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Response of Some Yellow Maize Crosses to N-fertilizer Rates and Plant Densities at Toshka Region

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FIELD studies were conducted at Toshka region, South Valley of Egypt , during the summer seasons of 2014 and 2015 to evaluate the some yellow maize single crosses, *i.e.* SC-162, SC-168 and SC-176 under three plant densities of (21000, 27300 and 33600 plant/fad) and three levels of nitrogen fertilizer (90,120 and 150 Kg N/fad). The results showed that N- levels were affected significantly all characters under study, *i.e*. growth characters, grain yield, protein content and the nitrogen use efficiency (NUE), except leaf area of the top most ear/plant. The application of 150 kg N / fad was resulted significant increase in grain yield and estimated by 4340 and 4235 kg /fad in 2014 and 2015, respectively. The plant densities also exhibited significant effect on the studied characters, except leaf area of the top most ear/plant, ear length, ear diameter, number of grains/row and protein content. The increasing of plant density from 21,000 to 33,600 plant/fad increased the grain yield up to 13.44 and 17.27 % in 2014 and 2015 seasons, respectively. The single crosses of maize differed significantly for ear length, NUE and grain yield during the 2014 season and the hybrid SC-176 recorded the highest value for grain yield of 4246.6 kg / fad.

The interaction N levels x plant densities interaction were significant for plant height and NUE in both seasons and grain yield in the 2015 season. The plant density x maize crosses interaction were significantly also for ear length, grain yield and NUE in the 2014 season and the 500-grain weight in the 2015 season. Moreover, significant interaction among the three factors for grain yield and NUE through the 2014 season and stem diameter in 2015 season.

The economic evaluation showed that the highest net return obtained from sowing SC-176 cross by plant density of 33600 plant/fad and supplemented by 150 kg N / fad.

Keywords: Nitrogen fertilizer, Cultivars, Plant densities

Toshka is one of the cultivated areas of the south valley of Egypt. This area is differs in its soil particle distribution, chemical analyses and its fertility as well as climatic conditions than both of Delta and Nile valley areas (Soliman *et al.*, 2005). Maize is one of the most strategically crop in Egypt. To cover the shortage in human needs, animal and poultry feeding from maize grain for many purposes such as bread making (20% of maize flower mixed with 80% wheat flower to reduce the imported quantity of wheat) and using high yielding hybrids make big yield productivity. Lamkey (1994), EL-Agamy *et al.* (1999) and Soliman *et al.*, (2005) found that at least 50% of the observed increase in grain yield is due mainly to sowing new hybrids of maize.

Agronomic practices *i.e.* nitrogen fertilization and plant densities and others also play important roles in maize production. Increasing plant densities markedly increased grain yield per unit and vice versa decreased plant height, number of ears/plant and grain yield/plant and delays pollen shedding and tassel appearance as reported by Tantawy *et al.*(1998), EL-Agamy *et al.*(1999) and Soliman *et al.* (1999 and 2005)

Widdicombe & Thelen (2002) found that increasing plant density from 56000 to 90000 plants/ha significantly increased grain yield from 10.536 to 11.683 tons/ha, respectively.

Nitrogen plays a vital role in nutritional and physiological status of plants, promotes changes in mineral composition of plant, and is the most important element for plant growth and development. Increasing nitrogen fertilizer rates up to certain levels delayed pollen shedding and silking dates and increased plant height, number of leaves per plant, LA, LAI and grain yield per unit area (Abdrabou *et al.*, 1996; Hussein *et al.*, 1998; El-Agamy*et al.*, 1999; Zeidan *et al*., 2006 and Ayman & Samier, 2015) . Nitrogen deficiency or excess can result in reduced maize yields. Maize nitrogen requirement depends upon many factors *i.e.* cultivar used, soil health and others. However, the amount of optimum nitrogen fertilizer varies cultivars and ecological conditions (Sencer, 1988; Sezer &Yanbeyi, 1997; Kirtok,1998; Karasu, 2012 and Nasser *et al*., 2015).

Study is aimed at evaluation the response of some yellow maize crosses to nitrogen levels under different plant densities as well as their interactions under Toshka Region, South Valley, Egypt.

Materials and Methods

Two field experiments were conducted at South Valley Farm Research Station, Toshka Region, Agriculture Research Center during 2014 and 2015 seasons. The physical and chemical analyses of the soil were done, results presented in Table 1.

