

## **Effect of Polymer-Coated Urea and Ammonium Nitrate Application on Nitrogen Behaviour in Sandy Soil and Yield Productivity**

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### **ABSTRACT**

A field experiment was carried out at El- Ismailia Agriculture Research Station farm, Agric. Res. Center (ARC), Egypt during two successive seasons (2015/2016). The institute farm is located at 30° 35' 41.9" N latitude and 32° 16' 45.8" E longitude. Wheat plants (*Triticum aestivum* L., CV. Giza 168) was planted during winter season (2015) and peanut plants (*Arachis hypogaea*) was planted during summer season (2016) in a sandy soil under sprinkler irrigation system, to improve the soil chemical properties, eliminate or reduce labor intensive of fertilizers losses, as well as increase in apparent nutrient recovery, through improving the nutritional status, minimize nitrogen loss, maintaining growth and yield of both wheat and peanut crops. Two sources of nitrogen fertilization were used, urea and ammonium nitrate with two rates (75% and 100% from the recommended dose) along with four rates of polymer (Hydrogel 0%, Hydrogel 1%, Hydrogel 2%, Hydrogel 3%) as a coating film material. Moreover, samples of the same nitrogen fertilizers were coated with the same four rates of polymers to be then incubated under laboratory condition to study the cumulative released percentage versus time, from both N- sources, along with the different rates of polymers; finally a field experiment was conducted. With regard to incubation experiment, results indicated that, the release of nitrogen from uncoated N-sources showed rapid and highly increase during the first two hours; the increase reached 94.35 % and 98.36% for both urea and ammonium nitrate respectively, uncoated urea being more responded as compared to uncoated ammonium nitrate. Generally, presence of polymer, as a coating material, caused slow gradual increase for soluble nitrogen as time goes up to 15 days as compared to without polymer treatment. The calculation of swelling ratio of hydrogel estimated that every one gram of hydrogel was swollen by uptake of 500 ml of water, this means that every 1 gram coating material from the used polymer absorbed 500 gm from the water. Also, Field Emission Scanning Electron Microscope noted that, the coated urea was smaller diameter, denser, more uniform and much smoother surface as compared to ammonium nitrate. On the contrary, the cross section of the coating shell of ammonium nitrate had a larger diameter, rough surface with large cavities along with both open and closed porosity. With regard to field experiment, results revealed that, the pH values in the soil after harvesting were significantly affected by both coated N-sources, as compared to uncoated treatments, for both tested crops; pH values increased significantly with time in presence of urea as compared to ammonium nitrate. Moreover, increasing the rate of nitrogen fertilization along with increasing the rate of applied polymer caused a significant increase in EC values during both tested seasons. Values representing nitrogen and potassium availability in soil, total contents (straw and grains or seeds) and yield components for both tested crops increased significantly in both coated urea and ammonium nitrate as compared to uncoated treatments. Furthermore, coated urea was more responded as compared to ammonium nitrate. Availability of N and K, total contents, (straw and seeds or grains) and yield components for both tested crops increased significantly by increasing the rate of nitrogen especially in presence of HG 2%. HG 2% ranked the first considering values under both fertilizer sources and rates. In contrast, the high rate of polymer (HG3%) for both N-sources caused a significant decrease in nutrient availability, total contents (straw and seeds or grains) and yield components for both tested crops. Again, the second rate of nitrogen fertilization (100%) was superior as compared to the first rate (75%) regarding increases in the wheat and peanut yield components (straw, grains and seeds). Apparent N and K recovery Efficiency (ANRE) was the highest due to application both nitrogen fertilizer sources coated with polymer as compared to control treatments. Also, increasing the rate of polymers caused a significant increase in ANRE of wheat and peanut plants. Regarding the rate of polymer, values of ANRE for N and K were significantly more stimulated with increasing the rate of polymer as a coating material for both N-sources as compared to un-coating up to HG2% as compared to control. On the other hand, the lowest ANRE was recorded in presence of HG3% as a coating material for both N- sources. Moreover, increasing the rate of polymer for both N-sources caused a positive increase in crude protein in grains and seeds of both crops (wheat and peanut) as compared to control. The highest crude protein (CP) % was obtained with application of high rate of coated urea (N2) with the second rate of polymer (HG2), coated urea was more pronounced as compared to coated ammonium nitrate for increasing the crude protein in grains of both tested crops. In conclusion, the application of both nitrogen fertilizers (urea and ammonium nitrate) coated with polymer at rate of 2 % hydrogel in sandy soil is an effective practice to reduce the losses of nitrogen, helpful to improve the soil chemical properties and positively reflected on total content of macronutrients, crude protein and ANRE as well as yield components of both wheat and peanut crops. Hydrogels act as a slow releasing fertilizers agent in sandy soil, through absorption of the nutrients needed by plants and releases them gradually by time for plants uptake and prevent nutrients from leaching.

**Keywords:** Polymer-coated urea and ammonium nitrate-nutritional status-wheat-peanut-yield- apparent nutrient recovery efficiency (ANRE) - crude protein - swelling - Scanning Electron Microscope (SEM).

### **INTRODUCTION**

Nitrogen is the most limiting nutrient in crop production and found in a higher concentration than all other mineral nutrients in plants (Ludwick *et al.*, 2002). Nitrogen fertilization is a major component of the cost of agricultural production, due to the high application of nitrogen fertilizers to crops and low efficiency of nitrogen fertilizer use. The sources of nitrogen fertilization are mainly ammonium nitrate, ammonium sulfate and urea. Urea is the most popular nitrogen fertilizer, widely used in agriculture due to its high nitrogen content (46%), low cost and easy of handling (Vlek and Byrnes, 1986). However, about 20–70% of the applied urea fertilizer is lost to the

environment, causing serious pollution and increasing costs of nitrogen fertilization. The losses of nitrogen fertilizers are due to leaching, decomposition, ammonia volatilization, handling and storage (Shaviv and Mikkelsen, 1993). Ammonium nitrate has an acidifying effect because it contains or produces ammonium when applied to the soil, generally hydrogen ( $H^+$ ) is released in the process of nitrification and free hydrogen ions release and increase acidity of the soil (Bai *et al.*, 2010). Moreover,  $NH_4^+$  increases acidity through plant roots absorption for  $NH_4^+$  as to secrete  $H^+$  ions into the soil solution to maintain a chemical charge balance.

The controlled-release technology, by coating, can be utilized to increase the efficiency of urea fertilizer. The

coating of urea has been studied by many investigators, with different techniques (rotating drum, fluidized bed) and various materials (sulfur, resin and polymers), (Posey and Hester, 1991). The integration of new technologies in urea fertilization can reduce nitrogen losses by volatilization and leaching. These losses were most reduced when using polymers coated urea (Nascimento *et al.*, 2013). However, the poor efficiency of urea as an N-fertilizer was reported widely due to a substantial loss of ammonia (Shamsuddin *et al.*, 2009). Broadcasting urea onto the surface of moist soils results in alkaline effects after its hydrolysis. An alkaline pH with a high concentration of ammonium ions ( $\text{NH}_4$ ) is the stirring force for  $\text{NH}_3$  volatilization (Fenn and Richards, 1986), losses by evaporation from amidic ammonia sources not incorporated into the soil (Trivelin *et al.*, 1998). In a study by Cantarella *et al.* (1999), 12-30% of the  $\text{NH}_3$ -N of the urea fertilizer was lost by volatilization. Vitti *et al.* (2007) reported that losses of more than about 30% of the N applied to cane.

Nascimento *et al.* (2013) mentioned that, the growth and yield quality are mainly dependent on the amount of the present water and fertilizer. So, it is very important to improve the use of water, fertilizer and nutrients. However, about 40-70, 80-90 and 50-70% of the applied amount of N, P and K fertilizer, respectively, Nitrogen is lost to the environment and cannot be absorbed by plants, causing great economic and nitrogen fertilizers losses (Wu and Liu, 2008). Urea coating causes a statistically significant reduction of  $\text{NH}_3$ -N losses from urea without coating.

Hygroscopic fertilizers tend to absorb moisture from the air and may have undesirable characteristics such as moistness and clumping, thus hampering their application. The increasing use of urea is due to its high contents of N (46%), although this nitrogen (N) source is highly susceptible to volatilization losses, particularly when applied to the soil surface. The volatilization losses can be minimized by slow or controlled release fertilizers, urea-coating materials and by stabilized nitrogen fertilizers through prolonging the period for N remaining in the soil as amide. In the past, several strategies were adopted to fulfill the requirements of plant nutrition and to reduce  $\text{NH}_3$  loss from surface applied urea, such as coating urea with polymers and sulfure (Fenn and Richards, 1986).

Hydrogels can be defined as hydrophilic macromolecular networks with three dimensional, that can absorb water many times of their dry mass and expanded in their volume (Aouada *et al.*, 2009). The structural of hydrogels depends on crosslinks between the polymer chains through covalent bonds, hydrogen bonding and van der Waals bonds interactions (Park *et al.*, 1993). The stability of the gel structure is due to a delicate balance between the hydrogen bonds and the degree of shrinking, swelling, pH, pressure and electric fields. Hydrogels are formed by physical or chemical crosslinks, which are appropriately used to give their specific chemical characteristics. Polymer serves as a physical barrier to urea release into the environment. This is because of increasing the concentration which means more particles coating. Therefore increasing the polymer rate means that layers which are bonded at the surface of the urea become less strong (Vashishtha *et al.*, 2010), which displays that for the

polymer that coated urea with 5% concentration, solution absorbed fewer than in the polymer at 15%.

