Original Research Article

Evaluation of Nitrogen Sources and Polymer Coated Fertilizers on Wheat Yield in Sandy Soil.

Abstract

Controlled-release fertilizers (CRF) are the newest and most technically advanced way of supplying mineral nutrients to crops. Compared to conventional fertilizers, their gradual pattern of nutrient release better meets plant needs, minimizes leaching, and therefore improves fertilizer use efficiency. A field experiment was carried out at south El -kantra Research Station Desert Research Center, North Sinai, Egypt (located at 30°53′27″ N, 32° 44′ 67″ E) to study the effects of different nitrogen sources, application times, and nitrogen rates at 107,160, and214 Kg/ha on wheat yield components, nutrients content and uptake by straw and grains of wheat crop (var. Sakha 93) and the level of available nutrients in the study soil.

Results showed that increasing the application rate of N increased yield components, nutrients content and uptake of wheat as well as increased the elements in soil. Application of 214 Kg/ha of Polymer-Coated Urea (PCU) at the heading stage gave the highest yield as: 6.47, 3.02, 3.35 ton/fed and 51g for dry weight of biological yield, grain, shoots and 1000-grain, respectively. This study concluded that the efficiency of fertilizers can be significantly improved with the use of PCU as N sources and subsequently the minimized pollution hazard with other studied N sources. The highest value of N recovery efficiency (30.99%) was obtained by application 214 Kg/ha of PCU at the heading stage when compare with the ordinary source.

Keywords: N fertilizers, Polymer-Coated Urea (PCU), nutrients uptake, efficiency of fertilizers, wheat production

Introduction

Nitrogen plays an essential role in plant growth; it is a component of the building blocks of almost all plant structures such as proteins, enzymes and chlorophyll. Optimal concentration of N increases leaf area , photosynthetic processes, leaf area length and net assimilation rate as well which eventually contributes towards higher grain yield. In most soils, ammonium is quickly converted to nitrate. Nitrate is not held on soil particles and is easily dissolved in water, thus it is susceptible to be leaching. Therefore, the timing and rates of nitrogen affected for plant growth and environmental.

Overuse of fertilizers is one of the causes for the degradation of environment and soil. Slow release fertilizers are the most technically basic way of supplying mineral nutrients to crops compare to conventional fertilizers; their gradual pattern of nutrient release meets plant needs, minimizes leaching, and therefore improves fertilizer use efficiency. **(Subbarao, *et. al.*, 2013)**

Nitrogen-recovery efficiency for cereal production international has been estimated at only 33% **(Raun and Johnson, 1999).** Some of the N not used by the crop is assumed lost through denitrification, runoff, volatilization, and leaching. Such losses raise concerns about water contamination and greenhouse gas emissions. Low use efficiency of fertilizer N in addition reduces economic returns from fertilizer inputs. Nitrogen-use efficiency can be improved by reducing N losses (**Englesjord et al., 1997).**

Controlled release N fertilizers or CRN consisting of urea with a polymer coating (PCU) Polymer-coated urea fertilizers use a hydrophobic coating that temporarily isolates the urea prill from the soil environment. These polymer coatings may be resins or mineral-based products that act as semi permeable membranes or impermeable membranes with tiny pores. Nutrient release through these membranes is controlled by the properties of the coating material, i.e., its permeability characteristics as affected by temperature and moisture.

Controlled Release Nitrogen (CRN) sources are a group of N fertilizers that may remove or reduce labor intensive and costly in-season N applications, as well as increase NUE. CRN releases N at controlled rates to retain maximum growth and minimize N loss. The two main forms of CRN are compounds of low solubility and coated water-soluble fertilizers (**Blaylock et al., 2005**). Previous work with CRN has been mostly unsuccessful in potatoes as the N release was too early and unpredictable, resulting in delays in tuberization and yield loss.

Polymer-Coated Urea (PCU) fertilizers are one kind of CRN that have the potential to provide enhanced N release timing. One such PCU is Environmentally Smart Nitrogen (ESN, Agrium U.S. Inc., Denver, CO). ESN was considered to release N to the crop with supplementary control and predictability with a micro-thin polymer coating. The N release rate is controlled by soil temperature, which coincides with plant growth and nutrient demand. The process of release is called temperature-controlled diffusion. In this process, water moves into the fertilizer granule through the coating and dissolves the N into solution. As temperature increases, N moves out through the polymer coating into the soil solution **(Agrium, 2005) and (Trent et. al., 2007).**

