Effect of Mineral and Nano Nitrogen Fertilizers on Yield and Yield Components of Some Yellow Maize Hybrids

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Abstract

Two field experiments were conducted at the Experiment and Research Center, Fac. Agric., Moshtohor, Benha Univ., during 2018 and 2019 summer seasons. The aim of this was to study response of three yellow maize hybrids (SC 2055, SC 176 and SC P3737) to three N fertilizer rates (60, 90 and 120 kg N fed^{-1}) and two Nano-N foliar applications (Without and Nano foliar applications). The experimental design was randomized complete block design (RCBD) using split split-plots arrangement with three replications. The yellow maize hybrids, N fertilizer levels and Nano-N foliar applications were arranged at random in the main plots, sub- plots and sub sub-plots, respectively. Single Cross P3737 was significantly earlier than the other hybrids regarding 50% tasseling and silking. Also, SC P3737 was superior to the other two hybrids in most of the studied traits. The highest values of plant height, ear length, ear diameter, No. grains row^{-1}, ear weight, ear grains weight, 100-grain weight, Forge yield fed^{-1} and grain yield fed^{-1} were obtained with fertilizer level of 120 N fed^{-1}. On the other hand, the earliest tasseling and silking were recorded with 60kg N fed^{-1}. Nano foliar application gave the greatest of all grain yield and attributes of yellow maize hybrids as compared with untreated. It could be concluded that under the conditions of the experiment, planting SC P3737 under 90 or 120 N fed^{-1} and nano foliar application is recommended.

Key Words: *Yellow maize hybrids, N application rates, N Nano chitosan, growth, Yield and yield components.*

Introduction

Maize (*Zea mays* L.) is one of the most important strategic crops in Egypt and the world, and it ranks third order after wheat and rice crops in the cultivated area and productivity. The Egyptian policy aims to increase yellow maize production to face the large demand in order to minimize its imports through breeding for high yielding hybrids. This could be achieved by using high yielding hybrids and fertilization. The productivity of grain crops, including maize, is greatly influenced by the availability and abundance of the essential nutrients N necessary for plant growth and production.

In this connection, maize hybrids differ in grain yield and yield attributes as reported by **Mehasen and Ahmed (2009); Mehasen and El-Gizawy (2010); El-Badawy and Mehasen (2011), Kandil, (2013), Eivazi and Habibi (2013), Gomaa, *et al,* (2017), Nassar, *et al,* (2017), Awdalla, *et al* (2018), AL-Shumary *et al,* (2019), Khalil, *et al* (2019), and Afolabi, *et al,* (2020).**

Several researchers reported that nitrogen is the most limiting factor to increase maize grain yield and its components. They found that plant height, ear length, No. of grains row^{-1}, ear weight, ear grain weight, 100-grain weight, forge yield fed^{-1} and grain yield fed^{-1} of maize were increased by increasing nitrogen level (**Akmal *et al,* 2010, Ali *et al*, 2011; Moraditochaee *et al,* 2012, Kandil, 2013, Sime and Aune, 2014, Bilal, *et al*, 2016, Nassar, *et al,* 2017, Khalil, *et al,* 2019 and Afolabi, *et al,* 2020).**

Therefore, it is necessary to use the best modern techniques to supply the plant with nutrients. These techniques include using nano fertilizers, balanced N nano fertilizer and adding them either by spraying the total vegetative. Nanotechnology can provide the solution to increasing the value of agricultural products and overcome environmental problems by using fertilizers with nanoparticles with sizes (1-100 nanometers). Thus we can control the release of mineral elements added as fertilizers, the basis of the work of nano fertilizers is the rapid supply of nutrients and increase the duration of the fertilizer effect. Consequently, many workers came to reported that nano fertilizers is the most limiting factor to increase maize grain yield and yield attributes (**Fan *et al,* 2012, Kandil 2013, Awadalla and Morsy 2016, Ahmad *et al,* 2018 and Emara *et al,* 2018, Al-Saray and Al-Rubaee, 2019, AL-Shumary *et al,* 2019, Khalil *et al,* 2019 and AL-Gym and Al-Asady, 2020**).

The present investigation aimed to study the effect of mineral and nano nitrogen fertilizers on yield and its attributes for yellow maize hybrids grown on a clay soil in Kalubia Governorate.

