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Effect of Different Slow Release Nitrogen Fertilizer Forms on Yield and Chemical Constituents of Maize and Soybean

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ABSTRACT

Field trials were conducted in order to study the effect of some slow release fertilizers application on yield and quality of maize and soybean. Sulphur coated urea (SCU), phosphogypsum coated urea (PGCU) and bentonite coated urea (BCU) were compared with uncoated urea (U) and applied at 80, 100 and 120 kg N/fed. for maize and 20, 40 and 60 kg N/fed. for soybean. The results showed that application of slow release fertilizers significantly increased the plant height, 100-seed weight and finally seed yield per plant which are the most important yield determining components in maize and soybean. Also application of the slow release nitrogen fertilizers to maize and soybean plants caused an increase in seed yield, straw yield, seed oil %., crude protein % and total carbohydrates of soybean. The obtained results of both crops indicate that it seems that soybean is more responsive to the different coated urea forms than that occurred by maize especially SCU. All forms of coated urea increased grain or seed yields by 4-10% for maize and 3-16% for soybean. Also it can be noticed that application of SCU at 80 kg/fed. to maize could effectively produce similar or more than that obtained by 100 kg N/fed. applied in the form of uncoated urea. Similarly, such tendency was true for soybean when SCU was applied at 20 kg N/fed soybean plants could effectively produce equal or better seed yield than the plants were fertilized with 40 kg N/fed. Therefore, such results indicate the potentiality of reducing application rates for both crops by 20 kg N/fed. units if the coated forms of urea were adopted than the uncoated urea.

Key words: Sulphur coated urea (SCU), Bentonite coated urea (BCU), and Phosphogypsum coated urea (PGCU), Maize, Soybean

Introduction

The fertilizer industry faces a continuing challenge to improve its products to increase the efficiency of their use, particularly of nitrogenous fertilizers, and to minimize any possible adverse environmental impact. This is done either through improvement of fertilizers already in use, or through development of new specific fertilizer types. Maize (*Zea mays* L) is grown widely in many countries of the world maize an important cereal of the world, ranked 1st in grain yield production. Soybean (*Glycine max* (L.) Merrill) is one of the most important protein and oilseed crops throughout the world. Its oil is the largest component of the world's edible oils. It has emerged as one of the important commercial crops in many countries. Soybean is also known as the Golden bean or Miracle crop because of its multiple uses. Signor and Barbiani (2013) indicated through the studies conducted from 2010 to 2012 on the cost effectiveness and effect on maize yield of slow release nitrogen fertilizers that using slow release fertilizer reduces the dosage used for maize and ensure excellent yield. Another alternative is to reduce nitrogen fertilizers with urea (up to 33 % less) and split the distribution in two applications.

Yang, *et al*., (2012) showed that slow release N could increase maize and rice yields, and N use efficiency significantly compared with conventional urea. The yield of maize and rice increased by 10.35 % and 8.00 % and the N use efficiency increased by 14.01 % and 7.41% with experimental fertilizer 1 and the yield increased by 10.12 % and 12.55 % and the N use efficiency increased by 5.87 % and 4.79 % with experimental fertilizer 2. The fertilizer 2 had a better effect in paddy field both of two kinds of slow release urea.

Mo, *et al.,* (1991) showed that the effects of slow release urea in increasing soybean yield were compared with ordinary urea. The slow release urea retained its effectiveness for 100-120 day. Applying slow release urea increased soybean yield, amino acid content and chlorophyll content by

5.8-25.3 %, 34.3 % and 0.8 %, respectively, compared with urea. The number of seeds/plant increased by 3.5-6.3, and 100-seed weight increased by 0.1-0.7 g.

Zhang *et al*., (2002) studied the effect of slow release fertilizer on dry matter accumulation/partitioning, nutrient absorption and yield of soybean was investigated in pot experiments. Dry matter accumulation during the growing period in all treatments was higher than that of the control. The slow release fertilizer with short releasing time had less effect on N absorption, while the long time one reduced the N absorption at the earlier stage. However, slow release fertilizers in general can increase the absorption of K^+ to a certain extent and yield and yield components of soybean.