Controlled-release N fertilizer consisting of urea with a polymer coating (PCU) that is permeable to water and gradually releases N in response to increasing temperatures over the growing season (**Agrium Inc. 2011**). It costs only 15 to 30% more than uncoated urea and considerably less than other such fertilizer products or earlier generation coated fertilizers (**Hopkins et. al. ,2008 and Wilson et. al., 2009**), which makes it a more attractive product for use for field crops. Field experiment of product grains and potato indicated that this PCU may increase crop yield, reduce the need for split N application, and decrease NO_3-N leaching compared with conventional N fertilizers (**Nelson et al. 2009; Wilson et. al., 2009 and 2010; Blackshaw et. al., 2011; Ziadi et. al., 2011 and Bernard *et.al*., 2012).** However, the crop yield response was largely dependent on soil moisture, and little difference should be expected where the risk of N loss is low (**Malhi et. al., 2010; McKenzie et. al., 2010).**

The objectives of this study is to constitute comparisons of polymer-coated urea with a variety of conventional N fertilizers and application practices on growth, yield and N, P and K nutritional status in wheat crop grown in a sandy soil and finally to compare N-use efficiency as RUE, PUE and AUE of PCU against the ordinary N fertilizer

Material and method

A field experiment was carried out at south El -kantra Research Station of the Desert Research Center, North Sinai, Egypt located at 30°53′27″ N, 32° 44′ 67″ E, wheat cultivated during two successive seasons, i.e. 2014 and 2015. To study the effects of three nitrogen sources (ammonium nitrate (AN, 33 % N) , ammonium sulfate (AS, 20.5% N) and the polymer coated urea (PCU, 43% N), two application timing used as a basal N fertilization one time after one month of germination and used as twice-split equal fertilization, the first was added after one month of germination and the other dose at the heading stage of plant growth) and four nitrogen rates (0, 107, 160 and 214kgN/ha) on the chemical composition and productivity of wheat. The recommended dose of NPK fertilizer for wheat was 214kg N/ha (as ammonium sulphat), 71 kg P_2O_5/ha (as ordinary super phosphate) and 120 kg K_2O/ha (as potassium sulphat) **(Shehab El-Din and El-Shamy, 2003)**. The experimental design was randomized complete block design split-split plots where nitrogen sources treatments represented in the main plots. Application timing represented in the sub-main plots. N rates were in the sub-sub-main plots. Each treatment included three replicates. This experiment contained 24 treatments. The plot area was 10.5 m^2 (3.5 long × 3 wide). Yield parameters were recorded for the studied two seasons. Sprinkler irrigation system for irrigation the grown plants was used in the experiment**.** Wheat grains (var. Sakha 93) were sown on 17th November in both seasons. Wheat was harvested during May 2015 and 2016. Soil samples were collected from the studied plots at depth (0-30) for determinations some physical and chemical properties initial analysis was is shown in Tables (1).The following data were recoded

1. **Growth and Yield parameters:**

At maturity, 1 m^2 in the center of each experimental plot was chosen to be harvested for the estimation of biological parameters (biological yields, dry weights of shoots and grain and 1000 grain weight).

Table (1). Initial status of some chemical and physical properties of the experimental soil.

Depth	0-30 cm
Particle size distribution %	
Sand	90.5
Silt	2.7
Clay	6.88
Texture class	sandy
pH (1:5) Suspension	8.6
EC(1:5) $dS.m^{-1}$ soil extract	0.61
Soluble ions (meq/L)	
Na	4.34
K	0.23
Ca	0.876
Mg	0.605
Cl	4.00
HCO_3	1.77
SO_4	0.281
Available nutrients (mg/kg)	
N	25
P	1.47
K	32

2. **Determination of nitrogen, phosphorus and potassium in straw and grain of plant**

N, P and K in both grain and shoots were determined in acid digested solution, which was prepared according to **(Cottenie *et al.* 1982)**.

3. Soil properties of the experiment

3.1. Mechanical analysis was determined according to **(Piper, 1950)**

3.2. Some chemical properties

Soil hydrogen potential (pH) was determined electrometrically in soil suspension 1:5 using bench Beckman Glass Electrode pH-Meter, total soluble salts (EC) were determined in soil suspension 1:5 were determined according to **(Jackson, 1973)**

3.3. Determination of available nitrogen, phosphorus and potassium in soil

Available nitrogen in soil samples was extracted by 2M potassium chloride solution and determined according to **Dhank and Johnson (1990)**. Available potassium and phosphorous were extracted by DTPA + ammonium carbonate solution and measurement according to the method described by **Soltanpour (1985)**.

3.4. ***Nutrient efficiency parameters*** *were evaluated using the following equations* **(Yadvinder *et al.*, 2004)**:

A- Recovery efficiency of N (RE) = 100 x (N uptake kg/fed of treated- N uptake kg/fed of untreated)/ applied N kg/fed

B- Physiological efficiency of N (PE) = (grain yield kg/fed of treated - grain yield kg/fed of untreated)/ (N uptake kg/fed of treated- N uptake kg/fed of untreated)

C- Agronomy efficiency of N (AE) = (grain yield kg/fed of treated - grain yield kg/fed of untreated)/ applied N kg/fed

Data of the present investigation were statistically analyzed and the differences between the means of the treatments were considered significant when they were more than the least significant differences (L.S.D) at the 5% level by using computer program of Statistix version 9 **(Analytical software, 2008).** Regression analyses were performed using Statistical Product and Service Solutions (SPSS 18.0).