The experimental design was a split-split plot design with three replications. Three nitrogen fertilizer rates of 90, 120 and 150 kg N/fad (faddan =4200 m^2) were distributed in main plots, three plant population densities of 5, 6.5 and 8 plants/m^2(providing a plant population densities of 21000, 27300 and 33600 plants/fad, respectively) arranged in the sub-plots and the three yellow maize single crosses (*i.e*. SC-162, SC-168 and SC-176) allocated in sub-sub plots. Drip irrigation system was followed and water requirements were applied according to Soliman *et al*.(2004). Plots consisted of 4 rows, 6 m long and one –meter width and 30cm apart between drippers. Nitrogen was applied in four split applications : 1^{st} after thinning

(18 days from sowing (DAS), 2nd 30 DAS , 3rd 40 DAS and 4th 50 DAS . Used in the form of ammonium nitrate (33.5% N) as a solution with water irrigation . Seeds were hand sowing in hills around the drip point on August 1st in both seasons and thinned to one plant/hill. All plots were irrigated two hours daily. Hoeing was practiced twice after 18 and 30 days from sowing . At harvest, plants were taken from two inner rows for recorded the following growth observations :

TABLE 1. Physical and chemical analyses of the soil sites in 2014 and 2015 seasons at Toshka Region in 2014 and 2015 seasons.

Soil characters	2014 season		2015 season	
	Soil depth (cm)			
	0-30	30-60	0-30	30-60
Soil particle distribution				
Sand (%)	67.0	51.5	65.8	51.9
Clay (%)	3.3	9.5	3.2	9.6
Silt (%)	29.7	39.0	31.0	38.5
Texture	Sand loam	Loam	Sand loam	Loam
Soil chemical characteristics and soil fertility conditions				
PH	9.10	9.10	9.11	9.2
EC (%)	0.04	0.03	0.04	0.03
CEC (meg/100 g)	14.80	15.00	15.00	16.00
Ca Co_3 (%)soil	12.80	13.80	11.90	12.10
N (ppm)	25.00	20.00	23.00	24.00
P (ppm)	6.00	5.00	5.50	5.50
K (ppm)	160.00	160.00	166.0	165.00
Fe (ppm)	10.00	12.00	10.00	11.00
Zn (ppm)	0.18	0.15	0.20	0.15
Mn (ppm)	4.00	4.00	4.00	4.00
Cu (ppm)	0.10	0.20	0.25	0.18
B (ppm)	0.80	0.90	0.80	0.80

Growth parameters

1-Plant height, cm.
2-Ear height, cm.
3-Number of green leaves/plant
4-Leaf area of the top-most ear/plant (dm^2). According to Alessi & Power (1975) as the following formula:

Leaf area = leaf length x maximum width x 75%.

5-Leaf area index (LAI) : It was calculated as the ratio by dividing the mean of the leaf area of five plants (cm^2) by occupied area by the plants (Diwaker & Oswalt, 1992).
6-Stem diameter, cm: Stem diameter of the second inter node in cm using venire caliperation method.

Yield and yield components

1- Ear length and ear diameter, cm.

2- Number of rows/ear and number of grains/row.
3- Grains weight/ear, g. adjust grain yield per plot/number of plants per plot.
4- 500-grainsweight, g. adjusted to 15.5% moisture.
5- Grain yield (ard. /fad.): it was measured from the weight of grains adjusted to 15. 5% moisture of each plot and converted to ardabs/ faddan (One ardab =140 kg).
6- Nitrogen use efficiency (NUE):(kg grain / kg N applied)
Grain nitrogen use efficiency (NUE) (Barbar,1976) was calculated as follows :

$$= \frac{Grain\ yield}{N\ applied}$$

Crud protein in grains

It was measured by using procedure of Microkeldahel as described by Cottenie *et al.* (1982).

Economic evaluation

In present study, the economic evaluation included four items as follows:
1-Total costs of yield
2-Total net return (Gross return) of yield production: Total net farm income is the value of yield according to the actual price (The price of grain yield was 350 L.E. /fad) as given by Extension Service Information, Ministry of Agriculture .
3-Net farm return (Profit) = Gross INC – Cost.

$$4 - \text{Benefit cost ratio (BCR)} = \frac{\text{Profit}}{\text{Cost}}$$

Economic valuation was done using the method described by CIMMYT. (1988).

Statistical analysis

Analysis of variance was done according to procedures outlined in Gomez & Gomez (1991). Means were compared using LSD at 5% levels of probability as revealed by Steel *et al.*(1997).