Under Egyptian conditions, El-Tohamy *et al*., (2009) indicated that increasing levels of slow release fertilizer significantly improved vegetative growth and yield of bean plants. The highest level of slow release fertilizer had significantly higher growth and yield compared to control plants that received the conventional nitrogen application of ammonium sulfate. Chemical analysis of leaves showed that the high levels of treatments significantly increased N content and protein content of pods.

Hassanein *et al*., (2013) found that adding 90 kg N/fed. slow release N/fed. (Enciabien) resulted in a significant increment in plant height, grain yield (g/m^2), grain yield (ton/fed.) and harvest index, while addition of slow release N fertilizers at the rate of 120 kg N/fed. surpassed the other treatments in other characters of wheat plants.

The objective of this study is to investigate the effect of different slow release nitrogen fertilizer forms on yield and quality in maize and soybean compared with the uncoated urea

Materials and Methods

The present investigation was carried out in two successive summer seasons, 2012 and 2013 at El-Hakmiya, Miet Ghamr region, El-Dakahilia Governorate, Egypt. The main objective was to study the efficiency of some manufactured forms of slow release fertilizers (SCU, BCU and PGCU on maize (single hybrid, 10) and soybean (Giza, 111) characteristics compared with uncoated urea under clay soil conditions.

Representative soil sample (0-30) was taken from experimental field before growing and after harvesting for each season to determine physical and chemical properties of the soil (Table 1).

Table 1: Some physico-chemical properties of the experimental sites before sowing.

Characteristics	2102	2013	Characteristics	2102	2013
Particle size distribution			Soluble cations and cations (meq/l)		
Sand (%)	10.33	10.22	K^+	0.36	0.40
Silt (%)	29.40	30.10	Na^+	2.06	2.39
Clay (%)	60.27	59.68	Ca^{++}	2.10	2.44
Texture	Clay soil	Clay soil	Mg^{++}	1.10	1.39
pH (1:2.5 soil: water)	7.81	7.86	$CO_3^{=}$	0.00	0.00
E.C (1:5) (dS/m)	0.56	0.66	$SO_4^{=}$	2.12	2.44
$CaCO_3$ (%)	2.02	2.12	HCO_3^-	0.58	0.76
O. M. (%)	1.23	1.25	Cl^-	2.92	3.42
Total N (%)			Available P (ppm)		
N	0.06	0.07	P	8.11	9.43

The soil samples were air dried ground and analyzed for physical and chemical characteristics according to (Olsen *et at*., 1958, Black, 1965 and Jackson, 1973).

Soybean seeds were inoculated prior to sowing with the specific strain of Rhizobium leguminous arum. Maize and soybean were sown in May 20th in the 1st and 2nd seasons. The experimental plot area was 10.5 m^2 contained of 5 ridges, each of 3 meters in length and 70 cm apart. Seeds were sown with the rate of 15 kg/fed. for maize and 30 kg/fed. for soybean . Grains of maize were sown one side of the ridge in hills 25 cm apart and one plant/hill was left at thinning. Seeds of soybean were sown one side of the ridge in hills 15 cm apart and two plant/hill were left at thinning (21days after sowing).

Phosphorus was added as (super phosphate15.5 % P_2O_5) at the rate of 60 kg P_2O_5/fed. pre sowing. Nitrogen fertilizer forms and rates were applied as Urea (U) in Sulphur coated urea (SCU), Bentonite coated urea, (BCU) and Phosphogypsum coated urea (PGCU) at the rates of 80, 100 and 120 kg N/fed. for maize and 20, 40 and 60 kg N/fed. for soybean nitrogen fertilizer rates were applied in tow doses after sowing for maize (21 and 35 days from sowing) and once , for soybean in (After 21 days from sowing). Potassium was added as (Potassium sulphate 48 % K_2O at the rate of 50 kg K_2O/fed. in once dose (after 45 days from sowing).

The Irrigation system was surface irrigation at 12 days intervals and other normal agronomic practices of growing maize and soybean plants were done. The experiment included 12 treatments which were the combinations of 3 rates and four nitrogen fertilizer forms. The design of the experiments was established as spilt plot design with replicated three.

At harvest (120 days after sowing) ten plants were taken at random from middle three ridges of each plot for the following measurements were recorded:

1. Plant height (cm).
2. Seed yield/plant (g).
3. 100-seed weight (g).

All plants of each plot were harvested then seeds threshed, seed and straw yields (ton/fed.) were determined by multiply seed and straw yields/plot*400.

