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Yield and Quality of Maize (*Zea mays* L.) As Affected by Slow-Release Nitrogen in Newly Reclaimed Sandy Soil

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Abstract: Two field trials were implemented during 2003 and 2004 summer seasons at private farm, Al-Nagah village, South El-Tahrir Province, El-Behiera Governorate, Egypt to study the response of maize (*Zea mays* L.) plants var. (Single-cross 10) to different levels of slow-release N (60, 80, 100 kg fed^{-1}) as (Enciabien 40%) and 120 kg N fed^{-1} as urea (46% N) as a control treatment in newly reclaimed sandy soils. The results showed that ear length, grains number and weight/row, 100-grain weight, grain and biological yield (ton/fed) of maize plants were significantly affected by increasing rates of slow-release N fertilizer treatments. Maize grown in soil amended with 100 kg N fed^{-1} as a slow-release gave the highest values in all studied traits compared with the control (fertilization with urea), which gave the lowest. Also, the application of slow-release fertilizers increased the concentration of NPK, protein and oil in grains compared with the control. Increasing the rate of slow-release nitrogen from 60 to 100 kg fed^{-1} significantly increased the above mentioned characters. Also, the results indicated that, maize plant received slow-release nitrogen caused an increase in N uptake either before or after silking compared with control treatment.

Key words: Maize · slow-release N · urea · yield · grain quality · sandy soil

INTRODUCTION

Maize (*Zea mays* L.) is one of the most strategically crop in Egypt, to overcome the increasing requirement from maize grain for bread industry (20% mixed with wheat flour to reduce the imported quantity of wheat), animal and poultry feeding as well as many industrial purposes.

Growing maize on the newly reclaimed area of Egypt is faced by various problems, the most important of these is the leaching of the applied fertilizer N resulted in reduced the uptake efficiency of the applied N by the target crop and is an agricultural and environmental problem.

Great efforts have been made by Egyptian scientists to improve maize productivity by increasing the efficiency of adding fertilizers by controlling the release or minimizing loss of nutrients. Nitrogen leaching from sandy soils is especially troublesome in the arid regions. In order to decrease N leaching in these environments, farmers use split N application, utilize slow-release fertilizers, incorporate soil treatments such as organic manure and sowing a stay green hybrid which had greater yields and took up more N. Paramasivam and Alva [1] reported that N losses from the soil could be controlled by coating soluble fertilizer with insoluble materials, thereby reducing its solubility and release into the soil. Amans and Slangen [2] stated that growth, yield and nitrogen concentration of onions were increased with controlled-release fertilizer applied. Scott Perin *et al.* [3] showed that amending sandy soil with slow release N can reduce N leaching, increase plant growth and increase N concentration in sweet corn. El-Kramany [4] showed that, the use of slow-release nitrogen fertilizer gave the highest 1000-grain weight, grain yield/plant, grain yield/fed. and grain nitrogen and protein content of wheat plants compared to the other nitrogen sources.

Slow-release fertilizers are excellent alternative to soluble fertilizers. Because nutrients are released at a slower rate throughout the season, plants are able to take up most of the nutrients without waste by leaching. A slow-release fertilizer is more convenient, since less frequent application is required. Fertilizer burn is not problem with the slow-release fertilizers even at high rate of application.

Therefore the present work was carried out to investigate the effect of slow-release N fertilizer levels on yield and nutrient uptake of maize plant.

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MATERIALS AND METHODS

Two field experiments were carried out at private farm, Al-Nagah village, South El-Tahrir Province, El-Behiera Governorate, Egypt during two successive summer growing seasons of 2003 and 2004 to study the response of maize (*Zea mays* L.) plants var. (Single-cross 10) to different levels of slow-release N fertilizers in newly reclaimed sandy soils. The soil texture of the experimental site was sandy, sand 94.70%, silt 4.30%, clay 1.00%, pH 8.20, organic matter 1.08%, $CaCo_3$ 2.90%, EC 0.06 mmhos cm^{-3} and available total N, P and K were 4.00, 1.85 and 6.20 mg 100 g^{-1} soil according to Chapman and Pratt [5]. The treatments were arranged in Randomized Complete Block Design with four replicates. The plot size was 3×3.5 m^2. Each treatment received 60 kg P_2O_5 as single super phosphate and 100 kg K_2O/fed as potassium sulphate as a soil application before sowing.