Materials and Methods

Two field experiments were carried out in the Experimental Field of the Faculty of Agriculture at

Mashtohor, Benha Univ., during 2018 and 2019 seasons, to study the effect of three N fertilizer levels (60, 90 and 120 kg N fed^{-1}) and two Nano-N foliar applications (Without and Nano foliar applications) on yield and yield attributes for three yellow maize hybrids (SC 2055, SC 176 and SC P3737). Maize hybrids namely SC 2055 was developed by haytic Company, SC 176 was developed by maize Depart. Research, ARC and SC P3737 was developed by Pioneer Company. The soil was clay in texture with a PH value of 7.95 and 7.92 and an organic matter content of 1.72 and 1.73% and available N of 51 and 52 ppm during the first and second seasons, respectively. The experimental sites were preceded by wheat in the two seasons.

The experimental design was randomized complete block design (RCBD) using split split-plots arrangement with three replications. The three yellow maize hybrids were arranged at random in the main plots, the sub- plots were assigned random by to three N fertilizer levels and the two Nano-N foliar applications were arranged random by in the sub sub-plots. The sub sub-plot area was 10.5 m^2 (1/400 fed) consisting of 5 ridges, 3.5 m long and 70 cm width while, the distance between plants was 25 cm. Planting date was May27th and 24th in 2018and 2019 seasons, respectively. Nitrogen levels in the form of urea 46% N were applied in two split applications before the first and second irrigations. Nano Fab Technology was used as Nano fertilizer obtained from the company. It contained N (5%) and inert ingredients (95%). Physical and chemical properties are colorless, liquid and urea nitrogen source. The average of nanoparticles was 15.02 g•mol^{-1}. Maize plants were sprayed twice with the aqueous solution of nano-N applications (Chitosan) at 30th and 45th days after planting, while control plants were sprayed with tap water. All other cultural practices were applied as recommended for this region in both seasons.

Days to 50% tasseling and silking were recorded. Plant height (cm) was measured after 85 days from planting as an average of 10 plants. At harvest, the following data were recorded on 10 individual plants at random: Ear length (cm), No. grains row^{-1}, ear weight (g), grains ear weight (g) and 100-grain weight (g). Forge yield (ton fed^{-1}) and grain yield (kg fed^{-1}) on whole plot basis and adjusted to 15.5% grain moisture content.

Analysis of variance was done for the data of each season by **Snedecor and Cochran (1980)** using the MSTAT-C Statistical Software package (**Michigan State University, 1983**). Mean comparisons were done by least significant difference (LSD) test at the 0.05 level of significance.

Results and Discussion

-Effect of maize hybrids:

The results reported in Table 1 indicate clearly that, there were significant differences among yellow maize hybrids in all studied traits in the first and second seasons. SC P3737 hybrid gave the highest values of plant height, ear length, No. grains row^{-1}, ear weight, grains ear weight, 100-grain weight, forge yield fed^{-1} and grain yield fed^{-1} compared with the other hybrids in both seasons. In addition, SC P3737 hybrid was significantly the earliest in tasseling and silking date compared with the other hybrids in the first and second seasons except tasseling date in the second season. Such results could be attributed to differences in the genetic constitution of the tested hybrids. The increase in grain yield fed^{-1} might be due to superiority in ear length, No. grains row^{-1}, ear weight, grains ear weight, and 100-grain weight grain as shown in Table (1). These results are in harmony with those obtained by **Mehasen and Ahmed (2009); Mehasen and El-Gizawy (2010); El-Badawy and Mehasen (2011), Kandil, (2013), Eivazi and Habibi (2013), Gomaa, *et al,* (2017), Nassar, *et al,* (2017), Awdalla, *et al* (2018), Khalil, *et al,* (2019), and Afolabi, *et al,* (2020).**

Table 1. Yield and its attributes of yellow maize as affected by hybrids in 2018 and 2019 seasons