Representative seed samples were taken after harvest and analyzed for macronutrients after washing in sequence with tap water, 0.01 N HCI acidified bidistilled water and bidistilled water, respectively, and then dried in a ventilated oven at 70°C till constant weight. The plant samples were grounded in stainless steel mill 0.5 mm sieve and kept in plastic containers for chemical analysis. Samples of 0.5 gram of plant material were digested with perchloric on a hot plate. The suspension was filtered on an ash free filter paper into 100 ml volumetric flask. The total nitrogen was determined using Micro-kjeldahal, while K was measured using flame photometer; P was determined spectrophotometricaly using the method of Cottenie *et al*., (1982). Crude protein was obtained by N % x 6.25 according to A.O.A.C. (1990). Total Carbohydrates percentage was determined according to Dubois (1956). Oil percentage was determined according to PN-EN ISO (1999).

Statistical analyses were performed using the analysis of variance. Results presented as means of the two years of experimentation. The least significant differences LSD at 5% were used to compare between means. (Snedecor and Cochran, 1990).

Results and Discussions

1. Maize:

Data presented in Table (2) clearly show that all treatments of slow release fertilizers significantly increased plant height of the maize in both seasons. The maximum increase in the plant height in both seasons was recorded by SCU being over the control by (25 and 30 cm) in the two seasons. However, the interaction effect was non-significant at all the treatments in both seasons. SCU significantly surpassed the other two forms (BCU and PGCU) in plant height in second season. These results are in accordance with those obtained by Shao *et al.,* (2013), Liu, *et al.,* (2012) and Hassanein *et al*., (2013)

Data presented in Table (2) revealed that all treatments significantly increased grain yield/plant in both seasons. Nitrogen fertilizers coated surpassed the uncoated urea .Such increase due to the coated forms SCU reached (3.26 %) over the control in the first season and BCU (8.83 %) over the control in second season. However, the interaction effect was non-significant at all the treatments in both seasons. Comparing the coated forms of nitrogen show that SCU highest BCU and PGCU in first season while BCU highest the other two N coated forms (SCU and PGCU) in second season. Similar results were obtained by Li, *et al*., (2012), Hassanein *et al*., (2013) and Yang *et al*., (2012).

From the same table it is observed that seed yield was positively affected by SCU, BCU and PGCU treatments in both seasons. Application of SCU, BCU and PGCU significantly increased the average of 100-grain weight of maize in both seasons. However, the interaction effect was non-significant in all the treatments. SCU significantly exceeded the other two forms. These data agree with the results of Signor and Barbiani (2013), Yang *et al*., (2012) and Shao *et al*., (2013).

Data of grain yield/fed. of the maize as affected by SCU, BCU and PGCU are given in Table (2). The obtained results revealed that application of SCU, BCU and PGCU significantly increased grain yield /fed. in both seasons. It is clear that SCU significantly surpassed BCU and PGCU in this respect in both seasons. The highest values of grain yield/fed. was obtained by SCU treatments (3.20 and 3.61 ton) in the first seasons respectively. However, the interaction effect was significant for all treatments in both seasons. The increases over the control due to SCU treatment was (0.29 and 0.34 ton) in the first and second seasons, respectively. The increase in grain yield could be mainly attributed to the increase in the weight of grain per plant and partially in weight of 100-grain. Such results are in accordance with those reported Yang *et al*., (2012), Shao *et al*., (2013) and Hassanein *et al*., (2013)

Data in Table (2) revealed that all treatments significantly increased straw yield in both seasons. The increases in straw yield due to BCU treatment were (0.59 and 2.08 ton) over the control in the first and second seasons, respectively. Also, the interaction effect was significant for all the treatments in first season but it was non- significant for all the treatments in second season.

Data in Table (2) indicated that BCU surpassed SCU and PGCU in straw yield /fed. with differences in both seasons. In this respect Signor and Barbiani (2013) and Yang *et al*., (2012) found that slow release fertilizers application increased the weight of straw yield.

Data of rates the maize as affected by SCU, BCU and PGCU are given in Table (2). There were gradual increases in growth characters i.e., plant height, grain yield/plant, 100-grain weight, grain yield/fed. and straw yield/fed. as fertilizer rate increased from 80, 100 or 120 kg N/fed.