Results and Discussion

Effect of nitrogen sources, application times and nitrogen fertilizer rates on yield parameters of wheat.

Data in Table (2) showed that the yield of wheat plants significantly affected by the studied different treatments through two seasons. The second season took the same trend of the first season so taking the average values of two seasons were taken for the yield of both shoots and grains. Polymer-Coated Urea (PCU) showed significantly higher increase of yield than the conventional fertilizers (AS or AN) of wheat (dry weights of biological yields, shoot, grain as well as 1000-grain weight). PCU produced greater yields in at the heading stage (twice split) compared with applied (once split), Also, yield increased significantly with increasing the rates of N fertilizers. The most effective treatment was 214 Kg N/ha of PCU when splitted the added fertilizer. The highest yield, as 6.37, 3.02, 3.35 ton/fed and 51 (g) dry weights of biological yields, grain, shoot and 1000-grain weights respectively. The polymer coating urea avoids at least some N losses.Wheat plants need nutrients continuously for the growth, but they absorb nutrients differently in quantity and speed, because plants absorb critical and urgent elements in different plant growth stages. Nitrogen is an essential macro nutrient that is required most for wheat production (**Hou et al., 2007),** but N deficiency N use efficiency adversely affect wheat growth and yield (**Kawakami et al., 2012)**. The release rate of PCU was slowly in the first month, and then accelerated under the field condition; the successive releases of N from PCU corresponded well to the requirements of N in the growth stages of wheat **(Geng, *et.al*, 2016)**

Hence using these materials as a source of due to de-nitrification, leaching, or ammonia volatilization. the loss mechanism supported by **Blaylock, *et al.*, (2005), Blackshaw, *et al.*, (2011), and Nelson, *et al.*, (2014)** reported that split-N application resulted in greater wheat biomass (2.77 Mg ha^{-1}) and greater N uptake (28.5 kg ha^{-1}) than fall-applied N in 2005.

Table(2). Effect of nitrogen sources, application times and nitrogen fertilizer rates on yield components of wheat.

N sources	time application	N Rates	**Biological dry yield (t/fed.)**	**Grain dry weight t/fed.**	**Shoot dry weight t/fed.**	**1000 grains dry weight (g)**
AS	One time	0	3.81	1.69	2.12	24.10
		107	3.96	1.93	2.03	32.57
		160	4.55	2.22	2.33	37.47
		214	5.35	2.55	2.80	45.15
	twice split	0	3.87	1.72	2.15	24.40
		107	4.55	2.22	2.33	37.44
		160	5.23	2.55	2.68	43.08
		214	6.28	3.07	3.21	50.90
AN	once	0	3.83	1.7	2.13	24.20
		107	4.17	2.04	2.13	33.35
		160	5.81	2.35	2.46	38.37
		214	6.05	2.83	2.95	46.23
	twice split	0	3.89	1.73	2.16	24.30
		107	4.59	2.25	2.34	36.65
		160	5.27	2.58	2.7	42.16
		214	6.38	3.11	3.27	50.80
PCU	once	0	3.85	1.71	2.14	24.30
		107	4.43	2.05	2.38	36.70
		160	5.54	2.68	2.86	44.30
		214	6.06	2.84	3.22	44.80
	twice split	0	3.88	1.74	2.14	32.57
		107	4.78	2.4	2.38	44.00
		160	5.84	2.98	2.86	47.10
		214	6.37	3.02	3.35	51.00
LSD 0.05 for						
N source			0.09	0.08	0.18	1.90
Time Application			0.1	0.04	0.02	0.20
N rates			0.09	0.11	0.13	2.15
N source x T. Application			0.16	0.09	0.18	1.92
N source x N rates			0.16	0.18	0.26	3.72
N rates x T. Application			0.15	0.13	0.16	2.65
3 Factors			0.23	0.24	0.31	5.64

AS= ammonium sulphate AN= Ammonium nitrate PCU=polymer coated urea

Effect of nitrogen sources, application times, and nitrogen fertilizer rates on nutrients content of wheat