Results and Discussion

Effect of nitrogen levels on growth parameters, maize grain yield and its attributes

Growth parameters

It is cleared that plant height increased significantly as nitrogen rates were increased from 90 to 150 kgN/fad in both growing seasons (Table 2). This increase may be due mainly to the role of nitrogen as a constituent of all proteins and nucleic acids which led to increase cells number and size which in turn encourage the elongation of the internodes of the stem. Similar results were obtained by El-Agamy *et al.*(1999), Abdel-Hameed (2005), Zeidan *et al.* (2006), Akmal *et al.* (2010), Karasu (2012), Aiad *et al.* (2014), Shahid *et al.* (2014) and Nassr *et al.* (2015).

Moreover, the data in Table 2 showed that the increasing of nitrogen fertilizer rates from 90 to 150 kgN/fad resulted in significant increase in number of green leaves/plant and leaf area index in both growing seasons. The results may be attributed to increasing the amount of absorbed N by plants especially to early growth stage, which led to increase cell number and size and allowed maintaining the oldest leaves healthy. These results are in accordance with reported by EL-Agamy *et al.* (1999), Adel-Hameed (2005) and Akmal *et al.* (2010).

Yield attributes

Results presented in Table 3 show the effect of N-fertilizer rates on the yield attributes (*i.e*. ear length and diameter, number of grains/row, 500 grains weight of grains weight/plant) during the two growing seasons. Raising N fertilizer rates from 90 to 120 and doubling the rate from 60 to 150 kg/fad were accompanied by a significant increase of aforementioned traits. These increase in accounted for ear length as 7.77 and 12.04% in the first and 5.28 and 17.19% in the second season, 500-grains weight as 7.39 and 11.45% in the first and 6.57 and 13.05% in the second season, grains weight/plant as 7.50 and 14.61% in the first and 5.02 and 11.13% in the second season, number of grain/row of 3.17 and 10.45% in the first season and ear diameter 4.43 and 13.79% in the second, respectively. The corresponding values of crud protein in grains were 10.06, 11.02 and 11.52 in the first season and 10.01, 10.93 and 11.94 in the second season, respectively. The increment in 500 grains weight as a result of increasing N-fertilization rate may be due to the role of nitrogen in increasing plant growth and grain filling. Meanwhile, in grain yield due to nitrogen fertilizer may be explained by the increase in most correlated yield components, which increase the final yield. The increase of protein percentage due to high N-content by maize grains under high rates of N-fertilizer. This might be attributed firstly to the increases in the root surface and enrichment of soil solution with nitrogen which reflects its influence on N-concentration in plant tissues. This raising in N% in plant tissues may be contributed in building up metabolites and subsequently increasing dry matter production up to full growth stage and thin increases nutrients uptake by maize plant. The previous results are in accordance with those reported by EL-Agamy (1999), Abdel-Hameed (2005), Zeidan *et al.*, (2006), Akmal *et al.* (2010), Karasu (2012), Aiad *et al.* (2014), Shahid *et al.* (2014) and Nassr *et al.* (2015).

Grain yield (kg/fad)

The data in Table 3 indicated that grain yield was significantly increased as nitrogen fertilizer rates increased up to 150 kgN/fad in both growing seasons. The percentages of increase in grain yield due to application of 120 and 150 kgN/fad relative to 90 kgN/fad were 3.80 and 9.19% in 2014 season, and 4.80 and 8.46% in 2015 season, respectively. The results may be due to the fact that nitrogen fertilization create strong and healthy plants which resulted in increasing the vegetative growth related to the source capacity of maize plants, *i.e.* plant height, leaf number/plant, leaf area/plant and LAI. These results are in harmony with those obtained by EL-Agamy *et al.* (1999), Abdel-Hameed (2005), Zeidan *et al.*, (2006), Akmal *et al.*, (2010), Karasu (2012), Aiad *et al.* (2014), Shahid *et al.* (2014), Nassr *et al.* (2015) and Hafez &Abdelaal (2015).

TABLE 2. Growth characters and N-use efficiency as influenced by nitrogen rates, plant densities and maize hybrid.