Table 2: Influence of N application rate from U, SCU, PGCU and BCU fertilizers on yield and yield components of maize.

Fertilizers	Rate (kg N/fed.)	Plant height (cm)	Grain yield /plant (g)	100-Grain weight (g)	Grain yield/ fed (ton)	Straw yield/ fed. (ton)	Plant height (cm)	Grain yield /plant (g)	100-Grain weight (g)	Grain yield/ fed. (ton)	Straw yield/fed. (ton)
		2012					2013				
U	80	303.00	201.92	38.31	2.76	4.92	324.00	284.05	40.99	3.18	5.60
	100	306.00	212.12	39.78	2.90	5.06	327.00	303.11	42.56	3.34	5.68
	120	322.00	229.38	40.52	3.07	5.82	344.00	301.94	43.36	3.54	6.43
SCU	80	325.00	204.35	41.17	2.90	5.19	358.00	306.04	44.05	3.34	6.70
	100	339.00	213.46	43.59	3.10	5.34	359.00	320.35	46.64	3.57	7.52
	120	343.00	246.61	45.52	3.61	6.58	370.00	338.59	48.71	4.16	8.95
PGCU	80	324.00	200.97	39.71	2.83	5.00	346.00	277.77	42.49	3.25	6.34
	100	326.00	219.09	40.72	2.98	5.37	342.00	292.24	43.57	3.43	6.83
	120	327.00	225.97	42.22	3.28	5.99	343.00	301.81	45.18	3.78	7.80
BCU	80	316.00	203.84	41.76	2.88	5.10	338.00	313.77	44.68	3.32	7.52
	100	331.00	212.72	42.66	3.02	6.16	354.00	323.27	45.65	3.48	7.82
	120	336.00	242.76	44.52	3.47	6.33	359.00	330.70	47.64	4.00	8.62
$LSD_{0.05}$		ns	ns	ns	0.05	0.27	ns	ns	ns	0.05	ns
Fertilizer type	U	311.00	214.47	39.53	2.91	5.27	332.00	296.37	42.30	3.35	5.90
	SCU	336.00	221.47	43.42	3.20	5.70	362.00	321.66	46.46	3.69	7.72
	PGCU	326.00	215.34	40.88	3.03	5.45	344.00	290.61	43.75	3.49	6.99
	BCU	328.00	219.77	42.98	3.12	5.86	350.00	322.54	45.99	3.60	7.98
$LSD_{0.05}$		12.0	7.94	2.60	0.04	0.19	8.00	23.67	2.78	0.04	1.05
Rate (kg/fed.)	80	318.00	202.77	40.24	2.84	5.05	342.00	295.41	43.05	3.27	6.54
	100	326.00	214.35	41.69	3.00	5.48	346.00	309.74	44.61	3.45	6.96
	120	332.00	236.18	43.20	3.36	6.18	354.00	318.26	46.22	3.87	7.95
$LSD_{0.05}$		12.00	6.50	1.76	0.02	0.13	11.00	19.63	1.89	0.03	0.60

Urea = U Sulphur coated urea =SCU Phosphogypsum coated urea = PGCU Bentonite coated urea = BCU

Chemical constituents:

Results in Table (3) indicate that all adopted treatments of SCU, BCU and PGCU showed positive statistical effects on grains phosphorus percentage of the maize in both growing seasons. However, the interaction effect was non-significant at all the treatments in both seasons. In this concern, Yang *et al*., (2012), Signor and Barbiani (2013) reported that application of slow release fertilizers increased the phosphorus percentage in grains of maize.

Results in Table (3) cleared that all adopted treatments of SCU, BCU and PGCU revealed significant statistical effects on percentage of potassium in maize grains in both growing seasons of 2012 and 2013. However, the interaction effect was non-significant for all the treatments. SCU significantly surpassed BCU and PGCU in K concentration in both seasons. Similar results were reported by Yang *et al*., (2012)

It is realized from Table (3) that all coated forms of urea significantly increased crude protein percentage of maize grains under investigation in both seasons. Results presented in Table (3) clearly indicate that grains of maize treated with SCU significantly exceeded BCU and PGCU in crude protein percentage in both seasons. The highest percentage of grain crude protein was recorded with SCU in both seasons being (16.29 and 24.22 %) more than the control treatment in the first and second seasons; respectively. However, the interaction effect was significant for all treatments in the first season and it was non-significant for all treatments in the second season.