Previous studies have shown that relatively small amounts of hydrogel are efficient in reducing urea volatilization or loss. The ability of hydrogels to undergo, swelling and collapsing in response to the presence and absence of water allows their application in different areas, (Poujavadi *et al.*, 2009). Furthermore, the addition of hydrogel (super absorbent polymer) to sandy soils should associate quickly with irrigation water to form gels, resulting in an increase of the soils capacity to store water. The water stored in this way is available to plants for some considerable time, due to the bonding effect of hydrogel molecules with soil particles and their swellability. Besides, beneficial changes in soil porosity, particularly the amount of the water retaining pores, are achieved by the conditioning process (El-Hady, *et al.*, 2002). The favorable property of hydrogel is their ability to swell, when put in contact with a solvent. When a hydrogel in its initial state is contact with solvent molecules, the water attacks the hydrogel surface and penetrates into the polymeric network (Ganji *et al.*, 2010).

Moreover, germination process, plant growth, nutrients uptake, yield and both water and fertilizer use efficiency were beneficially increased by mixing the plant pits in sandy soil with fertilizers coated with polymer.

A polymer coated urea, has been quite effective compared to uncoated urea and other N sources. This technology slows the dissolution and hydrolysis of the urea granule by encapsulating urea in a polymer shell. This slowed solubility of urea and makes possible the placement of coated urea in direct seed contact without seedling damage as would occur with uncoated urea. Slowed solubilizing of urea, allows a gradual supply of nitrogen to reach the plants, limiting the speed of nitrification and subsequently, nitrate leaching and denitrification. Urea coating has also proven valuable in improving NUE by decreasing ammonia volatilization, controlling N immobilization, slowing nitrification, and/or lowering leaching and denitrification losses. Polymer coated urea may meet plant demand more timely and efficiently through controlled release of nitrogen into the soil solution. This improves efficiency and increases yield and crops quality, prevents excess N loss through leaching, denitrification and reduce labor-intensive fertilization (Taysom *et al.*, 2007).

The objectives of the present study were to improve the soil chemical properties and eliminate or reduce intensive of fertilizers losses, as well as increase ANRE in sandy soil, through improving the nutritional status, minimize nitrogen loss, maintaining growth and yield of both wheat and peanut crops.

## MATERIALS AND METHODS

A field experiment was carried out at El- Ismailia Agriculture Research Station farm; Agric. Res. Center (ARC); Egypt during two successive seasons (2015/2016). The institute farm is located at 30° 35' 41.9" N latitude and 32° 16' 45.8" E longitude. Wheat plants (*Triticum aestivum* L., CV. Giza 168) was planted during winter season (2015) and peanut plants (*Arachishypogaea*) was planted during summer season (2016) in a sandy soil under sprinkler

irrigation system, to study the effect of coating urea and ammonium nitrate with polymers (HG) along with their different rates on chemical properties of sandy soil as well as nutritional status. Apparent Nutrient Recovery and yields of both wheat and peanut were considered.

The experiment was designed in a split split plot design with three replications. The main plots represent

nitrogen fertilizers sources , urea and ammonium nitrate, the sub main plots represent nitrogen rates (75% and 100% from the recommended dose) and the sub sub main plots stand for polymer rates ( HG0, HG1%, HG2%, HG3%) added as a coating film material.

Some physical and chemical properties of the studied soil before cultivation are shown in Table (1).

**Table 1. Some physical and chemical properties of the experimental soil**

Soil characteristics	Values	Soil characteristics	Values
		<u>Soluble cations and anions (meq L<sup>-1</sup>)</u>	
		Ca <sup>++</sup>	0.95
		Mg <sup>++</sup>	0.89
		Na <sup>+</sup>	1.50
		K <sup>+</sup>	0.45
		CO <sub>3</sub> <sup>--</sup>	-
		HCO <sub>3</sub> <sup>-</sup>	1.42
		Cl <sup>-</sup>	1.02
		SO <sub>4</sub> <sup>-</sup>	1.35
		<u>Available nutrients (mg Kg<sup>-1</sup>)</u>	
<u>Chemical properties</u>		N	45
pH (suspension 1:2.5)	7.70	P	11
EC dSm <sup>-1</sup> (saturated soil paste extract)	0.37	K	50
Organic matter %	0.38		

All experiment treatments received potassium sulfate (48 % K<sub>2</sub>O) as a recommended dose, at a rate of 100 kg fed<sup>-1</sup> in two equal doses after two weeks and five weeks from sowing for both wheat and peanut, respectively. Nitrogen was added as 120 kg fed<sup>-1</sup> for wheat crop and 40 kg fed<sup>-1</sup> for peanut crop as a recommended dose at rates of 75 % and 100% from the recommended nitrogen dose (N1, N2) as either urea (46% N) or ammonium nitrate (33%N). Phosphorus was added as superphosphate (15.5 % P<sub>2</sub>O<sub>5</sub>) at a rate of 200 kg fed<sup>-1</sup> added basically before sowing during the soil preparation for both tested crops.

Hydrogel was added at four rates (Zero, 1 % , 2% and 3%) as a coating material by encapsulating urea and ammonium nitrate granule with the polymer. Two sources of nitrogen fertilization, urea (46 %) and ammonium nitrate (33%) granules were coated with different rates of polymer (HG) by encapsulating in a polymer shell by spread on a plastic sheet then exposure the fertilizer to aeration, then spread the different rates of polymer on the both nitrogen sources. The polymers coated both N- fertilizers by mixing them thoroughly and putting in a container having two kilograms capacity each and shaking them rotating quickly. Through the hygroscopic properties of the N- fertilizers and contact with the polymer coating should be obtained. Coated nitrogen sources were applied in two split equal doses after 2 and 4 weeks from sowing for both crops respectively.

Control treatment received nitrogen fertilizer as two forms (urea and ammonium nitrate) without coating at 75% and 100% from the recommended dose for wheat and peanut crop, while mineral phosphorus and potassium fertilizers were applied at full dose for both crops.

**Soil and plant samples:**

Soil samples were taken (0-15 cm depth) after harvesting stage air-dried, ground and passed through a 2- mm sieve for chemical analysis according to Cottenie *et al.*(1982).

Wheat and peanut plants samples were taken at harvesting to determine yield components (straw and

grains or pods). Plant samples were oven dried at 70° C, then ground and digested using H<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>O<sub>2</sub> mixture for both N and K determination using Kjeldahl and Flame Photometer apparatus, respectively according to Cottenie *et al.* (1982).

**Statistical analysis:**

Statistical analysis of variance for both crops using L.S.D. at 0.05 level of probability was performed to estimate the significant differences among treatments according to Snedecor and Cochran, (1982).

Apparent Nutrients Recovery Efficiency (ANRE) was calculated according to Quanbao *et al.*, (2007).

ANRE = (Uptake in fertilized plot, kg fed<sup>-1</sup>- Uptake in control plot, kg fed<sup>-1</sup>) / quantity of fertilizer nutrient applied (kg fed<sup>-1</sup>)\*100

Crude protein (CP) % was estimated by multiplying N content in grains % by 5.70 for wheat and 6.25 for peanut (A.O.A.C, 2000).

**Measurement of release rate**

The release rate of nitrogen from coated urea and ammonium nitrate fertilizers to water was measured. For each sample, 5 g coated particles from both N- sources were put into a beaker containing 500 ml deionized water. Each beaker was covered with a Para film to prevent water evaporation and kept at room temperature. At certain time intervals, 5 mL of solution was sampled for evaluation of nitrogen content, 5 mL of water being added, as a replacement, into the beaker to maintain the solution volume constant. The solution was shaken before sampling. The nitrogen concentration was determined at zero time and after 1 h , 3h , 72( 3 day) , 144( 6 day) , 216 ( 9 day) , 288( 12 day) , 360( 15 day), 432 ( 18 day), 480 ( 21 day) hour or days, respectively using a Kjeldahl apparatus according to Cottenie *et al.* (1982).

**Scanned Electron Microscopy (SEM):**

Field emission scanning electron microscope (FE-SEM), model Quanta FEG250 Holland was used to visualize any unique physical characteristics of the urea and ammonium nitrate fertilizers coated with polymer. Samples were taken from the two coated N- source

granules; other samples were taken from the inner part of broken granules by cutting particles with a sharp knife. The cross section of the coating shell of both N-sources could be observed by the SEM images

**Swelling of Hydrogels**

The hydrogel samples were placed in a plastic dish at room temperature. One gram of the samples was weighed on a digital balance; put a calculated volume of water to the hydrogel sample by immersion in water to be then wiped to remove excess water on the surface. The samples were weighed at least twice a day until equilibrium was reached. The hydrogels were weighted in the dried state as well as before immersion in water. The extent of gel swelling was measured by the swelling ratio, which is defined by (Karadag and Saraydin, 2002) and Kim *et al.*, (2010) to be:

$$\text{Swelling ratio} = \frac{M1 - M0}{M0}$$

Where M1 is the mass of the swollen gel at time t and M0 is the mass of the dry gel at time 0

**RESULTS AND DISCUSSION**

**I-Laboratory experiment:**

**Effect of incubation period on release behavior of nitrogen from nitrogen sources coated with different rates of polymers:**

In this experiment two sources of nitrogen fertilizers were used (urea and ammonium nitrate) coated with four rates of polymer (HG0, HG 1% , HG 2%, HG 3%) and incubated under laboratory condition.

