدار التغير بالنقص في كل من الأحماض الأمينية والسكريات الكلية أقل في معاملات اليوريافورم عنها في معاملة اليوريا. ولوحظ أيضا زيادة

امتصاص العناصر الكبرى والصغرى في الثلاث محاصيل المتعاقبة لمعاملات اليوريافورم عنه في معاملة اليوريا وعلى النقيض من ذلك كان مستوى النترات في المحاصيل تحت معاملات اليوريافورم أقل بكثير عنه فى معاملة اليوريا مؤدية بذلك إلى إنتاج محاصيل خالية من البقايا النتراتية ذات قيمة تسويقة وتصديرية عالية. كانت كفاءة استعمال المحاصيل لنيتروجين اليوريافورم أعلى بكثير عن نظيره في معاملة اليوريا حيث بلغت في الحالة الأولى تقريباً ٨٢% وفى الحالة الثانية ٣٣ %، مما قد يكون له مردود إيجابي على الوضع البيئي حيث أن فقد حوالي ٦٧ % من نيتروجين اليوريا المستخدمة من المحتمل أن يكون جزء قد تسرب خلال قطاع التربة ملوثا الماء الأرضي والمجارى المائية.