Treatment	Plant height (cm)		Ear height (cm)		Number of green leaves/plant		Leaf area of the top most ear/plant (dm^2)		Leaf area index (LAI)		Stem diameter (cm)		N-use efficiency	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
N- rates (kg N/fad)														
90	175.08	180.22	138.92	134.63	13.83	13.95	7.85	7.52	7.21	6.99	2.08	2.03	44.16	43.38
120	180.30	179.26	139.48	138.08	14.17	14.13	7.88	7.52	7.40	7.09	2.05	2.12	34.38	34.10
150	187.22	185.82	142.11	143.63	14.92	14.75	7.94	7.98	7.98	7.71	2.10	2.31	28.93	28.23
$LSD_{0.05}$	4.38	4.47	NS	3.53	0.25	0.28	NS	NS	0.42	0.41	NS	0.08	0.67	0.73
Plant densities														
21000	188.52	185.55	141.04	137.00	14.28	14.10	8.03	7.69	5.73	5.41	2.14	2.24	33.51	32.24
27300	179.74	179.92	138.93	137.93	14.35	14.20	7.87	7.66	7.52	7.21	2.08	2.13	35.91	35.47
33600	177.04	177.11	140.56	141.41	14.30	14.54	7.78	7.56	9.25	9.16	2.00	2.08	38.03	38.02
$LSD_{0.05}$	1.38	1.21	NS	3.49	NS	0.28	NS	NS	0.23	0.38	0.10	0.12	0.58	0.74
Maize hybrid														
S.C. 162	181.41	181.00	140.04	139.70	14.37	14.32	7.91	7.64	7.52	7.28	2.06	2.17	35.79	35.05
S.C. 168	183.00	180.41	137.19	137.93	14.32	14.25	7.88	7.60	7.52	7.20	2.07	2.13	34.96	35.15
S.C. 176	180.89	181.19	143.30	138.70	14.24	14.26	7.89	7.67	7.45	7.30	2.08	2.17	36.70	35.52
$LSD_{0.05}$	NS	NS	4.43	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.23	NS

TABLE 3. Yield, yield attributes and quality parameters as influenced by nitrogen rates, plant densities and maize hybrid.

Treatment	Ear length (cm)		ear diameter (cm)		Number of rows/ear		number of grains/row		Grains weight/plant (g)		500-grainse weight (g)		Grain yield (Kg./fad)		Crud protein content(%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
N- rates (kg N/fad)																
90	15.45	15.71	4.54	4.61	14.57	14.50	40.67	40.07	175.96	180.81	151.30	152.11	3974.6	3904.6	10.06	10.01
120	16.65	16.54	4.27	4.48	14.18	14.56	41.96	42.89	189.15	189.89	162.48	162.11	4125.8	4092.2	11.02	10.93
150	17.31	18.41	4.25	4.15	14.04	14.08	44.92	46.04	201.67	200.93	168.63	171.96	4340.0	4235.0	11.52	11.94
$LSD_{0.05}$	0.95	1.16	NS	0.15	NS	0.31	3.10	NS	5.43	1.51	6.87	4.12	57.4	75.6	0.34	0.41
Plant densities																
21000	16.77	16.72	4.32	4.43	14.36	14.39	43.85	42.96	208.30	213.48	165.22	165.48	3885.0	3745.0	10.91	11.11
27300	16.11	17.03	4.40	4.40	14.43	14.44	41.30	43.15	190.81	190.59	159.00	161.81	4149.6	4096.4	10.94	10.86
33600	16.53	17.12	4.34	4.41	14.33	14.32	42.41	43.00	167.67	167.56	158.19	158.89	4407.2	4391.8	10.74	10.91
$LSD_{0.05}$	NS	NS	NS	NS	0.30	NS	NS	NS	4.51	2.44	3.12	2.89	47.6	61.6	NS	NS
Maize hybrid																
S.C. 162	16.50	16.95	4.37	4.45	14.28	14.30	42.44	41.81	188.26	190.37	161.22	161.04	4146.8	4050.2	10.91	10.89
S.C. 168	16.31	17.12	4.36	4.39	14.33	14.36	42.41	43.93	189.59	190.70	160.07	162.56	4046.0	4074.0	10.89	11.07
S.C. 176	16.60	16.80	4.33	4.40	14.17	14.50	42.70	43.37	188.93	190.56	160.56	162.59	4246.6	4107.6	10.80	10.92
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	25.2	NS	NS	NS

Effect of plant densities on growth parameters and maize grain yield and its attributes:

Growth characters

Plant height is an important component which helps for determining the growth attained during the growing period. The data showed that plant height was significantly affected by plant population (Table 2). Planting maize under high density of 33600 plants/fad gave the shortest plants of 177.04 cm in the first season and 177.11 cm in the second season. The tallest plants of 188.52 and 185.55 cm were recorded in 2014 and 2015 seasons, respectively, due to crowding effect of the plant and higher intra-specific competition for resources. This trend explains that as the number of plants increased in a given area the competition among the plants for nutrients uptake and sunlight interception also increased (Sangakkara *et al.,* 2004 and Abuzar *et al.,* 2011). Results presented in Table 2 show that increasing plant population densities 21000 to 27300 and 33600 plants/fad significantly increased the ear height and number of green leaves/plant in 2015 season and LAI in both seasons, but reduced stem diameter in both growing seasons. The increase of ear height, number of green leaves/plant and LAI by increasing plant population densities were mainly to that the reduction in leaf area/plant. Previous research findings also indicated that in high maize density, leaf area index, total dry weight and crop growth rate increased than low maize density throughout crop growth season (Saberali, 2007; EL-Metwally *et al.,* 2011and Abuzar *et al.,* 2011).