In this concern, Liu, *et al*., (2012) reported that application of slow release fertilizers increased the percentage of crude protein in grains of maize. Shao *et al*., (2013) found that application of slow release fertilizers increased the percentage of crude protein in grains of maize.

Data in Table (3) clearly showed that all treatments of SCU, BCU and PGCU significantly increased total carbohydrates of maize grains under investigation than the control treatment in both seasons, except PGCU treatment in the second season. The maximum increase in the total carbohydrates in both seasons was recorded by SCU being over the control by (6.59 %) and (7.32 %) in the first and second seasons, respectively. However, the interaction effect was non-significant for all treatments in both seasons. Data also revealed that SCU surpassed PGCU and BCU in this respect with significant difference in both seasons. These results are in accordance with those obtained by Li, *et al*., (2012).

Results in Table (3) cleared that all adopted treatments of SCU, BCU and PGCU revealed significant statistical effect on of oil percentage in grains of the maize in the two growing seasons of 2012 and 2013. However, the interaction effect was significant at all the treatments in first season and non significant in the second season. SCU surpassed BCU and PGCU in this respect with a significant difference between the two BCU and PGCU in both seasons, except BCU treatment in the second season. These results are in accordance with those reported by Signor and Barbiani (2013).

Table 3: Influence of N application rate from U, SCU, PGCU and BCU fertilizers on seeds quality of maize.

Fertilizers	Rate (kg N/fed.)	P	K	Protein	Carb.	Oil	P	K	Protein	Carb.	Oil
		(%)									
		2012					2013				
U	80	0.29	1.64	9.29	67.77	4.79	0.27	1.80	9.25	71.91	5.14
	100	0.33	1.77	10.25	69.86	5.19	0.31	1.95	10.44	75.98	5.57
	120	0.34	1.92	11.02	71.87	5.34	0.32	2.11	11.17	77.50	5.70
SCU	80	0.33	1.93	11.46	72.61	4.92	0.35	2.12	12.00	78.23	5.28
	100	0.34	2.06	11.73	73.88	5.95	0.36	2.27	12.54	80.15	5.64
	120	0.35	2.20	12.36	76.79	6.11	0.37	2.42	13.77	83.53	6.17
PGCU	80	0.29	1.72	10.00	69.33	4.83	0.28	1.89	10.40	75.89	5.18
	100	0.33	1.86	10.4	71.34	5.20	0.29	2.05	10.98	76.31	5.58
	120	0.34	1.94	11.09	73.34	5.60	0.29	2.18	11.29	77.99	5.93
BCU	80	0.33	1.84	10.09	70.99	4.88	0.28	2.02	11.10	76.50	5.24
	100	0.34	1.93	11.19	72.90	5.38	0.31	2.13	11.31	78.32	5.77
	120	0.35	2.03	11.63	74.06	5.80	0.32	2.23	12.42	79.19	6.08
LSD $_{0.05}$		ns	ns	0.40	ns	0.12	ns	ns	ns	ns	ns
Mean of main effect											
Fertilizer type	U	0.31	1.78	10.19	69.83	5.11	0.30	1.95	10.28	75.13	5.47
	SCU	0.34	2.04	11.85	74.43	5.66	0.36	2.27	12.77	80.63	5.70
	PGCU	0.31	1.84	10.5	71.34	5.21	0.29	2.04	10.89	76.73	5.56
	BCU	0.34	1.94	10.97	72.65	5.35	0.31	2.13	11.61	78.00	5.70
LSD $_{0.05}$		0.02	0.04	0.36	1.44	0.05	0.01	0.04	0.69	1.83	0.08
Rate (kg/fed.)	80	0.31	1.78	10.21	70.18	4.85	0.30	1.96	10.69	75.63	5.21
	100	0.33	1.91	10.89	71.99	5.43	0.32	2.10	11.32	77.69	5.64
	120	0.34	2.03	11.52	74.02	5.71	0.33	2.24	12.16	79.55	5.97
LSD $_{0.05}$		0.02	0.04	0.20	1.08	0.06	0.02	0.04	0.60	1.00	0.09

Phosphorus = P Potassium = K Total carbohydrates = Carb.