Characters	2018 season			LSD at 5%	2019 season			LSD at 5%
	SC 2055	SC 176	SC P3737		SC 2055	SC 176	SC P3737	
No. days to 50% tasseling	55.22	58.88	51.44	0.73	54.00	57.27	49.88	3.31
No. days to 50% silking	58.05	61.55	54.66	1.48	57.16	60.66	53.38	0.70
Plant height (cm)	226.3	190.9	235.9	16.5	280.1	263.2	281.9	6.1
Ear length (cm)	18.68	16.30	19.72	NS	19.17	18.31	21.12	NS
No. grains row^{-1}	38.76	33.58	43.80	1.13	38.92	36.00	46.05	4.93
Ear weight (g)	209.33	193.72	216.83	5.57	213.38	196.50	219.38	4.91
Grains ear weight (g)	161.94	148.00	177.44	5.26	166.38	150.94	177.83	3.61
100–grain weight (g)	34.44	32.50	39.44	1.71	36.55	34.00	41.11	1.70
Forge yield (ton fed^{-1})	24.44	20.50	26.22	1.08	25.77	21.50	27.00	1.74
Grain yield (kg fed^{-1})	2586.11	2162.8	2763.9	54.6	2661.7	2259.4	2822.8	81.1

NS=No significance

-Effect of Nitrogen Fertilizer:

Data in Table 2 show that mean values of yield and yield attributes in both seasons were significantly increased by increasing N levels up to 120 kg N fed[-1]. The highest values of tasseling and silking date, plant height, ear length, No. grains row[-1], ear weight, grains ear weight, 100-grain weight, forge yield fed[-1] and grain yield fed[-1] in the first and second seasons were obtained with fertilizer level 120 kg N fed[-1]. There were significant responses to nitrogen with characters asserting the vital need for N application to maize production in this soil. The increases in yield and components may be due to the increases in the growth characters and indirectly affected by N general functions in plant. Furthermore, the increase in grain yield/fed is attributed mainly to the increases in yield components. The adding of nitrogen of great importance in increasing vegetative growth and thus increasing the activity of photosynthesis and thus the accumulation of dry matter in the grain and its role in prolonging the period of full-grain and delaying senescence of leaves (**Otung, 2014**). The results of this experiment agree with those obtained by **Akmal** *et al,* **2010, Ali** *et al,* **2011; Moraditochaee** *et al,* **2012, Kandil, 2013, Sime and Aune, 2014, Bilal,** *et al,* **2016, Nassar,** *et al,* **2017, Khalil,** *et al,* **2019 and Afolabi,** *et al,* **2020.**

Table 2. Yield and its attributes of yellow maize as affected by N fertilizer rates in 2018 and 2019 seasons

Characters	2018 season			L.S.D at 5%	2019 season			L.S.D at 5%
	60	90	120		60	90	120	
No. days to 50% tasseling	54.05	55.00	56.50	0.54	53.00	53.94	54.22	NS
No. days to 50% silking	56.55	57.77	59.94	1.38	55.38	57.27	58.55	1.58
Plant height (cm)	208.42	218.94	225.78	7.67	266.50	277.50	281.27	4.69
Ear length (cm)	17.19	18.54	18.97	0.62	18.95	19.45	20.21	NS
No. grains row[-1]	36.57	38.95	40.61	1.20	37.26	41.25	42.45	2.25
Ear weight (g)	189.11	208.88	221.88	3.59	193.27	209.94	226.05	2.25
Grains ear weight (g)	145.33	164.88	177.16	5.71	146.38	165.66	183.11	3.18
100–grain weight (g)	30.77	35.66	39.94	1.45	32.55	37.61	41.50	1.89
Forge yield (ton fed[-1])	21.16	23.94	23.94	1.04	22.27	24.88	27.11	1.10
Grain yield (kg fed[-1])	1982.2	2558.3	2972.2	39.6	2042.8	2656.7	3044.4	64.8

NS=No significance

-Effect of Nano foliar application:

Results in Table 3 show in general that nearly all maize characters were significantly affect by nano foliar application treatment in both seasons except No. days to 50% tasseling and 100-grain weight in the second season. However, nano foliar application treatment increased significantly in silking date, plant height, ear length, No. grains row[-1], ear weight, grains ear weight, 100-grain weight, forge yield fed[-1] and grain yield fed[-1] in the two seasons, tasseling date and 100-grain weight in the first season only. The following sequence of treatments (nano foliar application treatment) was displayed with respect to yield and yield attributes. The results of this experiment agreed with (**Fan** *et al,* **2012, Kandil 2013, Awadalla and Morsy 2016, Ahmad** *et al,* **2018 and Emara** *et al,* **2018, Al-Saray and Al-Rubaee, 2019, AL-Shumary** *et al,* **2019, Khalil** *et al,* **2019 and AL-Gym and Al-Asady, 2020**).