Yield attributes

The influence of plant density on selected plant parameters, *i.e*. number of rows/ear, grains weight/plant and 500 grains weight is presented in Table 2. Plant population density had significant effects on the number of rows/ear in 2014 only, grains weight/plant and 500 grains weight in both seasons.

Number of rows/ear in 2014 was increased significantly by increased plant density from 21000 to 27300 plants. Planting 27300 plant/fad had the highest number of rows/ear, while planting 33600 plant/fad recorded the lowest number of rows/ear. Mohammed (1999) found that ear length, ear diameter, number of rows/ear, number of kernels/row and 100-kernels weight decreased with increasing plant densities from 20 to 35 thousand plants/fad. Increasing plant density from 21000 to 33600 plants/fad reduced grains weight/plant by 19.51 and 21.51% in 2014 and 2015 seasons, respectively. Also, increasing plant density from 21000 to 27300 plant/fad reduced grains weight/plant by 8.40 and 10.72 in 2014 and 2015 seasons, respectively. The reduction in grains weight/plant by increasing plant density may be due to interplant competition. High plant densities delay silk emergence that lead to decrease in grain number/ear and reduction in total grain yield. Edmeades *et al.* (2000) found that high plant densities enhance interplant competition for assimilates, particularly during the period bracketing silking, favoring epical dominance and decreasing the ratio of ear to tassel growth rate. Similar results were reported by Zeidan *et al*. (2006), Maddonni *et al.* (2006), Shakarami & Rafiee (2009), Gozubenli (2010), EL-Metwally *et al.* (2011) and Sarwar *et al*. (2016).

Grain yield (kg/fad)

Respecting plant population densities (Table 3) showed that significant increase was obtained from 3885.0 to 4149.6 and 4407.2 kg/fad in the first and from 3745.0 to 4096.4 and 4391.8 kg/fad in the second seasons when the plant population densities were increased from 21000 to 27300 and 33600 plants/fad, respectively. The current results could be attributed to the increase in LAI at the highest plant population densities which permit maize plant to intercept more solar radiation and increase the photosynthetic activity per unit area of the canopy, which was converted well to dry matter accumulation in case of dense planting. Therefore, 27.3 to 33.6 thousand plants/fad is considered to be adequate to produce the highest grain yield under Toshka, South valley of Egypt. These findings agree with those of several previous studies such as EL-Agamy *et al.* (1999), Farnham (2001), Widdicombe & Thelen (2002), Amer *et al.* (2004), Soliman *et al.* (2005), Zeidan *et al.* (2006), Abuzar *et al.* (2011), EL-Metwally *et al.* (2011), Adeniyan (2014), Farnia & Mansouri (2014) , Kandil (2014), Eszter (2015) and Sarwar *et al*. (2016).

Hybrids performance

Data presented in Table 2 showed significant differences between maize hybrids in 2014 season for ear height. SC-176 hybrid recorded the highest values of ear height 143.30 cm, whereas, the shortest one was obtained by SC-168 hybrid in 2014 season. Height of ear height can vary depending on the hybrid and growing condition (Gyner-Hegyi *et al.,* 2002). The hybrid of SC-176 surpassed all tested crosses in grain yield (kg/fad). Otherwise SC-162 and SC-168 were the lowest grain yield (kg/fad) in 2014 season . The superiority of SC-176 might have been due to lower percentage of barren plants, longer ears, higher weight of grains/ear and higher shilling percentage. Otherwise, the lower potential ability of SC-162 and SC-168 may be attributed to the lower values of ear characteristics and shelling percentage. Similar results were reported by Azam *et al.*, (2007), Compean *et al.* (2009), Sharifi *et al.* (2009), Alias *et al.* (2010), Gozubenli (2010) , EL-Metwally *et al.* (2011) and Hafez *et al*. (2015).