2. Soybean:

Data presented in Table (4) clearly show that all treatments of slow release fertilizers significantly increased plant height of soybean in both seasons. The maximum increase in plant height in both seasons was recorded when the plants were fertilized with SCU over the control by (14 and 15 cm) in the1st and 2nd seasons, respectively. However, the interaction effect was non-significant for all treatments in both seasons. Comparing the slow release fertilizer forms the data also revealed that SCU surpassed BCU and PGCU with significant differences among them in both seasons. These results are in accordance with those obtained by El-Tohamy *et al*., (2009) and Zhang *et al*., (2002).

Data in Table (4) revealed that all treatments significantly increased weight of seeds per plant in both seasons. The increases in weight of seeds per plant due to SCU treatment were (14.15 % and 14.17 %) over the control in both seasons. However, the interaction effect was non-significant for all treatments in significant for all treatment in second season and it was first season.

From the same table, the data indicate that SCU surpassed BCU and PGCU in seed yield/plant with significant differences in the first and the second seasons. In this concern Mo *et al*., (1991) and Zhang *et al*., (2002) found that slow release fertilizers application increased the weight of grains per plant.

It is revealed from Tables (4) that the seed index was positively affected by SCU, BCU and PGCU treatments in both seasons. Fertilizer treatments of SCU, BCU and PGCU significantly increased the average of 100-seed weight of soybean in both seasons. However, the interaction effect was significant for all treatments in the both seasons. The increases over the control due to SCU treatment was (7.10 % and 7.06 %) in the first and second seasons, respectively. It is worthy to note that SCU significantly exceeded 100-seed weight than the other coated forms differences in both seasons. These data agreed with the findings of Salvagiotti *et al*., (2009).

Data of seed yield/fed. of soybean as affected by SCU, BCU and PGCU are given in Table (4). The obtained results revealed that all treatments with SCU, BCU and PGCU significantly increased soybean yield of seeds/fed. in both seasons. It is clear that SCU significantly surpassed BCU and PGCU in this respect in both seasons. The highest increases of seeds yield/fed. were obtained by SCU ((16.38% and 16 %) over the control treatment in both seasons respectively. However, the interaction effect was non-significant in both seasons respectively for all treatments. The increases over the control due to SCU treatment was (0.19 and 0.20 ton) in the first and second seasons, respectively. It is worthy to note that the increase in seed yield could be mainly attributed to the increase in the weight of seeds per plant and partially in weight of 100 seed. The present findings are in accordance with those reported Mo *et al*., (1991) and El-Tohamy *et al*., (2009) and Zhang *et al*., (2002).

Data in Table (4) revealed that all treatments significantly increased straw yield /fed. in both seasons. The increases of straw yield due to SCU treatment were (18.31 and 18.93 %) over the control in the first and second seasons, respectively. However, the interaction effect was non-significant at all the treatments in both seasons. In this concerning, El-Tohamy *et al*., (2009) found that slow release fertilizers application increased the weight of straw yield.

Data of rates the soybean as affected by SCU, BCU and PGCU are given in Table (4). There were gradual increases in growth characters i.e., plant height, seed yield/plant, 100-seed weight, seed yield/fed. and straw yield/fed. as fertilizer rate increased from 20, 40 or 60 kg N/fed.

Table 4: Influence of N application rate from U, SCU, PGCU and BCU fertilizers on yield and yield components of soybean.