Table 3. Yield and its attributes of yellow maize as affected by Nano-N foliar application in 2018 and 2019 seasons

Characters	2018 season		L.S.D at 5%	2019 season		L.S.D at 5%
	Without	Nano		Without	Nano	
No. days to 50% tasseling	54.92	55.44	0.45	53.96	53.48	NS
No. days to 50% silking	57.55	58.63	0.77	56.51	57.63	0.14
Plant height (cm)	207.62	227.81	6.87	265.18	285.00	5.75
Ear length (cm)	17.52	18.95	0.30	19.00	20.07	0.88
No. grains row[-1]	37.11	40.32	1.31	38.09	42.55	1.42
Ear weight (g)	203.40	209.85	1.68	205.85	213.66	1.42
Grains ear weight (g)	157.81	167.11	4.10	160.55	169.55	2.20
100–grain weight (g)	34.85	36.07	0.65	36.85	37.59	NS
Forge yield (ton fed[-1])	23.44	24.00	0.46	24.44	25.07	0.41
Grain yield (kg fed[-1])	2446.7	2561.9	34.2	2525.2	2637.4	35.7

NS=No significance
- Effect of the interactions:

The significant interactions among yellow maize hybrids, N fertilizer levels and nano foliar application on the traits are shown in Tables 4a, 4b, 4c and 5.
The combination of yellow maize hybrids with N fertilizer levels indicated that the heaviest values were obtained by SC P3737 hybrid with 120 kg N fed^{-1} for grain yield fed^{-1}, in both seasons (Table 4a). On the other hand, the lowest values in grain yield fed^{-1} were obtained by SC 176 hybrid with 60 kg N fed^{-1} in the first and second seasons.

Table 4a. Effect of the interaction between of yellow maize hybrids and N fertilizer rates on grain yield kg fed^{-1} in 2018 and 2019 seasons

N fertilizer rates	2018 season			2019 season		
	yellow maize hybrids					
	SC 2055	SC 176	SC P3737	SC 2055	SC 176	SC P3737
60 kg fed^{-1}	2066.66	1738.33	2141.66	2141.66	1811.66	2175.00
90 kg fed^{-1}	2558.33	2233.33	2883.33	2141.66	2358.33	2951.66
120 kg fed^{-1}	3133.33	2883.33	3266.66	3183.33	2608.33	3341.66
L.S.D at 5%		84.65			112.4	

The combination of yellow maize hybrids with nano foliar application showed that the highest values were obtained by SC P3737 hybrid with nano foliar application treatment for ear length in both seasons are shown Table (4b). On the other hand, SC 176 hybrid with zero nano foliar application treatment gave the lowest values in ear length in both seasons.

The data presented in Table (4c) demonstrated that maximum values were gained in ear length 60 kg N fed^{-1} application with nano foliar application treatment in the first season. The highest values of grain yield (3000.00 and 3088.88 kg fed^{-1}) were obtained from application 120 kg N fed^{-1} with nano foliar application treatment in the first and second seasons, whereas the lowest values in these traits were exhibited by 60 kg N fed^{-1} with zero nano foliar application treatment in the first and second seasons.

Table 4b. Effect of the interaction between yellow maize hybrids and Nano N foliar application on ear length (cm) in 2018 and 2019 seasons

Nano-N foliar application	2018 season			2019 season		
	yellow maize hybrids					
	SC 2055	SC 176	SC P3737	SC 2055	SC 176	SC P3737
Without	17.93	15.36	19.26	18.95	17.56	20.48
Nano	19.43	17.24	20.17	19.40	19.05	21.77
L.S.D at 5%		0.53			NS	

NS=No significance

Table 4c. Effect of the interaction between N fertilizer rates and Nano N foliar application on ear length (cm) and grain yield kg fed^{-1} in 2018 and 2019 seasons

Nano-N foliar application	2018 season			2019 season		
	N fertilizer rates kg fed^{-1}					
	60	90	120	60	90	120
Ear length (cm)						
Without	16.22	17.51	18.83	17.98	19.16	19.85
Nano	18.16	19.57	19.11	19.91	19.74	20.56
L.S.D at 5%		0.52			NS	
Grain yield kg fed^{-1}						
Without	1934.44	2461.11	2944.44	2007.77	2567.77	3000.00
Nano	2030.00	2655.55	3000.00	2077.77	2745.55	3088.88
L.S.D at 5%		59.32			61.85	