The interaction effects

The interaction effects of plant density with nitrogen fertilizer on plant height and grain yield are presented in Table 4. The combined treatment 21000 plants/fad with 150 kgN/fad gave the highest values of 193.33 and 192.78 cm for plant height in 2014 and 2015, respectively. Otherwise, the lowest value of plant height (174.00cm) was recorded with 33600 plants/fad along with 90 kgN/fad in 2014 season and 172.78 cm from 27300 plants/fad with 90 kgN/fad in 2015 season. The highest values of grain yield was obtained from 33600 plants/fed along the 150 kgN/fad, while the lowest value (3685.89 Kg/fad in 2014 season and 3509.80 kg/fad in 2015 season) obtained with 21000 plants/fed along with 90 kgN/fad in both seasons. These results are in agreement with those mentioned by Shoa *et al.* (2009), Bello *et al.* (2010), Rafiq *et al.* (2010), Dawadi & Sah (2012) and Ayman & Samier (2015). Regarding to the interaction effect between plant densities and maize hybrid on ear height in 2014 season (Table 5), it could be reported that highest ears were obtained at planting 33600 plants/fad and from SC-176, but the shortest ear height was resulted through planting 27300 plants/fad and using SC-168 hybrid.

TABLE 4. Effect of the interaction between N-rates and plant densities on plant height, grain yield and nitrogen use efficiency of maize.

N-rates (kg/fad) (A)	**Plant height (cm)**					
	2104 season			2015 season		
	Plant densities (Plant/fed.) (B)			Plant densities (Plant/fed.) (B)		
	21000	27300	33600	21000	27300	33600
90	186.34	180.33	174.00	179.56	172.78	172.89
120	185.89	174.56	177.56	184.78	179.67	176.89
150	193.33	184.56	179.56	192.78	187.33	181.55
L.S.D 5%	**2.38**			**2.09**		
N-rates (kg/fad) (A)	**Grain yield (kg/fad)**					
	2104 season			2015 season		
	Plant densities (Plant/fad) (B)			Plant densities (Plant/fad) (B)		
	21000	21000	27300	21000	27300	33600
90	3685.89	4014.11	4221.93	3509.80	3966.20	4237.80
120	3875.51	4135.91	4368.00	3738.00	4116.00	4424.00
150	4091.73	4297.69	4631.2	3985.80	4208.40	4510.80
L.S.D 5%	**NS**			**0.78**		
N-rates (kg/fad) (A)	**Nitrogen use efficiency (NUE)**					
	2104 season			2015 season		
	Plant densities (Plant/fad) (B)			Plant densities (Plant/fad) (B)		
	21000	21000	27300	21000	21000	27300
90	40.95	44.60	46.83	39.00	44.06	47.09
120	32.29	34.47	36.40	31.16	34.29	36.87
150	27.28	28.65	30.87	26.57	28.05	30.09
L.S.D 5%	**1.00**			**1.28**		

Data in Table 5 show that planting 33600 plants/fad from SC-176 hybrid produced the greatest 500 grains weight in 2015 season. Also, the data in same table indicated that planting 33600 plants/fed from SC-176 hybrid gave the greatest grain yield in 2014 season. The smallest grain yield was obtained at planting 21000 plants/fad from SC- 168 in 2014 season.

As shown in Table 6 the highest values of grain yield were obtained with the second order of interaction between (N x cross) 150 kgN/fad, 33600 plants/fad and SC-176 hybrid in 2014 season. As well as ear diameter were obtained with interaction between 150 kgN/fad, 21000 plants/fad and SC-162 hybrid, while the lowest values were obtained with interaction of 90 kgN/fad, 21000 plants/fad and SC-168 hybrid in grain yield 2014 season. Moreover, same result could be found for the interaction between 90 kgN/fad, 33600 plants/fad and SC-176 hybrid in ear diameter 2015 season.

Nitrogen use efficiency

Grain yield kg/fad/nitrogen applied, kg/fad

Nitrogen use efficiency in terms of productivity factor clearly showed that application of nitrogen with low rates caused a higher value on nitrogen use efficiency. Data in Table 2 show that there was significant decrease in NUE in both 2014 and 2015 seasons by increasing N rates 150 kgN/fad. This might be due to that any small amount of nitrogen applied could give a large yield response. This result was in agreement with that of Gauar *et al.* (1992) who reports that NUE is generally the greatest with low rates of applied N and decreases as the amount of N applied increases. Also, there was significant increase in NUE by applying plant densities in both seasons. The highest value was obtained with 33600 plant/fad followed by 27300 plant/fad and 21000 plant/fad in both seasons. Data in Table 4 indicate that the combination between 90 kg N/fad and 33600 plant/fad produced the maximum NUE 46.83 in the first season and 47.09 in the second season. Otherwise, the minimum one was 27.28 and 26.57 in the first and second season, respectively, produced from adding 150 kgN/fad and 21000 plant/fad. Plant densities and maize hybrid interaction was significant on NUE in 2014 season. The most amount of NUE was 45.29 observed with application of 21000 plant/fad and SC-176.