The release process of nitrogen from coated fertilizers in water can be described as the following process; water penetrates through the coating shell and dissolves the fertilizer then the dissolved N-sources diffuses into the water medium through the coating

shell. Moreover, the polymer is associated quickly with the water to gels resulting in decrease of the release of nitrogen by increasing the rate of polymer.

Generally, Data presented in Fig. (1) Shows the cumulative released percentage versus time, from both N- sources, along with different rates of polymer. Uncoated N-source shows rapid and highly increase during the first two hours reached to 94.35 % and 98.36% for both urea and ammonium nitrate, respectively. Also, the uncoated urea shows constant rate released at all stages of the incubation period; ammonium nitrate data show a positive constant increase of N in the initial stage up to 6 days then released reduced till the end.

With respect to both N- sources, data in Fig.(1) show that uncoated urea was more responded as compared to uncoated ammonium nitrate, due to release nitrogen slow from coated urea as compared to ammonium nitrate. Furthermore, presence of polymers was important for preventing the nitrogen fertilizers from losses in sandy soil. Generally, presence of polymer as a coating material, causes slow gradual increase for soluble nitrogen by time up to 15 days as compared to without polymer.

With respect to hydrogel rate, results revealed that solubility of nitrogen from both coated N source decreased gradually along with increasing the rate of polymer, the high rate of polymer (3%) being superior as compared to others concentrations. During the first hour from the added nitrogen as urea, 59.65% to 31.65% of N was soluble as compared to 80.95 % to 57.53% of ammonium nitrate in presence of different rates of polymers.

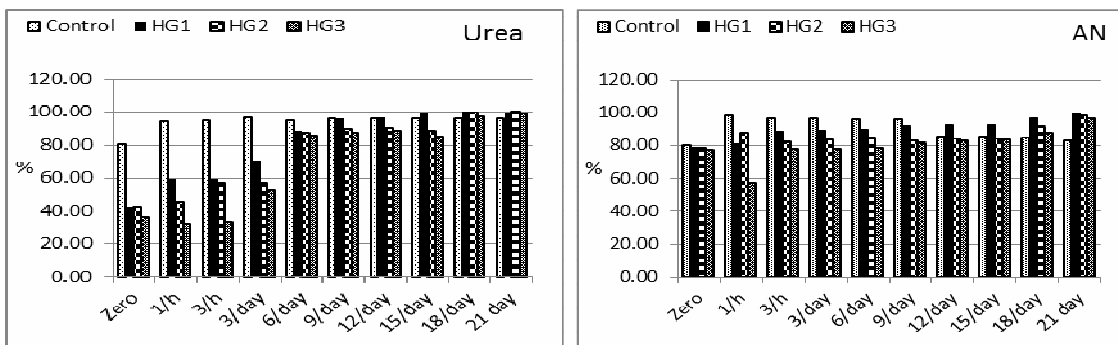


Fig. 1. Soluble nitrogen (%) from both coated N- sources as affected by time.

**Swelling of Hydrogels**

The extent of gel swelling was evaluated by the swelling ratio; hydrogels were characterized as relatively rapid swelling with hydrogel samples reaching their equilibrium swelling in several minutes to a few hours because of their large pores and open structure.

The calculation of swelling ratio of hydrogel showed that every one gram of hydrogel has been swollen by uptake of 500 ml of water; this includes nitrogen fertilizer source due to its hydrophilic properties, the hydrophilicity of the network is due to the presence of groups of hydroxylic (-OH), carboxylic (-COOH), amidic (-CONH-), primary amidic (-CONH2), sulphonic (-SO3H), that can be found within the polymer backbone

or as lateral chains (Ganji *et al.*, 2010). So, it can be concluded that , polymers act as a slow releasing fertilizer agent of soil matrix, through absorption of the nutrients needed by plants and releases them gradually for plant uptake and prevent nutrients from leaching.

**Scanned Electron Microscopy (SEM):**

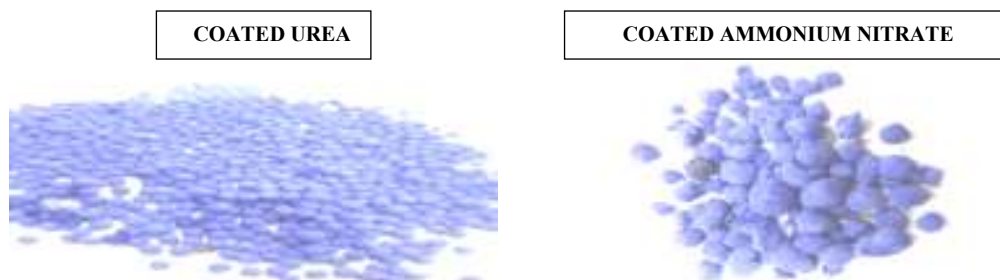
Photos presented in Fig. ( 2 ) show urea and ammonium nitrate coated with polymer mixed with blue color, to distinguish between the uncoated and coated fertilizers. Furthermore, this product was tested by microscopic analysis.

Microscopic images presented in Fig. (3, 4 and 5). Illustrate the differences between the surfaces of the coated urea and ammonium nitrate granules. The coated

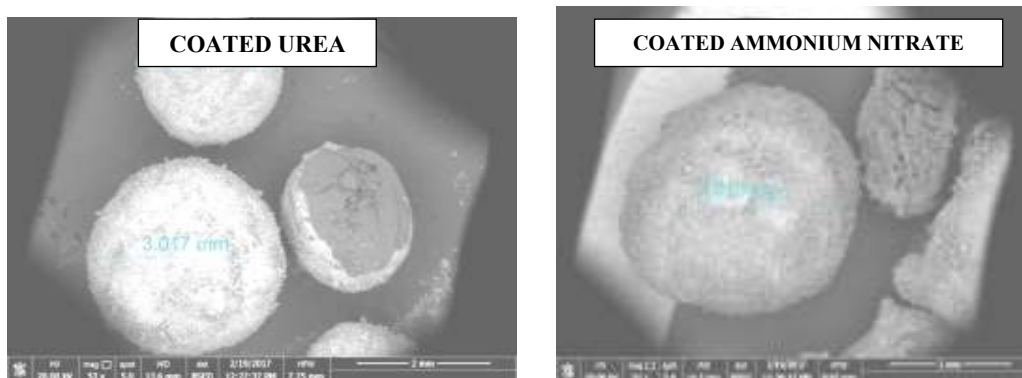
urea was smaller diameter, denser, more uniform and much smoother surface as compared to ammonium nitrate. On the country, ammonium nitrate has a larger diameter and rough surface. Additionally, from the cross section of the coating shell observed large cavities and has both open and closed pores. Differences in the surfaces are due to their manufacture processes and coatings rate. Generally polymer is added to improve porosity and characteristics of the fertilizer granules as to absorb the nutrients needed by plant and release them gradually to prevent nutrients from leaching.

Moreover, results show that ammonium nitrate granules becomes less effective as the final product as

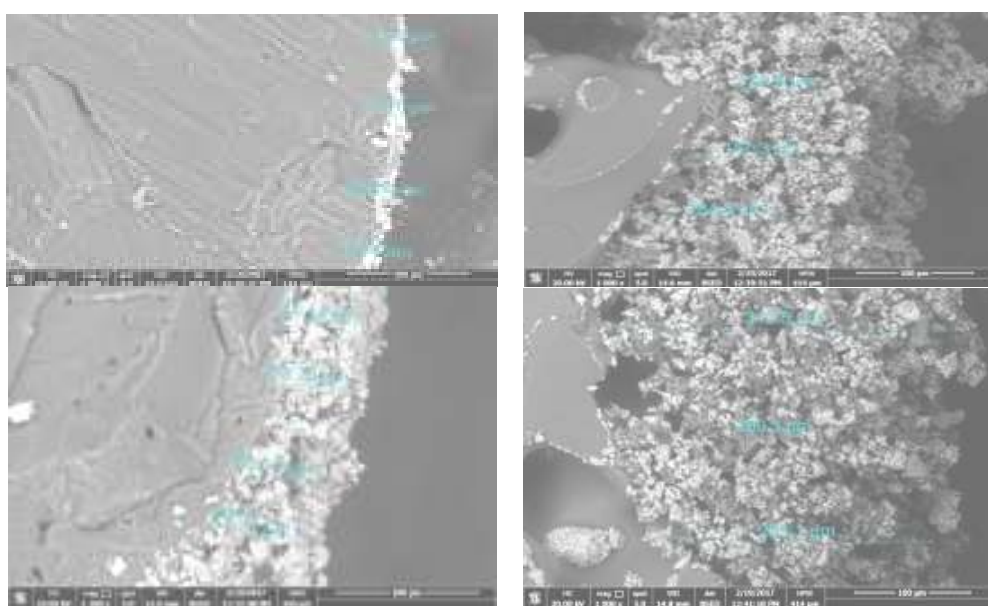
compared to coated urea and becomes less easy to handle due to its instantly friable and caking, as a result of both open and closed porosity. As a result, it has been observed that water does not easily penetrate the coating even though the open porosity remains uncoated. This may occur during handling the fertilizers in presence of ammonium nitrate due to broken granule because of friable structure due to presence of pores which makes water easily penetrate the granules.