NS=No significance

The highest values of ear length (20.36 cm) were obtained from SC P3737 hybrid + 60 kg N fed^{-1} application + nano foliar application in the first season. On the other hand, SC 176 hybrid under zero N kg fed^{-1} with zero nano foliar application treatment gave the lowest value in ear length (14.30 cm) in the first season. It could be concluded that under the conditions of the experiment planting SC P3737 hybrid under application of 90 or 120 kg N fed^{-1} application with nano foliar application treatment is recommended.

Table 5. Effect of the interaction between yellow maize hybrids, N fertilizer rates and Nano N foliar application on ear length (cm) in 2018 and 2019 seasons

N fertilizer rates	Nano-N foliar application	2018 season			2019 season		
		yellow maize hybrids					
		SC 2055	SC 176	SC P3737	SC 2055	SC 176	SC P3737
60 kg fed^{-1}	Without	16.46	14.30	17.90	17.63	17.03	19.30
	Nano	18.66	15.86	19.96	19.90	18.70	21.14
90 kg fed^{-1}	Without	17.80	14.93	19.80	19.23	17.83	20.42
	Nano	19.90	18.46	20.36	17.76	19.20	22.26
120 kg fed^{-1}	Without	19.53	16.86	20.10	20.00	17.83	21.73
	Nano	19.73	17.40	20.20	20.53	19.26	21.90
L.S.D at 5%		0.91			NS		

NS=No significance

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تأثير التمسيد النيتروجيني المعدني والنانو علي المحصول ومكوناتة لبعض هجن الذرة الشامية الصفراء

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[1]قسم المحاصيل – كلية الزراعة بمشتهر – جامعة بنها

[2]قسم الأراضي – كلية الزراعة بمشتهر – جامعة بنها

أجريت تجربتان حقليتان بمركز البحوث والتجارب بكلية الزراعة بمشتهر – جامعة بنها خلال موسمى الصيف 2018 و 2019 م لدراسة إستجابة ثلاث هجن فردية للذرة الشامية الصفراء (هايتك 2055 ، 176 ، بايونير P3737) لثلاث معدلات من التسميد النيتروجيني (60 ، 90 ، 120 كجم ن ف [1-]) ومعدلين من التسميد النيتروجيني بتقنية النانو (صفر و3 مليلتر لتر[1-]) علي المحصول وبعض مكوناتة. تم استخدام تصميم القطاعات كاملة العشوائية فى توزيع القطع المنشقة مرتين باستخدام ثلاث مكررات. وتم وضع الهجن الصفراء فى القطع الرئيسية ومستويات التسميد النيتروجينى فى القطع الشقية ومعاملات النانو فى القطع تحت الشقية. سجل الهجين بايونير P3737 أعلى متوسطات و بفرق معنوي فى معظم الصفات المدروسة مقارنة بالهجن الأخرى لكلا موسمي الزراعة. وأيضا سجل نفس الهجين أقل عدد أيام من الزراعة حتي طرد النورة المذكرة والمؤنثة في كلا موسمي الزراعة. ازداد كل من عدد الأيام حتي طرد النورة المذكرة و المؤنثة ، طول النبات (سم) ، طول الكوز (سم) ، عدد حبوب الكوز ، وزن الكوز (جم) ، وزن حبوب الكوز (جم) ، وزن الـ 100 حبة (جم) ، محصول العلف الأخضر (طن فدان[1-]) ومحصول الحبوب (كجم فدان[1-]) زيادة معنوية بزيادة معدل التسميد النيتروجيني حتي 120كجم ن فدان[1-] في كل من موسمي الزراعة الأول والثاني. كانت هناك زيادة معنوية فى معظم الصفات الدروسة عند رش نباتات الذرة بسماد النانو في كل من موسمي الزراعة الأول والثاني. توصي هذه الدراسة تحت ظروف تلك التجربة بزراعة الهجين بايونير 3737 مع التسميد النيتروجين بمعدل 90 أو 120 كجم ن فدان [1-] ورش نباتات الذرة بسماد النانو .