Data in Table 6 showed that interaction among N-rates, plant densities and maize hybrid was significant on NUE in the 2014 season. The highest values of NUE were 47.82 in 2014 season, produced from 90 kg N/fad, 33600 plant/fad and SC-176.

Economic evaluation

Data in Table 7 show that net return increased by increasing nitrogen rates. Net return showed considerable variation due to the nitrogen rates indicating that significantly net return 6553.94 L.E/fad were obtained by 150 kg/fad, followed by 120 kg/fad with 6166 L.E/fad and the lowest net return 5803.22 L.E/fad were obtained by 90 kg/fad. Similar results of economics increased nitrogen rates were also reported by Bhatt Spadana (2012). Net return increased by increasing plant densities applying 33600 plant/fad gave the highest value 6847.78 L.E/fad, while the smallest value was 5474.19 L.E/fad resulted from applying 21000 plant/fad. Regarding to maize hybrid, higher net return 6339.39 L.E/fad was obtained by SC-176 which was comparable with SC-162 (6138.92 L.E/fad) and SC-168 (6045.78 L.E/fad). The treatment combination of 150 kg N/fad with 33600 plant/fad and SC-176 maize hybrid due to interaction gave the greatest net return which equal 7413.50 L.E/fad, while the lowest net return was 4820.00 L.E/fad produced from 90 kg N/fad, 21000 plant/fad and SC-168 maize hybrid .

TABLE 5. Effect of the interaction between plant densities and maize hybrid on ear height, grain yield and N- use efficiency (2014 season), 500-grains weight (2015 season) of maize .

Plant densities Plant/fad (B)	Ear height (cm)			Grain yield (kg/fad)			Nitrogen use efficiency			500-grainse weight (g)		
	2014 season			2014 season			2014 season			2015 season		
	Maize hybrid (C)			Maize hybrid (C)			Maize hybrid (C)			Maize hybrid (C)		
	SC 162	SC 168	SC 176	SC 162	SC 162	SC 176	SC 162	SC 162	SC 176	SC 176	SC 168	SC 176
21000	139.00	139.11	138.67	3969.0	3876.6	4075.4	44.02	43.07	45.29	153.22	150.89	149.78
27300	139.44	135.56	143.44	4128.6	4030.6	4218.2	34.41	33.59	35.16	163.89	161.66	161.89
33600	141.67	136.89	147.30	4340.0	4232.2	4447.8	28.94	28.21	29.65	168.22	167.67	170.00
L.S.D 5%	**7.67**			**0.32**			**0.39**			**5.03**		

TABLE 6. Effect of the interaction between N-rates and plant densities and maize hybrid on grain yield and N- use efficiency (Season2014) and ear diameter (season2015) of maize.

N-rates (kg/fad) (A)	Plant densities Plant/fad (B)	Grain yield (kg/fad)			Nitrogen applied (kg/fad)	Nitrogen use efficiency			Stem diameter (cm)		
		2014 season				2014 season			2015 season		
		Maize hybrid (C)				Maize hybrid (C)			Maize hybrid (C)		
		SC 162	SC 168	SC 176		SC 162	SC 168	SC 176	SC 162	SC 168	SC 176
90	21000	3696.0	3518.2	3686.2	90 kg/fad	41.07	44.83	46.42	2.04	2.03	2.21
	27300	4034.8	3927.0	4079.6		39.09	43.63	46.50	2.11	2.04	1.99
	33600	4177.6	4184.6	4303.6		42.71	45.33	47.82	2.04	2.04	1.77
120	21000	3862.6	3787.0	3976.0	120 kg/fad	32.19	34.58	36.46	2.23	1.97	2.22
	27300	4149.6	4081.0	4176.2		31.56	34.01	35.21	2.19	2.06	2.06
	33600	4375.0	4225.2	4503.8		33.13	34.80	37.53	2.15	2.12	2.10
150	21000	4107.6	3950.8	4215.4	150 kg/fad	27.38	28.49	30.94	2.54	2.46	2.48
	27300	4272.8	4242.0	4379.2		26.34	28.28	30.03	2.15	2.23	2.38
	33600	4641.0	4503.8	4748.8		28.10	29.19	31.66	2.07	2.17	2.30
L.S.D 5%		0.55				0.68			0.22		

TABLE 7. Total costs, Gross return (L.E./fad) and benefit : cost ratio (BCR) as affected by nitrogen rates , plant densities and maize hybrids (average of 2014/2015 season