**Fig. 2. Urea and ammonium nitrate coated with polymer after adding blue colour.**



**Fig. 3. Scanned Electron Microscope images showing the micro-structure of the surface of the polymer coated urea and ammonium nitrate.**



**Fig. 4. Scanned Electron Microscope images showing the micro-structure of the surface of the polymer coated fertilizers and the inner part of broken granule.**

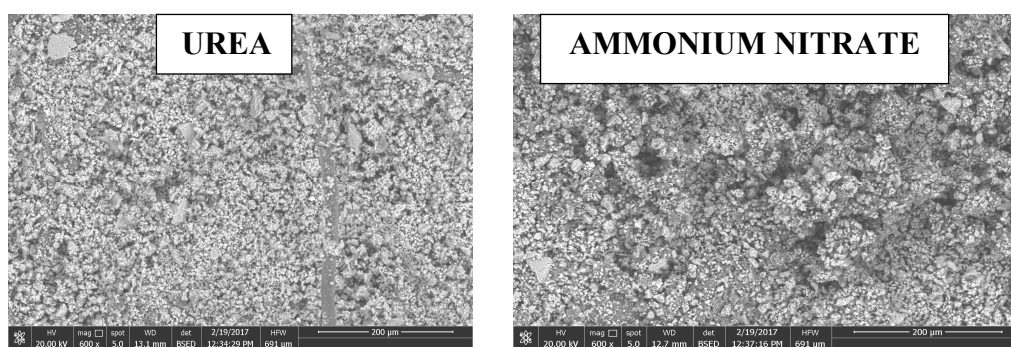


Fig. 5. Scanned Electron Microscope images showing the micro-structure of the coating materials on surface of urea and ammonium nitrate.

## II. Field experiment

### Soil chemical properties:

Data presented in Table (2) show the changes of some soil chemical properties as affected by studied treatments of urea and ammonium nitrate coated with different rates of hydrogel under two rates of nitrogen fertilizers.

### Soil reaction (pH)

Results revealed that, pH values of soil after plant harvesting were significantly affected by both N-sources, urea and ammonium nitrate coated with polymers as compared to uncoated treatments for both tested crops. This may be due to presence of exchangeable ions in super absorbent polymers; these results are in well agreement with those obtained by Bai *et al.*, (2010). Moreover, pH values increased significantly in presence of urea as compared to ammonium nitrate; this may be due to its hydrolysis through the release of ammonia (Hamid *et al.*, 1998). Ammonium nitrate, on the other hand, had an acidifying effect due to containing or producing ammonium when applied to the soil; hydrogen ( $H^+$ ) is released in the process of nitrification, and free hydrogen ions increase acidity of the soil (Bai *et al.*, 2010).

Moreover,  $NH_4^+$  increases acidity through plant roots absorption of  $NH_4^+$ ;  $H^+$  ions secrete into the soil solution to maintain a chemical charge balance. Also, Increasing the rates of both nitrogen fertilization and polymer coating caused a slightly decrease in pH values.

The interaction effect between nitrogen form, level and / or polymer rate were insignificant; this indicates that nitrogen levels were similar responded in presence of both nitrogen sources and HG rates.

### Electric conductivity (EC)

Results in Table (2) showed that significant differences were detected for N- forms, rates and hydrogel rates; EC values were more superior in presence of coated urea as compared to ammonium nitrate. Moreover, EC values, as expected, increased significantly with increasing the rate of nitrogen fertilization during both tested seasons. Moreover, increasing the rate of polymer as a coating material caused significant increase in EC values for both N-sources after harvesting of wheat and peanut crops due to negative charge carried by polymers in the hydrated state that has the capability to attract some positive ions

of the soil causing significant increase in EC values (Roqieh *et al.*, 2013).

Moreover, positive response was observed for EC values to the rates of polymers due to layers bonded at the surface of both N-sources; coating with low rate gave less effects than the high rate of polymer. Obtained results coincided well with findings of Landis and Haase (2012) who found that the dust that urea coated with 5% concentration gave less effects than the dust at 15%.

Also, exchangeable ions presented in super absorbent polymers can influence soil properties such as increase the nutrient availability which increase the EC values; similar results were obtained by Bai *et al.*, (2010).

### Macronutrients availability

The data representing availability of soil nutrients (N and K) after wheat and peanut harvesting are shown in Table (2). Values of nitrogen and potassium availability for both tested crops increased significantly with both N-sources (coated urea and ammonium nitrate) as compared to uncoated sources. Furthermore, coated urea was more responded as compared to ammonium nitrate due to slow dissolution and hydrolysis of the urea granule by encapsulating urea in a polymer shell; this slows solubility, makes possible the placement of coated urea in direct seed contact without seedling damage as would occur with uncoated urea. Availability of nitrogen, for both tested crops, as expected, increased significantly by increasing the rate of nitrogen especially in presence of HG2 due to absorption and storage of soil nitrogen and reducing leaching.

Moreover, increasing the polymer rate as a coating material caused a significant increase in the nutrient availability; this may be due to favorable conditions effect due to presence of hydrogel which absorb and storage soil nitrogen and reduce N- from leaching. Moreover, polymers absorb the nutrients needed by plants and release them gradually as to prevent nutrients from leaching. Also, increasing the polymer rate as a coating materials up to (HG2) caused a significant increase in nutrient availability.

The interaction effects between nitrogen form, level and polymer rate were insignificant; this means that, HG 2 ranked the first under conditions of both fertilizer sources and rates due to more particles coating first and makes layer bonded more strong as to reduce

the nutrients from leaching. Also, polymers carry negative charge in the hydrate state that has a capability to attract some positive ions of soil. These results are in great harmony with those of Roqieh *et al.* (2013). Moreover, silica gel has large surface area, which makes it an effective carrier, having amide, sulfonic and carbonyl groups that could bind ions thereby making a functional polymer. (Rebecca and Bello, 2014). In contrast , high rate of polymer (HG3), for both N-

sources, caused a significant decrease in nutrient availability for both tested crops. Similar results were reported by Adams *et al.*( 2013) who found a lack of available nitrogen due to slow release of N from polymer coated urea and delayed in getting into plants when needed, in the vegetative growth, with variations seen within polymer coated urea products, coating thickness and materials.

**Table 2. Effect of urea and ammonium nitrate coated with different rates of hydrogel along with nitrogen fertilizer rate on some soil chemical properties and nutrient availability.**

Treatment	Hydrogel rate %	Winter season (Wheat)				Summer season (Peanut)			
		PH	EC(dS <sup>-1</sup> )	N(ppm)	K(ppm)	PH	EC(dS <sup>-1</sup> )	N(ppm)	K(ppm)
Coated Urea									
75%	0	7.60	0.35	175.00	49.93	7.77	0.66	78.83	64.23
	1	7.59	0.37	180.00	52.62	7.64	0.70	93.97	64.57
	2	7.50	0.79	256.00	58.80	7.63	0.79	133.00	77.68
	3	7.34	0.96	224.00	77.75	7.57	0.85	126.00	76.37
100%	0	7.55	0.43	210.00	55.17	7.65	0.69	116.00	74.12
	1	7.51	0.51	245.00	58.80	7.61	0.84	129.00	85.22
	2	7.48	0.93	266.00	66.18	7.51	0.81	154.00	92.87
	3	7.25	1.20	248.33	82.60	7.45	2.43	137.40	85.92
Coated ammonium nitrate									
75%	0	7.52	0.28	168.00	35.28	7.67	0.66	75.33	56.52
	1	7.45	0.28	182.00	45.17	7.54	0.66	86.33	75.02
	2	7.31	0.46	238.00	59.52	7.50	0.71	124.67	81.63
	3	7.27	0.80	196.00	59.67	7.50	0.84	115.33	75.78
100%	0	7.51	0.41	217.00	53.33	7.54	0.67	113.33	59.65
	1	7.37	0.47	231.00	53.60	7.47	0.68	125.00	83.30
	2	7.25	0.69	260.00	62.13	7.41	0.91	133.33	95.00
	3	7.07	0.97	246.00	80.67	7.37	1.10	123.33	79.32
<u>Mean values of N-form(A)</u>									
Coated urea		7.48	0.69	225.5	62.73	7.60	0.97	121.02	77.62
Coated ammonium nitrate		7.34	0.54	217.3	56.17	7.50	0.78	112.08	75.78
N1		7.45	0.54	202.4	59.78	7.60	0.73	104.18	71.48
N2		7.37	0.70	240.4	65.69	7.50	1.02	128.92	81.92
<u>Mean values of HG rate(C)</u>									
HG0		7.54	0.37	192.5	48.43	7.66	0.67	95.87	63.63
HG1		7.48	0.41	209.5	52.55	7.56	0.72	108.57	77.03
HG2		7.38	0.72	255.0	61.66	7.51	0.80	136.25	86.80
HG3		7.23	0.98	228.6	75.17	7.47	1.31	125.52	79.35
<u>LSD at 5%</u>									
N- form (A)		0.109	0.037	1.020	1.210	0.089	0.089	0.992	1.095
N- level (B)		0.090	0.028	2.391	1.240	0.086	0.105	2.876	1.386
HG rate ( C )		0.074	0.052	8.694	2.120	0.083	0.099	3.207	2.626
A*B		NS	0.060	3.381	1.240	NS	0.148	3.010	1.960
A*C		NS	0.073	4.020	2.260	NS	0.141	4.535	3.714
B*C		NS	0.073	12.295	2.260	NS	0.141	4.535	3.714
A*B*C		NS	0.110	NS	NS	NS	0.269	NS	NS