Nitrogen fertilizers treatments as follows:

130 kg N fed^{-1} as urea (46% N) (Control)
60 kg N fed^{-1} as slow-release N
80 kg N fed^{-1} as slow-release N
100 kg N fed^{-1} as slow-release N

Slow-release N doses were applied at sowing, while urea divided into three equal doses, which applied at 15, 45 and 60 days from sowing. Slow-release N fertilizers (Enciabien 40% N) obtained from the General Organization for Agricultural Equalization Fund (G.O.A.E.F.), Egypt.

Random samples of ten guarded plants in each plot were taken at harvest to estimate the following characters: Ear length (cm), number of rows/ear, number of grains/row, weight of grains/ear (g) and 100-grains weight (g). Also at harvest time the inner three ridges were taken from each plot for determining the grain and biological yields (ton / fed.).

Chemical analysis: Five flag leaves during tassling period were taken from each plot to estimate pigment content (chlorophyll a and b) according to the method of Von Wettestein [6]. The micro-kjeldahl method was used to determine the total nitrogen content according to A.O.A.C. [7], P was determined by spectrophotometer and K by flame photometer according to Jackson [8]. The method used for the extraction of oil content in grain was essentially similar to that described by Meara [9].

Statistical analysis of data: Recorded data were analysed using MSTAT-C software. A combined analysis of the two summer seasons was made and the treatments mean were compared by LSD at 5% probability according to Gomez and Gomez [10].

RESULTS AND DISCUSSION

Data presented in Table 1 clearly indicate that ear length, grains number and weight/ear, 100-grain weight, grain and biological yield (ton/fed) of maize plants were significantly affected by increasing rates of slow-release N fertilizer treatments.

Maize grown in soil amended with 100 kg N fed^{-1} as a slow-release N fertilizer gave the highest values in all studied traits compared with the control (fertilization with urea), which gave the lowest. These results may be due to that sandy soil is very low water-holding capacity and high nutrient leaching losses. Flower and Brydon [11] stated that, when urea fertilizers are applied to the surface without incorporation, losses of fertilizer N as NH_3 can exceed 40% and generally greater with increasing temperature, soil pH and surface residue. Hanafi *et al.* [12] reported that the uncoated compound fertilizer such as urea gave significantly higher amounts of nutrients loss compared to slow-release N fertilizer. Ranu and Johnson [13] reported that, when fertilizer N is applied at rates in excess of that needed for maximum yield in cereal crops, NO_3 leaching can be increased. El-Kramany [4] found that, slow-release nitrogen fertilizer gave the highest 1000-grain weight, grain and biological yield/fed of wheat. Yerokun [14] reported that increasing nitrogen supply up to 134 kg N ha^{-1} improved maize yield. who also suggested that maize responded to cogranulated urea and urea phosphate than urea. Khedr [15] reported that grain yield, grain yield/ear, ear length, number of grains/row and 100-grain weight of maize gradually increased as rate of nitrogen was increased up to 120 kg fed^{-1}.

Data in Table 2 show that the application of slow-release fertilizers increased the concentration of NPK, protein and oil in grains compared with the control treatment. Increasing the rate of slow-release nitrogen from 80 to 100 kg fed^{-1} gave significantly increased in the above mentioned characters in comparison to the treatment received 60 kg N as slow-release or control treatment. These results could be attributed to the beneficial effect of coating material on plant which regulation of nutrient release and enhancement the nitrogen use efficiency by plants than the uncoated fertilizers and reducing-N leaching losses and provide a constant supply of nutrients to the root. El-Aila *et al.* [16] found that, addition of slow-release nitrogen gave the

Table 1: Effect of different levels of slow-release nitrogen and urea fertilizers on yield and yield components of maize (combined data over two seasons)