Data in Table (3) revealed that the N, P and K content (%) in straw and grain of wheat were significantly affected by the treatments. The highest significant increase in nutrient content was by using Polymer-Coated Urea (PCU) compared with As and AN. Also, the result showed that the values increased with increasing the rates of N fertilizers the superior treatment 214kgN/ha of PCU added twice split gave values of 0.900, 0.076 and 2.35 % for N, P and K content, respectively, in straw. While in seeds were 2.627, 0.267 and 0.600 %, respectively. It should be noted that application of PCU (twice split) was as effective as (once time) application of either AS or AN. The second season took the same trend of the first season. These results in accordance with those obtained by **Blaylock, et al., (2005)**, **Henry, et al.,(2010)** and **Nelson**, et **al.,(2014)** who reported that split-applied N resulted in greater wheat tissue N concentration,

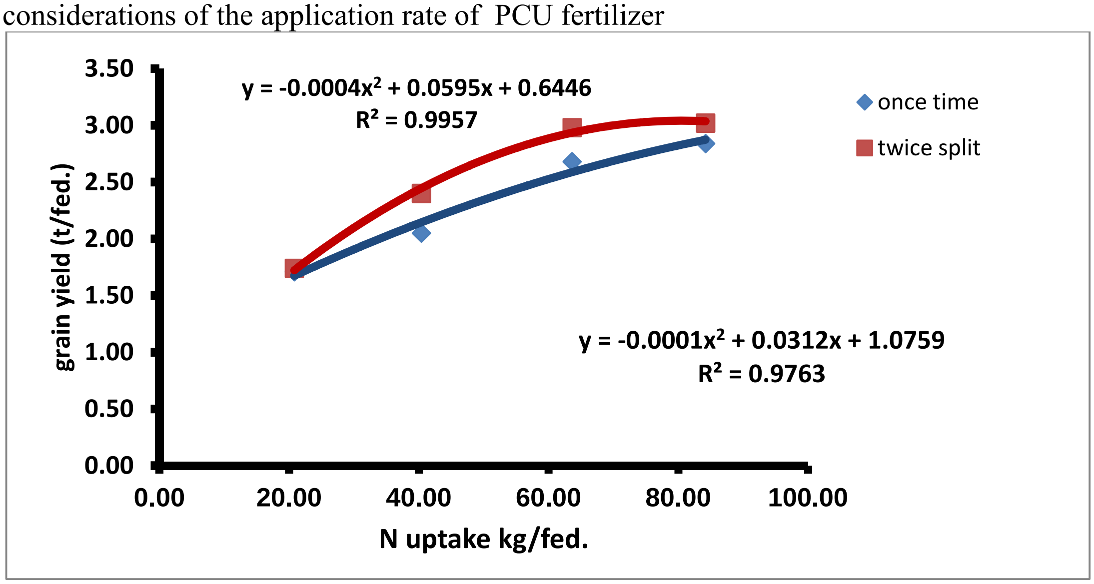
Table (3). **Effect of nitrogen sources, application times and nitrogen fertilizer rates on nutrients content in grain and straw of wheat.**

N sources	time application	N Rates	Nutrients content in straw (%)			Nutrients content in seeds (%)		
			N	P	K	N	P	K
AS	once	0	0.300	0.022	0.860	1.127	0.137	0.160
		107	0.507	0.037	1.347	1.590	0.14	0.34
		160	0.577	0.042	1.550	1.827	0.159	0.387
		214	0.697	0.051	1.870	2.200	0.191	0.467
	twice split	0	0.330	0.024	0.890	1.157	0.143	0.167
		107	0.577	0.042	1.550	1.820	0.158	0.3867
		160	0.663	0.049	1.780	2.093	0.182	0.443
		214	0.800	0.058	2.147	2.523	0.219	0.540
AN	once	0	0.310	0.023	0.870	1.137	0.141	0.170
		107	0.493	0.048	1.457	1.660	0.1783	0.34
		160	0.567	0.056	1.677	1.913	0.187	0.387
		214	0.683	0.067	2.017	2.297	0.225	0.470
	twice split	0	0.310	0.025	0.910	1.177	0.145	0.170
		107	0.493	0.054	1.660	1.820	0.1623	0.37
		160	0.567	0.061	1.840	2.093	0.205	0.427
		214	0.683	0.074	2.213	2.523	0.247	0.510
PCU	once	0	0.360	0.024	0.880	1.147	0.142	0.180
		107	0.400	0.026	1.707	1.327	0.156	0.29
		160	0.450	0.028	1.897	1.577	0.180	0.317
		214	0.683	0.035	2.023	1.877	0.199	0.370
	twice split	0	0.320	0.260	0.940	1.187	0.147	0.190
		107	0.310	0.030	1.980	1.677	0.1707	0.33
		160	0.700	0.051	2.043	2.127	0.213	0.410
		214	0.900	0.076	2.350	2.627	0.267	0.600
LSD 0.05 for N source			0.025	0.002	0.053	0.076	0.008	0.014
Time Application			0.001	0.001	0.003	0.006	0.001	0.002
N rates			0.011	0.002	0.026	0.036	0.004	0.007
N source x T. Application			0.025	0.002	0.053	0.077	0.008	0.014
N source x N rates			0.030	0.003	0.065	0.093	0.009	0.017
N rates x T. Application			0.014	0.002	0.033	0.045	0.005	0.008
3 Factors			0.031	0.004	0.069	0.095	0.009	0.018