**2- Total contents of macronutrients**

With respect to individual effects of the tested treatments, on the total contents of nitrogen and potassium for wheat and peanut crops, data presented in Table ( 3 ) revealed that the encapsulated urea and ammonium nitrate fertilizers using hydrogel were more favorable for both wheat and peanut plants as compared to un encapsulated urea or ammonium nitrate. Encapsulated urea was more effective as compared to encapsulated ammonium nitrate , possibly due to slow solubilization of urea which allows a gradual supply of nitrogen to reach plants, limiting the speed of nitrification and limiting the nitrate leaching. Furthermore, increasing the rate of nitrogen fertilizers

caused a significant increase in total contents of nitrogen and potassium for both straw and seeds or grains for both tested crops.

Moreover, presented data indicated that, increasing the rate of polymer as a coating material up to (HG2), increased the total content of nutrients absorbed by plants due to releasing fertilizer agent of soil matrix, through absorption of the nutrients needed by plants and releasing them gradually for the plant uptake and preventing nutrients from leaching. Also, the hydrogel acted as a controlled release system. Increasing the polymer at (HG3) caused a significant decrease in the total contents of nitrogen and potassium due to holding them tightly and consequently delaying

their dissolution. Similar results were reported by Roqieh *et al.* (2013).

The statistical interaction analyses, between nitrogen form, level and polymer rate, showed that all applied treatments increased significantly the total content of macronutrients over the control treatments (without coating); this trend was true for both

straw and grains or seeds of wheat and peanut crops. Application of HG2 along with either nitrogen sources and rates was significantly superior for increasing the total contents of both nitrogen and potassium; interaction between nitrogen sources and rates, however, reflected insignificantly for straw of both wheat and peanut crops.

**Table 3. Effect of urea and ammonium nitrate coated with different rates of hydrogel along with nitrogen fertilizer rate on the total contents of macronutrients.**

Treatment		Total contents (Kg fed. <sup>-1</sup> )							
		Winter season (Wheat)				Summer season (Peanut)			
		Straw		Grains		Straw		Grains	
Nitrogen rate	Hydrogel rate %	N	K	N	K	N	K	N	K
Coated Urea									
75%	0	28.08	24.57	18.84	6.97	12.98	14.15	11.63	6.12
	1	59.57	44.72	47.00	10.47	20.36	18.10	19.58	14.47
	2	83.6	55.17	51.80	13.46	28.33	25.47	25.00	20.22
	3	63.72	51.54	41.62	12.40	21.10	24.34	30.30	17.64
100%	0	46.68	41.74	38.37	8.71	17.33	16.95	12.22	8.09
	1	69.73	53.73	63.95	12.32	26.65	20.90	20.85	17.14
	2	87.08	78.00	70.00	20.82	34.65	30.98	37.25	28.69
	3	75.32	64.34	65.93	17.59	27.34	27.64	31.75	21.01
Coated ammonium nitrate									
75%	0	20.36	31.48	17.58	4.25	10.91	10.42	10.24	4.59
	1	41.96	32.15	36.54	10.08	17.12	14.70	16.98	7.75
	2	66.80	64.96	50.20	12.18	26.38	17.03	24.73	15.97
	3	61.10	56.41	36.28	10.43	18.02	22.21	24.83	13.53
100%	0	39.65	44.48	25.20	4.90	14.15	11.05	14.65	5.78
	1	52.62	45.52	56.29	13.54	25.13	23.20	17.78	11.90
	2	76.41	75.33	62.00	17.18	28.95	26.46	32.70	19.18
	3	54.00	62.86	45.52	11.05	29.04	23.74	29.05	13.70
Mean values of N-form(A)		63.97	51.73	49.68	12.84	23.59	22.32	23.57	16.67
Coated urea		52.68	51.65	41.16	10.45	21.21	18.60	21.37	11.55
<u>Coated ammonium nitrate</u> Mean values of N- level (B)									
N1		52.59	45.12	37.47	10.03	19.40	18.30	20.41	12.54
N2		63.93	58.25	53.37	13.26	25.41	22.62	24.53	15.69
<u>Mean values of HG rate(C)</u>									
HG0		33.19	35.57	24.99	6.21	13.84	13.14	12.18	6.14
HG1		55.97	44.03	50.92	11.60	22.32	19.23	18.80	12.82
HG2		78.47	68.36	58.50	15.91	29.58	24.98	29.92	21.02
HG3		66.04	58.79	47.27	12.87	23.88	24.48	28.98	16.47
<u>LSD at 5%</u>									
N- form (A)		1.025	0.10	2.551	1.875	1.618	0.588	1.007	0.345
N- level (B)		1.693	2.30	0.332	1.101	1.559	2.204	1.990	0.584
HG rate (C)		2.795	3.19	1.249	1.060	1.106	1.823	1.533	1.157
A*B		NS	NS	0.535	1.060	NS	NS	1.530	0.826
A*C		2.366	3.00	2.131	1.500	1.110	2.578	2.168	1.636
B*C		2.200	4.517	2.171	1.500	1.564	2.578	2.168	1.636
A*B*C		2.589	NS	2.899	2.121	2.212	2.578	2.168	2.313

**3-Effect of fertilizers coated with different rates of hydrogel on the yield components of both wheat and peanut crops**

With respect to studied factors separately, data shown in Table (4) revealed that wheat and peanut yield components (straw, grains and seeds) of both studied crops were significantly stimulated due to applied both nitrogen fertilizers sources encapsulated with polymer as compared to control treatments; this may be due to caking occurring in case of coated ammonium nitrate due to Van der Waals force, which are electrostatic and moisture bonding forces when particles come into contact. The deviation of particle shape from round or spherical increased the area of particle contact and thereby increased caking (Lotspeich and Petr ,2014).

Furthermore, coated urea was more effective as compared to ammonium nitrate for increasing the yield components at both studied seasons, probably due to high solubility of ammonium nitrate fertilizers that increase concentration of soluble salts in the root zone and osmotic stress, specific injuries to plant at different growth stages thus decreasing yield (Fenn and Hossner, 1985) and (Hassan *et al.* 2010). Also, ammonium nitrate hydrolyzed to NO<sub>3</sub> and NH<sub>4</sub> forms to be then converted to nitrate by action of nitrifying bacteria.

The NO<sub>3</sub> is losses as nitrogen gas or nitrous oxides by the action of denitrifying bacteria and through percolation of soil water (Maqsood *et al.*, 2016). Generally, increasing the rate of N- fertilizers from both N- sources increased significantly the total yield for



both tested crops because the nitrogen importance for plant growth and representing the main constituent of major cell parts and protein production. Moreover, increasing the rate of N- fertilizers from both encapsulated N- sources increased significantly the total yield for both tested crops as compared to control treatments, possibly due to slow releasing of nitrogen fertilizers to let absorption of nutrients needed by plants and releasing them gradually to be plant uptaken and prevent nutrients from leaching. These results are confirmed with the finding of El-Hady, *et al.*(2001) who found that germination process, plant growth, nutrient uptake, and yield were beneficially increased by mixing the plant pits in sandy soil with hydrogels .

Again, the second rate of nitrogen fertilization (100%) was superior as compared to the first rate (75%) for increasing the wheat and peanut yield components (straw, grains and seeds). Increasing the rates of polymer (hydrogel) up to HG2 as a coating material for both N-sources caused a significant increase in

productivity of wheat and peanut. This may be due to hydrogels (super absorbent materials) act ion as a hydrophilic organic polymeric product, when mixed with sandy soils, associated quickly with irrigation water to form gels resulting in an increase of the soils capacity to store water as a solution of fertilization nutrient. The water stored in this way is available to plants for some considerable time. Also, the bonding effect of hydrogel molecules with soil particles and their swell ability, as afore mentioned improved, stable structure of the sandy soil; besides, beneficial changes in soil porosity. So, the hydrogel act as a controlled release system by favoring the uptake, improved growth and yield. These results are in harmony with those obtained by Ouchi, *et al.*,(1990) and El-Hady, *et al.*,( 2002), who reported that the germination process, plant growth, nutrient uptake and yield were beneficially increased by mixing the plant pits in sandy soil with hydrogels.