Fertilizers	Rate (kg N/fed.)	Plant height (cm)	Seed weight /plant (g)	100-Seed weight (g)	Seed yield/fed. (ton)	Straw yield/fed. (ton)	Plant height (cm)	Seed weight /plant (g)	100-Seed weight (g)	Seed yield/ fed. (ton)	Straw yield/ fed. (ton)
		2012					2013				
U	20	104.00	14.53	14.98	0.94	1.95	112.00	15.54	16.03	1.01	2.23
	40	114.00	17.60	15.05	1.15	2.07	122.00	18.83	16.11	1.24	2.37
	60	123.00	21.09	15.21	1.40	2.36	132.00	22.56	16.27	1.50	2.70
SCU	20	121.00	17.21	15.87	1.12	2.18	129.00	18.42	16.99	1.22	2.49
	40	127.00	20.66	16.26	1.38	2.59	135.00	22.11	17.40	1.48	2.97
	60	137.00	22.86	16.32	1.55	2.80	146.00	24.47	17.46	1.66	3.20
PGCU	20	116.00	15.05	14.89	0.99	1.96	124.00	16.11	15.93	1.05	2.25
	40	122.00	17.44	15.11	1.16	2.21	130.00	18.67	16.17	1.23	2.53
	60	127.00	21.66	15.45	1.47	2.41	136.00	23.18	16.53	1.57	2.76
BCU	20	117.00	16.22	15.37	1.06	2.14	125.00	17.36	16.45	1.15	2.44
	40	124.00	18.05	15.42	1.21	2.34	132.00	19.32	16.50	1.29	2.68
	60	132.00	22.60	15.60	1.51	2.55	141.00	24.19	16.69	1.63	2.91
$LSD_{0.05}$		ns	ns	0.18	ns	ns	ns	1.12	0.20	ns	ns
Fertilizer type	U	114.00	17.74	15.08	1.16	2.13	122.00	18.98	16.14	1.25	2.43
	SCU	128.00	20.25	16.15	1.35	2.52	137.00	21.67	17.28	1.45	2.89
	PGCU	122.00	18.05	15.15	1.20	2.19	130.00	19.32	16.21	1.29	2.51
	BCU	124.00	18.96	15.46	1.26	2.34	133.00	20.29	16.55	1.36	2.68
$LSD_{0.05}$		3.00	0.60	0.16	0.05	0.33	3.00	0.64	0.17	0.04	0.38
Rate (kg/fed.)	20	114.00	15.75	15.28	1.03	2.06	122.00	16.86	16.35	1.11	2.35
	40	122.00	18.44	15.46	1.22	2.31	130.00	19.73	16.54	1.31	2.64
	60	130.00	22.05	15.64	1.48	2.53	139.00	23.60	16.74	1.59	2.89
$LSD_{0.05}$		3.00	0.61	0.09	0.04	0.18	4.00	0.65	0.10	0.04	0.20

Chemical constituents:

Results in Table (5) indicate that all adopted treatments of SCU, BCU and PGCU showed positive statistical effect on seed phosphorus and potassium percentage of the soybean in both growing seasons. However, the interaction effect was non-significant at all the treatments in the both seasons. The present findings are in accordance with those reported by Zhang *et al*., (2002). In this concern, El-Tohamy *et al*., (2009) reported that application of slow release fertilizers increased the phosphorus percentage in seeds of bean. Mo *et al.,* (1991) found that application of slow release fertilizers increased the percentage of phosphorus in seeds of soybean.

It is realized from Table (5) that SCU, BCU and PGCU treatments significantly increased grain crude protein percentage of soybean seeds under investigation in both studied seasons. The highest percentage of seeds crude protein was recorded with SCU in both seasons being (6.11 and 11.13 %) more than the control treatment in the first and second season; respectively. However, the interaction effect was non-significant at all the treatments in both seasons.

In this concern, El-Tohamy *et al*., (2009) reported that application of slow release fertilizers increased the percentage of crude protein in seeds of bean. Mo *et al*., (2009) found that application of slow release fertilizers increased the percentage of crude protein in seeds of soybean

Data in Table (5) clearly show that all treatments of SCU, BCU and PGCU significantly increased total carbohydrates and oil of the under investigation in both seasons. The maximum increase in the total carbohydrates in both seasons recorded by SCU over the control by (9.82 %) and (10.99 %) in the first and second seasons, respectively. However, the interaction effect was non-significant for total carbohydrate but it was significant for oil percentage in both seasons. Data also revealed that SCU significantly surpassed PGCU and BCU in carbohydrate and oil contents in both seasons, except BCU in carbohydrates contents in the second season. These results are in accordance with those obtained by

Salvagiotti *et al*., (2009) and Zhang *et al*., (2002).The present findings are in accordance with those reported by Mo *et al.,* (1991).