Effect of application of nitrogen sources, application times and nitrogen fertilizer rates on nutrients uptake by wheat

The previous results from yield and nutrients content were assured in results of nutrients uptake in Table (4) showed that the treatment Polymer-Coated Urea (PCU) gave higher nutrients uptake by wheat plant during two seasons than other studied treatments. The N, P and K uptake increased with increasing the rate of N application for all treatments. The highest significant increase was by using 214 Kg N/ha of PCU at the heading stage treatment gave values of 30.17, 2.55and 78.66 for N, P and K kg/fed uptake by straw, respectively. For seeds, it gave values of 84.18, 8.58 and 19.20 kg/fed uptake, respectively. The nutrients uptake in seeds and straw in second season showed similar trends of as the first season. These results could be due to the fact that the successive releases of N from PCU corresponded well to the requirements of N in the growth stages of wheat. Nutrient release rates of PCU are known to be significantly affected by temperature and moisture content **(Geng *et al.*, 2015).** Thus, the N release longevity of PCU in field condition was longer compared with the conventional fertilizers. On the other hand, the rapid hydrolyses process of urea caused heavy N losses this fact supported by **(Khan et al., 2015),** these results in accordance with those obtained by **Blaylock, *et al.*, (2005). Henry, *et al.*, (2010) and Nelson**, *et* ***al.*,(2014)** reported that split-applied N resulted in greater wheat tissue N concentration.

Relationship between total N uptake and wheat grain yields at timing of application of PCU was show in figure (1) There was a good quadratic relationship between yield and N uptake at pre-plant stage (R^2 = 0.9763), and at the heading stage (R^2 = 0.9957) These indicate that The increasing rate of Polymer-Coated Urea (PCU) fertilizer had a potential to increase grain yield. This figure will be modified later according to target grain yields for economic considerations of the application rate of PCU fertilizer



Fig(1). Relationship between total N uptake **and wheat grain yields**

Table(4). Effect of application of nitrogen sources, application times, and Nitrogen fertilizer rates on nutrients uptake in grain and straw of wheat.

N sources	time application	N Rates	Nutrient uptake in straw kg/fed			Nutrient uptake in seeds kg/fed		
			N	P	K	N	P	K
AS	once	0	6.41	0.47	18.26	19.19	2.39	2.76
		107	10.19	0.74	27.38	30.63	2.66	6.50
		160	13.58	0.98	36.28	40.53	3.52	8.59
		214	19.52	1.42	52.29	58.91	5.12	12.47
	twice split	0	7.18	0.52	19.26	20.05	2.42	2.86
		107	13.58	0.99	36.46	40.48	3.52	6.50
		160	17.99	1.31	48.31	53.55	3.51	11.35
		214	25.99	1.89	69.62	77.82	6.76	16.48
AN	once	0	6.71	0.47	18.26	19.47	2.42	2.94
		107	11.49	1.13	33.99	33.89	3.32	6.89
		160	15.23	1.50	45.04	44.84	4.39	11.00
		214	22.00	2.16	64.91	65.16	6.38	13.22
	twice split	0	7.32	0.54	19.51	20.51	2.53	2.89
		107	12.91	1.27	38.09	40.93	4.00	8.32
		160	17.88	1.76	52.79	54.15	5.30	11.00
		214	24.26	2.38	71.49	78.69	7.71	13.23
PCU	once	0	6.86	0.51	18.78	19.76	2.45	3.13
		107	8.54	0.56	36.42	27.34	3.22	6.01
		160	11.06	0.69	46.58	42.41	4.84	8.47
		214	16.27	1.04	59.73	53.38	5.66	10.64
	twice split	0	7.89	0.58	20.81	20.80	2.58	3.26
		107	16.72	1.01	62.61	40.39	4.12	8.02
		160	21.49	1.56	66.09	63.61	6.38	12.29
		214	30.17	2.55	78.66	84.18	8.58	19.20
LSD 0.05 for N source			1.178	0.088	2.316	2.198	0.275	0.382
Time Application			0.578	0.040	1.628	1.114	0.120	0.211
N rates			0.852	0.072	2.317	2.325	0.245	0.444
N source x T. Application			1.372	0.100	3.050	2.583	0.312	0.460
N source x N rates			1.718	0.137	4.139	4.088	0.454	0.763
N rates x T. Application			1.190	0.096	3.262	3.053	0.323	0.583
3 Factors			2.315	0.170	6.610	6.401	0.575	1.024

AS= ammonium sulphate AN= Ammonium nitrate PCU=polymer coated urea

Effect of application of nitrogen sources, application times, and Nitrogen fertilizer rates on nutrient efficiency parameters of wheat.