**Table 4. Effect of urea and ammonium nitrate coated with different rates of hydrogel along with nitrogen fertilizer rate on the yield component of wheat and peanut (ton fed<sup>-1</sup>).**

Treatments		Wheat			Peanut		
Nitrogen rate	Hydrogel rate %	Straw	Grains	Biological yield	Straw	Seeds	Biological yield
Coated urea							
75 %	0	4.55	1.98	6.53	1.46	0.76	2.22
	1	7.59	2.57	10.16	2.18	1.28	3.46
	2	9.00	2.75	11.75	2.58	2.51	5.09
	3	7.83	2.63	10.46	2.35	1.45	3.80
100 %	0	6.43	2.44	8.87	1.84	0.90	2.74
	1	8.36	2.61	10.97	2.88	1.33	4.21
	2	9.42	4.11	13.53	3.30	2.62	5.92
	3	8.50	3.33	11.83	2.70	1.98	4.68
Coated ammonium nitrate							
75 %	0	4.78	1.10	5.88	0.99	0.53	1.52
	1	5.27	2.32	7.59	1.49	0.81	2.30
	2	8.31	3.14	11.45	2.29	1.58	3.87
	3	7.62	2.70	10.32	1.78	1.23	3.01
100 %	0	5.33	1.24	6.57	1.15	0.73	1.88
	1	7.23	2.75	9.98	2.51	0.92	3.43
	2	8.70	4.32	13.02	2.57	1.75	4.32
	3	8.11	3.35	11.46	2.74	1.35	4.09
Mean values of N-form(A)		7.71	2.80		2.41	1.602	
Coated urea		6.92	2.62		1.94	1.111	
<u>Coated ammonium nitrate</u>		<u>Mean values of N- level (B)</u>					
N1		6.87	2.41		1.89	1.267	
N2		7.76	3.02		2.46	1.447	
<u>Mean values of HG rate(C)</u>							
HG0		5.27	1.69		1.36	0.729	
HG1		7.11	2.56		2.27	1.083	
HG2		8.86	3.58		2.68	2.114	
HG3		8.02	3.02		2.39	1.500	
<u>LSD at 5%</u>							
N- form (A)		0.330	0.142		0.146	0.115	
N- level (B)		0.152	0.134		0.128	0.042	
HG rate ( C )		0.148	0.207		0.122	0.045	
A*B		NS	NS		NS	NS	
A*C		0.209	0.292		0.173	0.063	
B*C		0.209	0.292		0.173	0.063	
A*B*C		0.295	0.295		0.245	0.089	

The opposite trend was obtained by increasing the rate of hydrogel up to HG3. Significantly decrease in a productivity of wheat and peanut yields (straw, grains and seeds) due to increasing the rate of hydrogel.

Dissolvent of the nitrogen fertilizers could be reduced because of the soil moisture was absorbed by the hydrogel. In the same way, the hydrogel also may have

prevented soil moisture from reaching to the plant and thereby inhibit root initiation. (Taysom *et al.*, 2007).

The statistical interaction analyses, between nitrogen form, level and polymer rates, indicated that, coated urea treatment with the two rates of nitrogen fertilizers (N1, N2) along with (HG2) recorded the highest values of both wheat and peanut yield components as compared to uncoated urea possibly due to slow released urea, thus take more time to hydrolyze and to be ready for plant absorption and improving N-use efficiency of crops through reducing N losses (Aziz and El-Ashry, 2009). Moreover, hydrogels are, as mentioned previously, characterized by relatively rapid swelling kinetics reaching their equilibrium swelling in several minutes to a few hours because of their large pores and open structure as to reduce the losses of nitrogen during the growth stage.

**Apparent nutrient recovery efficiency**

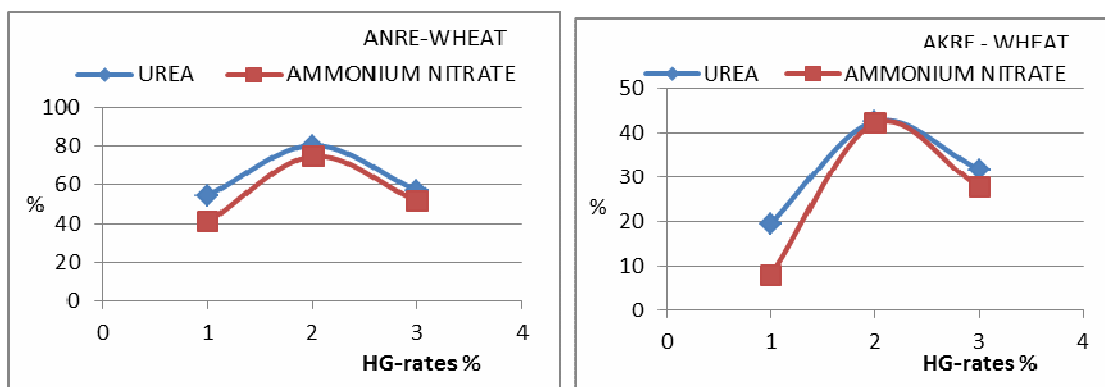
Apparent nutrient (N and K) recovery efficiency (ANRE) was defined as the ratio of total content of nutrient either N or K with treatment application minus total content of nutrients without treatment application (chick treatment), then divided by nutrient application as Kg unit<sup>-1</sup>, this parameter are presented in Figs. (6 and 7).

Presented data indicated that apparent N and K recovery efficiency was the highest due to applied both nitrogen fertilizers sources encapsulated with polymer as compared to control treatments; these results agree

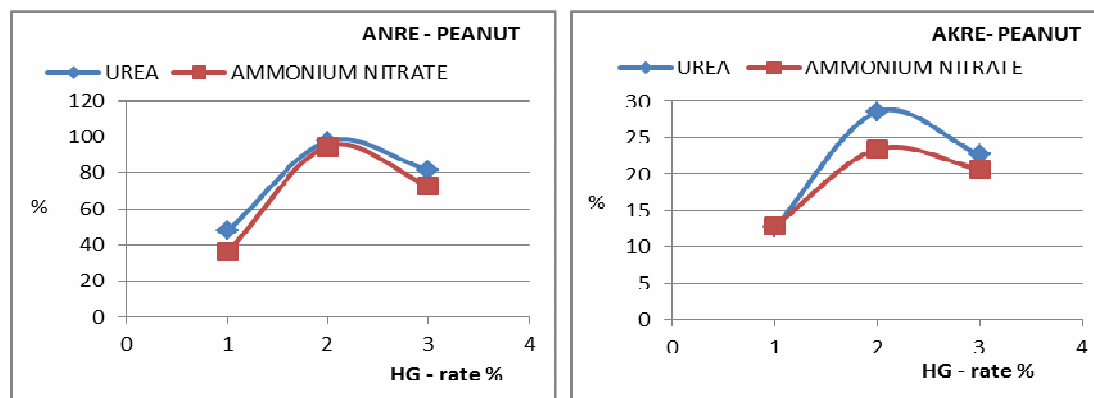
with the finding of Ouchi, *et al.* (1990) who found that germination process, plant growth, nutrient uptake and fertilizer use efficiency were beneficially increased in presence of polymers. Again, increasing the rate of polymers caused a significant increase in ANRE of wheat and peanut plants.

Regarding the rate of polymer, values of ANRE for N and K were significantly more stimulated with increasing the rate of polymer as a capsulated material for both N-sources as compared to those un encapsulated up to HG2 as compared to control. This may be due to urea coating effect on improving NUE by decreasing ammonia volatilization, controlling nitrogen immobilization, lowering leaching, enhancing the nutrient use efficiency by the slow release of the applied nutrients and reducing nutrient losses (El-Hady *et al.*, 2002). Positive responses were recorded due to encapsulated urea as compared to ammonium nitrate.

On the other hand, the lowest ANRE was recorded in presence of HG3 as a coating material for both N- sources; this may be due to decrease in nutrient availability, because of slow release of N from polymer coated materials and delayed in getting into the plants due to coating thickness, decrease in total contents of nitrogen and potassium due to holding them tightly and delaying their dissolution. So the data took the same trend to those of ANRE with wheat and peanut plant discussed before.