Generally, application of the slow release nitrogen fertilizers to maize and soybean plants caused an increase in 100-grain weight, grain yield, straw yield, oil %, crude protein % and total carbohydrates. The results may be due to the beneficial effect coating material on plant which regulation of nutrient release and enhancement the nitrogen use efficiency by plant than uncoated fertilizers and reducing N leaching losses and provide a constant supply of nutrients to the root. This approach also provides an efficient way of applying nitrogen to such soils to increase the efficiency of N application and the minimize leaching as well as to prevent environmental pollution by the excess nitrogen in the soil. Moreover, apart from the genetic constitution, the physiological factors such as inefficient partitioning of assimilates, poor pod setting, excessive flower abscission and lack of nutrients during the critical stages of soybean growth were found to be some of the yield barriers of soybean (Alberta and Bower, 1983; Promila Kumari and Varma, 1983) and nutrients play a pivotal role in increasing the seed yield in pulses. In the present study, it was revealed that the application of slow release fertilizers significantly increased the plant height, 100-seed weight and finally seed yield per plant which are the most important yield determining components in maize and soybean.

Table 5: Influence of N application rate from U, SCU, PGCU and BCU fertilizers on seeds quality of soybean.

Fertilizers	Rate (kg N/fed.)	P	K	Protein	Carb.	Oil	P	K	Protein	Carb.	Oil
		(%)									
		2012					2013				
U	20	0.42	1.70	24.71	29.99	19.94	0.48	1.87	25.17	30.22	20.61
	40	0.44	1.85	26.00	31.35	21.69	0.55	2.04	26.75	31.25	22.41
	60	0.47	2.01	26.90	33.70	23.01	0.56	2.20	29.48	35.43	23.77
SCU	20	0.56	2.00	26.55	33.11	22.73	0.51	2.20	27.9	33.00	23.48
	40	0.63	2.17	27.08	34.93	23.53	0.57	2.35	29.75	35.28	24.31
	60	0.68	2.33	28.71	36.34	23.84	0.67	2.52	32.81	39.28	24.63
PGCU	20	0.47	1.79	25.50	28.99	20.68	0.52	1.97	26.46	28.20	21.37
	40	0.52	1.94	25.85	31.68	21.34	0.53	2.13	28.04	31.59	22.05
	60	0.55	2.05	26.54	32.95	23.39	0.56	2.25	28.42	32.13	24.17
BCU	20	0.50	1.91	26.42	30.40	22.31	0.53	2.10	28.79	32.30	23.06
	40	0.52	2.01	26.13	33.42	22.77	0.55	2.21	30.04	35.72	23.53
	60	0.53	2.11	27.11	34.50	23.25	0.59	2.36	30.65	36.32	24.03
$LSD_{0.05}$		ns	ns	ns	ns	0.53	ns	ns	ns	ns	0.54
Mean of main effect											
Fertilizer type	U	0.44	1.85	25.87	31.68	21.55	0.53	2.04	27.13	32.30	22.26
	SCU	0.63	2.17	27.45	34.79	23.36	0.56	2.36	30.15	35.85	24.14
	PGCU	0.51	1.93	25.97	31.21	21.80	0.54	2.12	27.64	30.64	22.53
	BCU	0.52	2.01	26.55	32.77	22.78	0.55	2.21	29.83	34.78	23.54
$LSD_{0.05}$		0.06	0.04	2.03	1.09	0.19	0.06	0.04	2.35	1.26	0.20
Rate (kg/fed.)	20	0.49	1.85	25.79	30.62	21.42	0.51	2.04	27.08	30.93	22.13
	40	0.53	1.99	26.27	32.85	22.33	0.55	2.18	28.65	33.46	23.07
	60	0.56	2.13	27.31	34.38	23.37	0.59	2.32	30.34	35.79	24.15
$LSD_{0.05}$		0.04	0.03	1.46	0.83	0.26	0.03	0.04	1.51	1.38	0.27

Conclusion:

Slow release nitrogen fertilizers such as SCU, BCU and PGCU improved the quantity and quality of maize and soybean. The obtained results of both crops indicate that it seems that soybean is more responsive to the different coated urea forms than that occurred by maize especially SCU. All forms of coated urea increased grain or seed yields by 4-10 % for maize and 3-16 % for soybean. Also it can be noticed that application of SCU at 80 kg/fed. to maize could effectively produce similar or more than that obtained by 100 kg N/fed. applied in the form of uncoated urea. Similarly, such tendency was true for soybean when SCU was applied at 20 kg N/fed. soybean plants could effectively produce equal or better seed yield than the plants were fertilized with 40 kg N/fed. Therefore, such results indicate the potentiality of reducing application rates for both crops by 20 kg N/fed. units if the coated forms of urea were adopted than the uncoated urea.

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