Recovery efficiency, physiological efficiency and agronomic efficiency of wheat were affected by the studied different treatments (Table 5). The highest value of recovery efficiency (41.88%) was obtained by adding 214kgN/ha of Polymer-Coated Urea (PCU) specially when spillted N fertilizer, agronomic efficiency (8.08 kg grain/kg N uptake) was obtained by 160kg N/ha of PCU when spillted N fertilizer treatment of wheat due to more availability of N from PCU, while The highest value of physiological efficiency was obtained by 107kgN/ha of PCU at adding Nonce time treatment. Also Increasing NPK dose decreased physiological efficiency of wheat but it increased recovery efficiency and agronomic efficiency. The data also showed that with using only a rate of 160kg N/ha of PCU source gave recovery efficiency higher than applying 214 Kg N/ha of the ordinary source. In both seasons. Controlled-release fertilizers generally better granular urea fertilizer in reducing N losses, stimulating plant growth, and increasing nitrogen use efficiency **Kiran *et.al.*,(2010).** PCU has higher N recovery compared to AS or AN. Once time N fertilizers is much less effective than splitted fertilizer treatments and is apparently subject to much greater N loss by leaching since N that is not recovered by the crop during the growing season is most likely lost .These results in accordance with those obtained by **Salvagiotti and Miralles**, (**2008**), **Rehab H. Hegab (2013)** and **Chen*, et.al.,(*2017).** The lower recovery efficiency was possibly due to less availability of N due to lower grain yields during the particular year This fact supported by **(Yadvinder *et.al.*, 2004**).

Table (5). Effect of application of nitrogen sources, application times, and Nitrogen fertilizer rates on recovery N efficiency (%), physiological efficiency and agronomic efficiency of wheat

N sources	time application	N Rates	**recovery efficiency (%)**	**physiological efficiency (kg grain/kg N uptake)**	**agronomic efficiency (kg grain/kg N applied)**
AS	once	0	0.00	0.00	0.00
		107	6.93	20.23	1.05
		160	8.65	24.40	1.58
		214	12.03	24.61	2.23
	twice split	0	0.00	0.00	0.00
		107	12.22	24.00	2.23
		160	13.46	24.56	2.50
		214	17.44	23.32	3.07
AN	once	0	0.00	0.00	0.00
		107	8.74	23.10	1.52
		160	16.57	25.19	3.12
		214	22.36	24.55	4.11
	twice split	0	0.00	0.00	0.00
		107	11.85	24.74	2.30
		160	21.61	25.01	4.11
		214	27.54	23.58	5.03
PCU	once	0	0.00	0.00	0.00
		107	9.05	44.40	3.29
		160	17.50	42.68	6.30
		214	21.03	33.42	5.49
	twice split	0	0.00	0.00	0.00

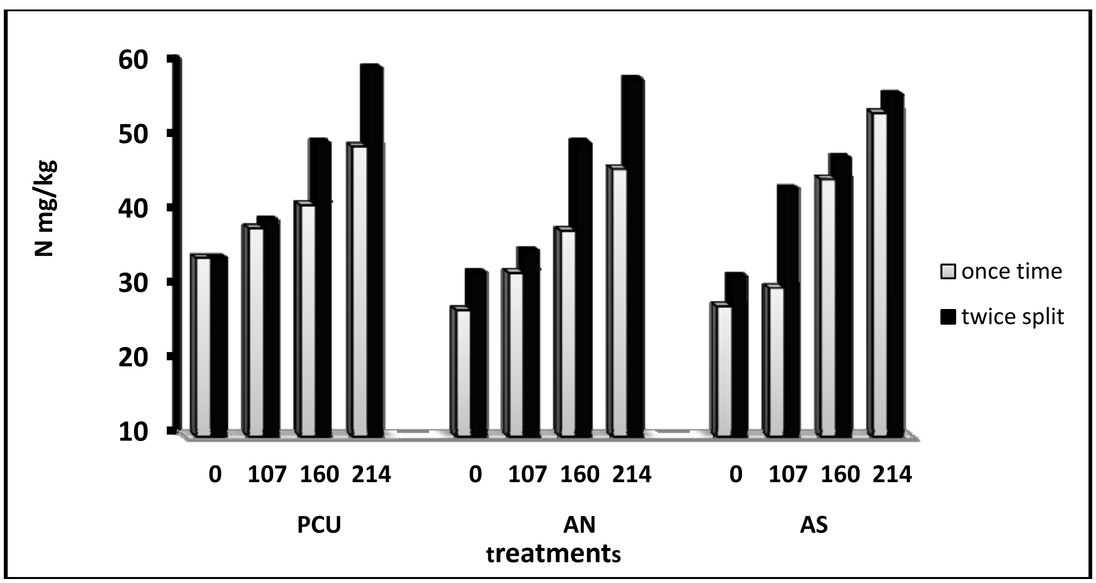
107	27.79	33.45	6.41
160	36.77	28.94	8.08
214	41.88	22.95	7.11