**Fig. 6. Apparent nutrient recovery efficiency for nitrogen (ANRE) and potassium (AKRE) as responded to urea and ammonium nitrate coated with different rates of hydrogel for wheat crops**



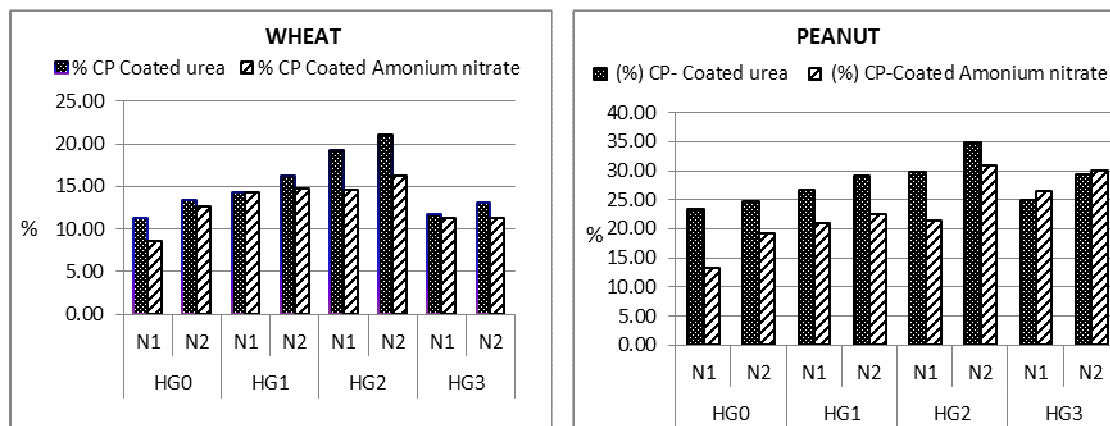
**Fig. 7. Apparent nutrients recovery efficiency for nitrogen (ANRE) and potassium (AKRE) as responded to urea and ammonium nitrate coated with different rates of hydrogel for peanut crop.**

**Crude protein (CP) %:**

Results presented in Fig. (8), revealed that increasing the rate of coated N- source caused a positive increase in crude protein in grains and seeds of both crops (wheat and peanut) as compared to control treatment. Furthermore, results showed that the highest crude protein (CP) % was obtained with application of high rate of coated urea (N2) with the second rate of

polymer (HG2%); this is due to synthesis of urea coated with a polymer HG2%, increased the total content of nitrogen in grains for both tested crops consequently , as expected, increasing protein content.

Moreover, coated urea was more responded as compared to coated ammonium nitrate for increasing the crude protein in grains of both tested crops.



**Fig. 8. Crude protein (%) as responded to urea and ammonium nitrate coated with different rates of hydrogel along with nitrogen fertilizer rates for wheat and peanut crops.**

**CONCLUSION**

In conclusion, the application of both nitrogen fertilizers (urea and ammonium nitrate) coated with hydrogel at rate of 2 % to sandy soil is an effective practice to reduce the losses of nitrogen, helpful to improve the soil chemical properties and positively reflected on total content of macronutrients, crude protein and Apparent Nutrient Recovery Efficiency as well as yield components of both wheat and peanut crops. Hydrogels are characterized as a relatively rapid swelling kinetics, reaching their equilibrium swelling in several minutes to a few hours; polymers act as a slow releasing fertilizers agent in sandy soil, through absorption for the nutrients needed by plant, releasing them gradually by time for plant uptake and preventing nutrients from leaching.

**REFERENCES**

Adams, C., J. Frantz and B. Bugbee (2013). Macro and micronutrient release characteristics of three polymer-coated fertilizers: Theory and measurements. *Jour. of Plant Nutr. Soil Sci.* Issue 1,176,: 76–88.

A.O.A.C. (2000). *Official Methods of Analysis of the Association of Official Analytical Chemist.* 14th ed. Washigton, D. C., USA.

Aouada, F. A., Z. Pan, W. J. Orts and L. H. C. Mattoso (2009a). Removal of paraquat pesticide from aqueous solutions using a novel adsorbent material based on polyacrylamide and methylcellulose hydrogels. *Jour. of Appl. Polymer Sci.*, 114: 2139-2148.

Aziz, E.E. and S.M. El-Ashry (2009). Efficiency of slow release urea fertilizer on herb yield and essential oil production of Lemon Balmplant. *Amer. Eurasian. J. Agric. and Environ. Sci.* 5:141-147.

Bai, W., H. Zhang, B. Liu, Y. Wu and J. Song (2010). Effects of super-absorbent polymers on the physical and chemical properties of soil following different wetting and drying cycles. *Soil Use and Management*, 26: 253-260.

Cantarella, H., R. Rosseto, W. Barbosa, M.J. Penna and L.C.L. Resende (1999). Perdas de nitrogênio por volatilização da amônia e resposta da cana-de-açúcar à adubação nitrogenada, em sistema de colheita de cana sem queima prévia. In: *Congresso Nacional Da STAB*, 7., Londrina, Anais. Londrina, STAB, 82-87.

Cottenie, A., M. Verloo, L. Kiek, G. Velghe and R. Camerlynck (1982): " *Chemical Analysis of Plants and Soils*" Lab. Anal. And Agroch. State Univ., Ghent, Belgium.

El-Hady, O.A., A.A. Abd El-Kader and N. M. Badran (2001). Forage yield, nutrients uptake and water and fertilizers use efficiency by ryegrass (*Lolium multiflorum*, L.) grown on a sandy calcareous soil treated with acrylamide hydrogels or/ and manures. *J. Agric. Sci. Mansoura Univ.*, 96: 4055-4071.

El-Hady, O.A., M.A. Safia and A.A. Abdel-Kader (2002). Sand-Compost-Hydrogel mix for low cost production of tomato seedlings. *Egypt J. Soil Sci.* 42: 767-782.

Fenn, L.B. and L.R. Hossner (1985). Ammonia volatilization from ammonium forming nitrogen fertilizers. *Adv. Soil Sci.* 1:123-170.

- Fenn, L.B. and J. Richards (1986). Ammonia losses from surface applied urea-acid products. *Fertilizer Res.*, 9: 265-275.
- Ganji, F. , F. V Samira and F.V. Ibrahim (2010). Theoretical Description of Hydrogel Swelling: A Review. *Iranian polymer j.* 19: 375-398
- Hamid, A., M. Ahmad and M. Yaqub (1998). Behaviour of nitrogen fertilizers in alkaline soils. *Pak.J. Soil Sci.* 15:56-61.
- Hassan, H. S. A. , M.M. S. Saleh and A. A. Abd El-Kader (2010). Growth and leaf mineral content of some fruit species seedlings as affected by a slow release nitrogen fertilizer. *Res. J. Agric. Biol. Sci.*, 6:417-423.
- Karadag E and D. Saraydin (2002). Swelling studies of super water retainer acrylamide/crotonic acid hydrogels crosslinked by trimethylolpropane triacrylate and 1,4-butanediol dimethacrylate, *Polym Bull*, 48: 299-307.
- Kim, S., G. Iyer, A. Nadarajah, J. M. Frantz and A. L. Spongberg (2010). Polyacrylamide hydrogel properties for hort. *Intern. Jour. Polymer Anal Charact.*, 15: 307-318.
- Landis T.D. and D.L. Haase (2012): Applications of Hydrogels in the nursery and during out planting. National proceedings: Forest and Conservation Nursery Associations-2011. Fort Collins (Co): USDA Forest Service, Mountain research station. Proceedings RMRS, 53-58.
- Lotspeich, E . and V. Petr (2014) The Characterization of Ammonium Nitrate Mini-Prills. *Technology and Engineering*, Chapter 45 Colorado School of Mines, CO 80401, USA.
- Ludwick, A. E., L. C. Bonxzkowski, M. H. Buttress, C. J. Hurst, S. E. Petrie, I. L. Phillips, J. J. Smith and T. A. Tindall (2002). *Western Fertilizer Handbook*, Ninth edition. Interstate Publi., Inc., Danville, IL.
- Maqsood, M. A., U.K. Awan, T. Aziz, H., Arsha, N. Ashrafd, and M. Ali (2016). Nitrogen management in calcareous soils problems and solution. *Pak. J. Agri. Sci.*, 53: 79 95ISSN (Print) 0552-9034, ISSN (Online) 2076-0906 DOI:10.21162/PAKJAS/16.4867
- Nascimento , C.A.C. , G.C. Vitti, L.A.Faria, P.H.C. Luz and F. L. Mendes ( 2013). Ammonia volatilization from coated urea forms. *Rev. Bras. Cienc. Solo.* 37
- Ouchi S., A. Nishikawa and E. Kameda (1990). Soil improving effect of a super-water-absorbent polymer. II. Evaporation, leaching of salts and growth of vegetables. *Jap. J. Soil Sci. Pl. Nutr.* 61: 606-613.
- Park, K., W. S. W. Shalaby and H. Park (1993). *Biodegradable Hydrogels for Drug Delivery*, Technomic Publishers, 9781566760041, Lancaster.
- Posey, T. and R. D. Hester (1991). Developing a Biodegradable Film for Controlled Release of Fertilizer I. *Plastics Engineering.* 50:19-21.
- Poujavadi, A., B. Farhadpour and F. Seidi (2009). Synthesis and investigation of swelling behavior of new agar based superabsorbent hydrogel as a candidate for agrochemical delivery. *Journal of Polymer Research*, 16: 655-665, 1022-9760.
- Quanbao, Y. , Z. Hongcheng , W. Haiyan , Z. Ying , W. Benfo , H. Zhongyang , D. Qigen and X. Ke (2007). Effects of nitrogen fertilizer on nitrogen use efficiency and yield of rice under different soil conditions. *Agric. China.* 1: 30-36.
- Rebecca, O. A. and O.S. Bello (2014). Use of Composite Sorbents for the Removal of Copper (II) ions from Aqueous Solution. *Pak. J. Anal. Environ. Chem.* 15
- Roqieh, B., E. Panahpour and M. H. M. Beni (2013). Super Absorbent Polymer (Hydrogel) and its Application in Agriculture, *World of Sciences Journal*, 1: 223-228.
- Shamsuddin, R, O.H. Ahmed and N. M. A . Majid (2009). Controlling ammonia volatilization by mixing urea with humic acid, fulvic acid, triple superphosphate and muriate of potash. *Am. J. Environ. Sci.* 5(5): 605-609.
- Shavive , A. and R.L. Mikkelsen(1993). Controlled-release fertilizers to increase efficiency of nutrient use and minimize environmental degradation, a review I, *Fertilizer Research.* 35: 1-12.
- Snedecor G.W. and W.G. Cochran (1982). "Statistical Methods". 7th Edition. Iowa state Univ. Press. Amer., IA. USA.
- Trivelin, P.C.O., J.A. Bendassolli, M.W. Oliveira and T. Muraoka (1998). Potencialidade da mistura de aquamônia com vinhaça na fertilização de canaviais colhidos sem despalha a fogo. Parte II: Perdas por volatilização de amônia e recuperação do 15N aplicado ao solo. *STAB*, 16:23-29.
- Tyson, R. V., E. H. Simonne, M. Davis, E. M. Lamb, J. M. White and D. D. Treadwell (2007). Effect of Nutrient Solution, Nitrate-Nitrogen Concentration, and pH on Nitrification Rate in Perlite Medium. *Journal of Plant Nutrition*, 30:901-913, ISSN 0190-4167
- Vashishtha, M. Dongara and D. Singh (2010). Improvement in properties of urea by phosphogypsum coatingI, *Int. J. of Chem.Tech. Research*, 2: 36-44
- Vitti, A.C., P.C.O.Trivelin, G.J.C.Gava , C.P.Penatti, I.R. Bologna , C.E. Faroni and H.C.J. Franco (2007). Produtividade da cana de açúcar relacionada ao nitrogênio residual da adubação e do sistema radicular. *Pesq. Agropec. Bras.*, 42:249-256,
- Vlek, P. L.G and B. H. Byrnes( 1986). The efficacy and loss of fertilizer N in lowland rice. *Fertilizers Res.*, Issue 1, 9: 131-147.
- WU, L. and M. LIU (2008). Preparation and properties of chitosan-coated NPK compound fertilizer with controlled-retention. *Carb. Poly.*, 72:240-247.