Fertilizer treatments	Ear length (cm)	No. of rows/ear	No. of grains/row	Grain wt/ear (g)	100 grains wt (g)	Grain yield (ton/fed)	Bio. yield (ton/fed)
Control							
(120 kg N fed^{-1}) as urea 46%)	18.00	12.00	41.30	158.40	27.49	2.93	5.52
60 kg N fed^{-1} (as slow release N)	19.13	13.00	47.50	168.10	31.81	3.34	6.51
80 kg N fed^{-1} (as slow release N)	21.13	13.00	50.50	194.20	33.49	3.98	6.75
100 kg N fed^{-1} (as slow release N)	21.13	13.50	51.30	242.60	34.59	4.23	7.98
LSD 5%	1.01	NS	6.97	27.88	4.16	0.41	0.89

Table 2: Effect of different levels of slow-release nitrogen and urea fertilizers on chlorophyll a and b, grain quality and N uptake after and before sillking (combined data over two seasons)

	Chlorophyll (mg g^{-1})		Grain (%)					N uptake (kg fed^{-1})	
Fertilizer treatments	a	b	Oil	Protein	N	P	K	Before silking	After silking
Control									
(120 kg N fed^{-1}) as urea 46%)	0.67	0.79	9.90	7.75	1.24	0.37	3.70	60.90	23.10
60 kg N fed^{-1} (as slow release N)	0.86	1.03	10.05	8.25	1.32	0.45	3.95	66.78	27.72
80 kg N fed^{-1} (as slow release N)	0.99	1.20	10.60	9.00	1.44	0.48	4.20	83.16	29.82
100 kg N fed^{-1} (as slow release N)	1.03	1.32	11.90	9.37	1.50	0.54	4.53	99.46	37.38
LSD 5%	0.08	0.10	0.38	0.27	0.36	0.12	0.52	10.50	3.72

highest value of NPK concentration than urea. Wuerst and Cassman [17] found that grain protein was increased by about 0.75% when slow-release nitrogen were added compared with urea. Lewis *et al.* [18] found that slow-release nitrogen caused an increased radish N uptake by tops and decreased NO_3 leaching by 30% compared with ammonium sulphate. Amans and Slangen [2] found that N concentration of onions was increased with a controlled-release N fertilizer applied.

Table 2 also indicated that, maize plant with slow-release nitrogen caused an increase in N uptake either before or after silking compared with control uncoated urea. Results also revealed that maize grow in sandy soil treated with slow-release took up more N by (9.65, 36.55 and 63.32%) before and (20.00, 29.10 and 61.82%) after silking compared with the control treatment. Results indicated that the use of slow-release nitrogen is an important trait to reduce nitrite leaching under high N application and less pollution of ground water compared with uncoated urea. Scott Perin *et al.* [13] concluded that, use of slow-release N fertilizer minimizes N leaching from sandy soils while sustaining normal plant growth. Wang and Alva [19] demonstrated that the amounts and forms of fertilizer N leached from sandy soils depend on the solubility of the fertilizer and the soil type. William and Gordon [20] reported that when urea fertilizers are applied to the surface without incorporation, loss of fertilizer N as NH_3 can exceed 40% and generally greater with increasing temperature, soil pH and surface residue. Fenn and Hossner [21] reported that excess nutrient supply resulting from application of conventional fertilizers may result in a high concentration of soluble salts in the root zone. This may induce problems such as osmotic stress, specific injuries to plant at different growth stages or undesired development such as lodging and decrease yield.

CONCLUSIONS

From the previous results it could be concluded that, application of nitrogen fertilizer as slow-release nitrogen improved quantity and quality of maize yield as compared to urea. Application slow-release nitrogen to maize plants (single cross 10) caused an increase in N uptake either before or after silking compared with control uncoated urea. These results could be attributed to the beneficial effect of coating material on plant which regulation of nutrient release and enhancement the nitrogen use efficiency by plants than the uncoated fertilizers and reducing-N leaching losses and provide a constant supply of nutrients to the root. So, using nitrogen fertilizer as slow-release in newly reclaimed sandy soil is considered suitable source for fertilize the maize and safe in environment.

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