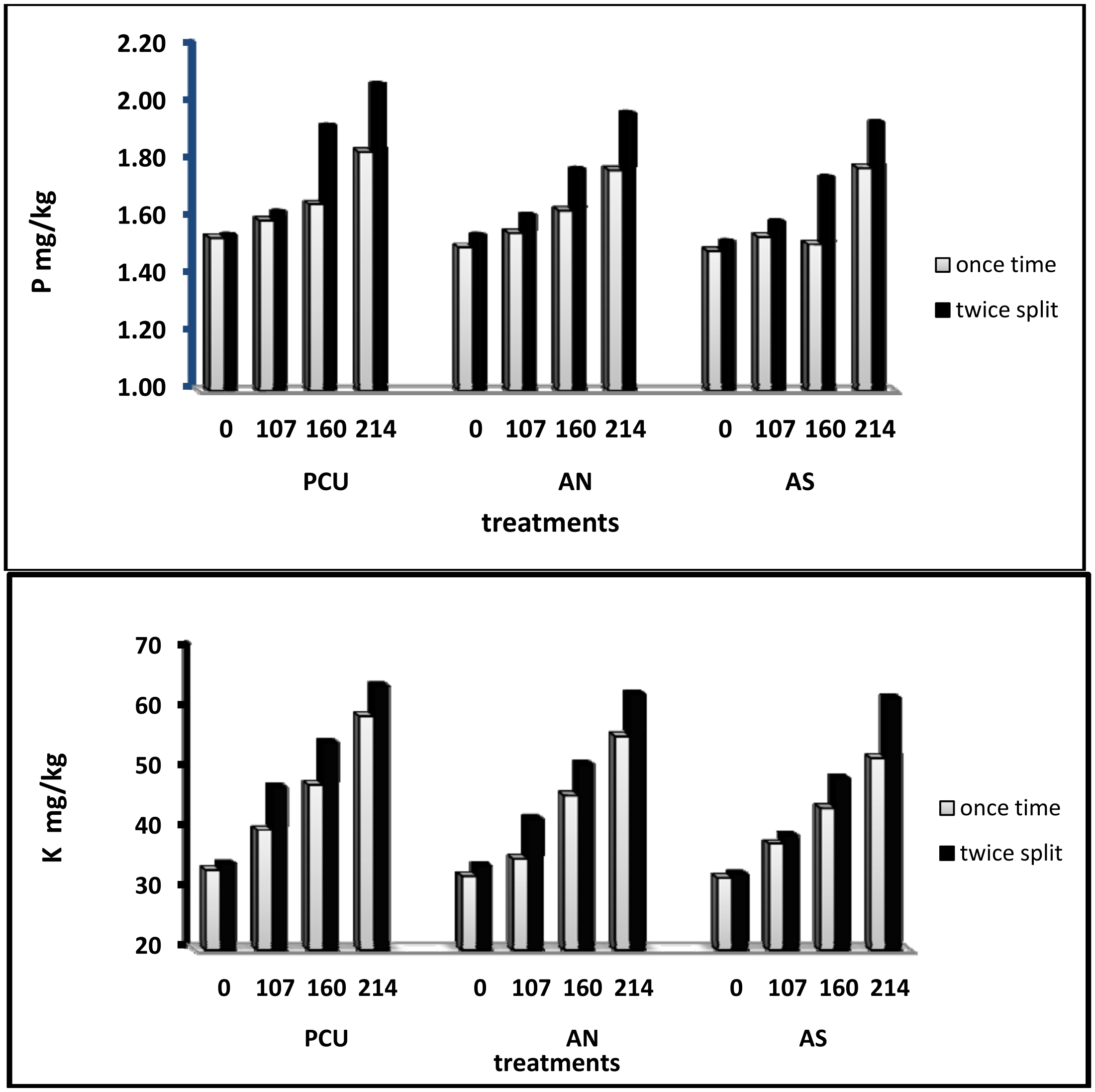
AS= ammonium sulphate AN= Ammonium nitrate PCU=polymer coated urea

Effect of application of nitrogen sources, application times, and Nitrogen fertilizer rates on the availability of N,P and K in soil at the end of the experiment.