## تأثير اضافة اليوريا و نترات الامونيوم المغطاه بالبولىمر على سلوك النيتروجين في الاراضى الرملية و انتاجية المحصول

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أقيمت تجربة حقلية بمحطة البحوث الزراعية بالإسماعيلية خلال موسمين متتاليين (2015/2016) . على محصولي القمح (2015) و الفول السوداني (2016) تحت نظام الري بالرش لتحسين الخواص الكيميائية للارض الرملية وتقليل الفقد في الاسمدة وكذلك زيادة معدل الاستفادة من العناصر خلال تحسين الحالة الغذائية وتقليل الفقد في النيتروجين وتحسين النمو والمحصول لكل من القمح والفول السودانى. استخدم مصدرين من التسميد النيتروجينى ( اليوريا و نترات الامونيوم) مع معدلين من كلا منهما ( 75 % ، 100%) من المقرر السمدى مع استخدام اربعة معدلات من البولىمر (هيدروجيل) ( بدون ، 1% ، 2% ، 3%) وتم اضافتهم كمادة تغليف لكلا المصدرين من الاسمدة النيتروجينية. علاوة على ذلك ، تم اجراء تجربة معملية استخدم فيها مصدرى الاسمدة النيتروجينية ( اليوريا و نترات الامونيوم) مع تغليفهم باربعة معدلات من الهيدروجيل فى تجربة تحضين بالمعمل لدراسة تأثير هذه المعاملات على النسبة المئوية لمعدل انطلاق النيتروجين من هذه المعاملات مع الزمن و اعقب ذلك اجراء تجربة حقلية. بالنسبة لتجربة التحضين ، اوضحت النتائج ان انطلاق النيتروجين من اليوريا و نترات الامونيوم الغير مغطاه زاد زيادة كبيرة و سريعة خلال الساعتين الاولى من الاضافة وصلت الي 94.35 % ، 98.36 % لكل من اليوريا و نترات الامونيوم بالتتابع وكانت اليوريا افضل من نترات الامونيوم. وبصفة عامة فان وجود البولىمر كمادة تغليف سبب زيادة تدريجية بطيئة للنيتروجين الذائب مع الزمن وذلك حتى 15 يوم بالمقارنة بدون اضافة بولىمر. وبحساب القدرة على التمدد والانفتاح للبولىمر المقدره بالمعمل ، وجد ان كل جرام من البولىمر لة القدرة على التشبع ب 500 مل ماء محتوى على النيتروجين السمدى من كلا المصدرين، وقد لوحظ ايضا من خلال التصوير بالميكروسكوب الالكترونى لكل من اليوريا و نترات الامونيوم ان اليوريا المغطاه كانت اصغر قطرا و متماسكة ولها شكل محدد و مميز ولها سطح املس بالمقارنة بنترات الامونيوم ، وعلى العكس من ذلك ، كانت نترات الامونيوم ذات قطر اكبر و سطح خشن . ومن خلال عمل قطاع عرضى فى حبيبة السمد تم ملاحظة وجود فجوات كبيرة و مسام مغلقة و مفتوحة بها. وبالنسبة للتجربة الحقلية، اوضحت النتائج ان قيم رقم الحموضة بالتربة بعد حصاد محصولي القمح و الفول السودانى تأثرت معنويا باضافة اليوريا المغطاه و نترات الامونيوم بالمقارنة بالكنترول. كذلك حدثت زيادة معنوية فى قيم رقم الحموضة فى وجود اليوريا بالمقارنة بنترات الامونيوم ، علاوة على ذلك فان زيادة معدل اضافة النيتروجين مع زيادة معدل البولىمر سبب ذلك زيادة معنوية فى قيم التوصيل الكهربى فى كلا الموسمين. اوضحت النتائج ان قيم النيتروجين و البوتاسيوم الميسر فى التربة و المحتوى الكلى من العناصر (النيتروجين و البوتاسيوم) فى القش و الحبوب وكذلك مكونات محصولي القمح و الفول السودانى زادت معنويا فى وجود اليوريا و نترات الامونيوم المغطاه بالمقارنة بعدم التغطية ، علاوة على ذلك فان اليوريا المغطاه كانت افضل من نترات الامونيوم ، كذلك تيسر النيتروجين و البوتاسيوم بالتربة و المحتوى من العناصر فى القش و الحبوب وكذلك مكونات محصولي القمح و الفول السودانى زادت معنويا بزيادة معدل اضافة النيتروجين و خصوصا فى وجود الهيدروجيل بتركيز 2% ، وبالتالي يرتب هذا المعدل على انة افضل معاملة تحت معاملتى التسميد النيتروجينى . وعلى العكس من ذلك فان التركيز العالى من البولىمر (الهيدروجيل بتركيز 3% ) مع معاملتى التسميد النيتروجينى سبب انخفاض معنوى فى تيسر العناصر و المحتوى الكلى منها (فى القش و الحبوب) و المحصول الكلى بمكوناته فى كلا الموسمين . المعدل الثانى من النيتروجين (100%) كان افضل من (75%) فى زيادة محصولي القمح و الفول السودانى بمكوناته . كذلك كفاءة الاستفادة من عنصرى النيتروجين و البوتاسيوم كانت اكبر مع التغطية بالمقارنة بالكنترول ، ايضا فان زيادة معدل اضافة البولىمر ادى الى زيادة معدل الاستفادة من العناصر فى كلا المحصولين. وبالنسبة لمعدل البولىمر ، فان القيم التي تعبر عن كفاءة الاستفادة من عنصرى النيتروجين و البوتاسيوم تحسنت كثيرا مع زيادة معدل البولىمر لكل من اليوريا و نترات الامونيوم حتى المعدل ( 2%) بالمقارنة بالكنترول وعلى العكس من ذلك فان اقل كفاءة استفادة كانت فى وجود المعدل (3%) لكلا المصدرين من الاسمدة النيتروجينية . زيادة معدل البولىمر ادى الى زيادة فى محتوى الحبوب من البروتين لكلا المحصولين بالمقارنة بالكنترول ، وكانت افضل معاملة اعطت اعلى محتوى من البروتين هى (100%) نيتروجين مع (2%) بولىمر وكانت فى اليوريا المغطاه اكبر من نترات الامونيوم فى كلا المحصولين . وبالتالي يمكن استنتاج ان، اضافة الاسمدة النيتروجينية (اليوريا و نترات الامونيوم) مع تغطيتها بالبولىمر بمعدل (2%) طريقة فعالة لتقليل الفاقد من النيتروجين و مفيد فى تحسين الخواص الكيميائية للارض الرملية و يعود ايجابيا على المحتوى الكلى للعناصر فى النبات و البروتين و كفاءة الاستفادة من العناصر بالاضافة الى زيادة المحصول بدرجة كبيرة . وبالتالي فان الهيدروجيل فى الاراضى الرملية يعمل على بطء فى انطلاق العناصر السمدية و يحدث ذلك تدريجيا مع الوقت من خلال امتصاصها لمنعها من الفقد بالغسيل و يجعلها جاهزة للامتصاص بواسطة النبات.