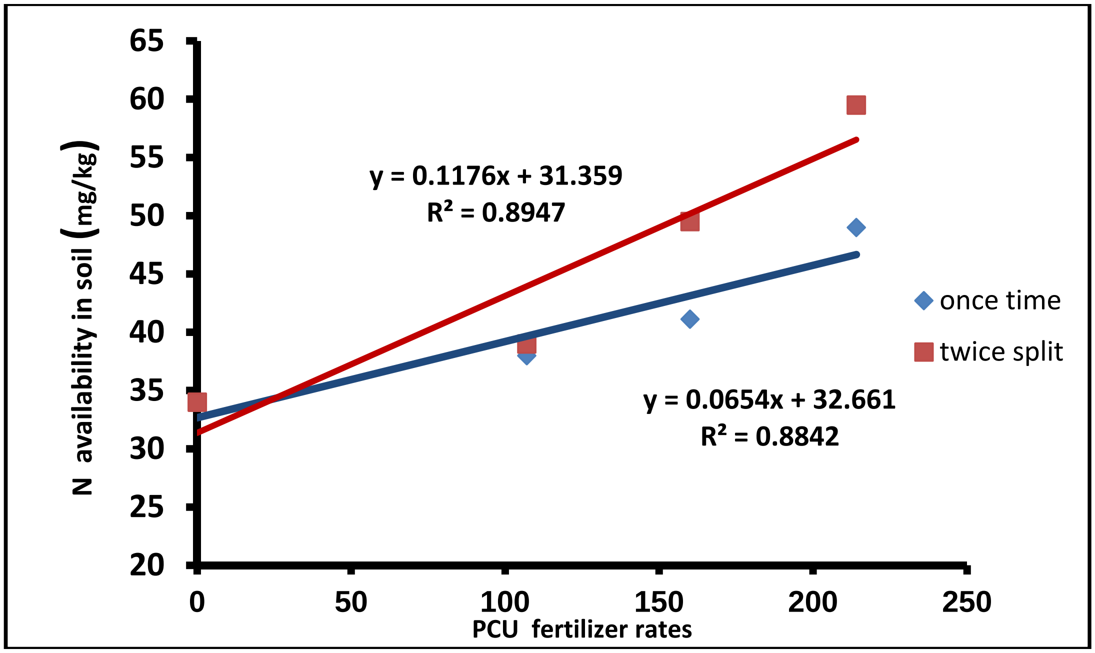
The availability of N, P and K in soil at the end of the experiment is presented in Figure (2). The application of studied treatments increased the available elements in soil. Polymer-Coated Urea (PCU) was higher in increasing the elements availability in soil when compared with the other studied fertilizers. The most effective treatment 214 Kg N/ha of PCU when adding through two dose gave higher significant increases on available elements in soil than adding the conventional fertilizer at layer 0-30 cm by (93, 2.07 and 94mg/kg) for available N, P and K, respectively. Due to the slow release nature, slowly released fraction of stored urea, additionally contributed to ponded water N concentration throughout the growing season. The previous facts are assured by the results obtained by **Ellison et al., (2013)** and **Heiniger, et al., (2014) .**

The constant value from the linear regression as show in figure (3) is 31.359 at adding N fertilizer at once time. However, this value increased to 32.661 in when N fertilizer spllited at heading stage, This indicate that application of Polymer-Coated Urea (PCU) had a potential to increase N content. This slowly released and steady supply of N may be responsible for greater use efficiency in PCU generally reported in literature **Tang, *et.al.*, (2007). Yang *et. al..*, (2012)** reported that using controlled-release urea (CRU) in rice without additional fertilizer application during the growing season significantly increased N availability in soil and improved yields by 13.6%–26.5%.





Fig(2). Effect of application of nitrogen sources, application times, and Nitrogen fertilizer rates **on nutrient availability in soil.**



Fig(3). Interaction between Polymer-Coated Urea (PCU) fertilizer and nitrogen availability in soil.

Conclusions:

The obtained results showed that the use of PCU is much better than conventional fertilizers; however, application of Polymer-Coated Urea (PCU) had an important role for increasing crop productivity and minimizes the pollution hazard through improving the use efficiency. Yield components, nutrients content and uptake by wheat were increased with using the PCU, compared with the other adding fertilizers. Also, splitting application fertilizers are more effective than when adding once time application. The apparent recovery efficiency of N was increased significantly by using the PCU source. Using only a rate of 50 or 75% of the recommended rate from PCU source gave recovery efficiency of N higher than applying 100% of the ordinary source, with almost similar or higher yield. This study came to a conclusion that using PCU fertilizers can reduce the amount of wasted chemicals and hence minimizes the pollution hazard. we can recommended that, wheat crop treated with adding to 214 Kg N/ha of PCU when splitted through two equal doses to gave the highest nutrients uptake and productivity of wheat under sandy soil of Sinai region conditions, Egypt.

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