N-rates (kg/fad) (A)	Plant densities (plant/fad) (B)	Maize Hybrid (C)	Total costs L.E./fad	Gross return L.E./fad	Net return L.E./fad	Benefit : cost ratio (BCR)
90 kg/fad	21000 (plant/fad)	SC162	4000.00	9080.75	5080.75	1.27
		SC168		8820.00	4820.00	1.21
		SC176		9082.50	5082.50	1.27
	27300 (plant/fad)	SC162	4045.00	9997.75	5952.75	1.47
		SC168		9723.00	5678.00	1.40
		SC176		10204.25	6159.25	1.52
	33600 (plant/fad)	SC162	4090.00	10419.50	6329.50	1.55
		SC168		10514.00	6424.00	1.57
		SC176		10792.25	6702.25	1.64
120 kg/fad	21000 (plant/fad)	SC162	4060.00	9457.00	5397.00	1.33
		SC168		9261.00	5201.00	1.28
		SC176		9817.50	5757.50	1.42
	27300 (plant/fad)	SC162	4105.00	10379.25	6274.25	1.53
		SC168		10295.25	6190.25	1.51
		SC176		10267.25	6162.25	1.50
	33600 (plant/fad)	SC162	4150.00	11002.25	6852.25	1.65
		SC168		10778.25	6628.25	1.60
		SC176		11189.50	7039.50	1.70
150 kg/fad	21000 (plant/fad)	SC162	4120.00	10113.25	5993.25	1.45
		SC168		9959.25	5839.25	1.42
		SC176		10216.50	6096.50	1.48
	27300 (plant/fad)	SC162	4165.00	10393.25	6229.25	1.50
		SC168		10697.75	6532.75	1.57
		SC176		10806.25	6641.25	1.59
	33600 (plant/fad)	SC162	4210.00	11352.25	7142.25	1.70
		SC168		11308.50	7098.50	1.69
		SC176		11623.50	7413.50	1.76
Mean of factors	90 kg/fad (A1)		4045.00	9848.22	5803.22	1.43
	120 kg/fad (A2)		4105.00	10271.92	6166.92	1.50
	150 kg/fad(A3)		4165.00	10718.94	6553.94	1.57
	21000 (plant/fad)(B1)		4060.00	9534.19	5474.19	1.35
	21000 (plant/fad) (B2)		4105.00	10307.11	6202.11	1.51
	21000 (plant/fad) (B)		4150.00	10997.78	6847.78	1.65
	SC 162 (C1)		4105.00	10243.92	6138.92	1.50
	SC 168 (C2)		4105.00	10150.78	6045.78	1.47
	SC 167 (C3)		4105.00	10444.39	6339.39	1.54

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إستجابة بعض هجن الذرة الشامية الصفراء تحت مستويات مختلفة من الكثافات النباتية والتسميد الآزوتى بمنطقة توشكى

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أجريت الدراسات الحقلية بمحطة البحوث الزراعية بجنوب الوادى بمنطقة توشكى خلال صيف موسمى ٢٠١٤ و ٢٠١٥ لتقييم ثلاث هجن فردية للذرة الصفراء (هـ. ف ١٦٢ ، هـ . ف ١٦٨ ، هـ . ف ١٧٦) تحت ثلاث كثافات نباتية (٢١٠٠٠ ، ٢٧٣٠٠ ، ٣٣٦٠٠ ألف نبات للفدان) و ثلاث مستويات من التسميد النيتروجينى المعدنى (٩٠ ، ١٢٠ ، ١٥٠ كجم نيتروجين للفدان) .

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :

أظهرت النتائج أن معدلات التسميد النيتروجينى كانت معنوية فى كل الصفات تحت الدراسة سواء كانت صفات النمو أو المحصول ومحتوى البروتين وكذلك كفاءة إستخدام النيتروجين ما عدا صفة مساحة ورقة الكوز/نبات . وقد أدى تطبيق النيتروجين بمعدل ١٥٠ كجم نيتروجين/فدان إلى زيادة معنوية فى محصول الحبوب قدرها ٤٣٤٠ ، ٤٢٣٥ كجم / فدان خلال موسمى ٢٠١٤ ، ٢٠١٥ على الترتيب .

وكذلك أنه كلما زاد كثافة عدد النباتات بالفدان كان هناك تأثير معنوى فى الصفات تحت الدراسة ما عدا صفة مساحة ورقة الكوز ، طول الكوز ، قطر الكوز ، عدد الحبوب بالصف ، محتوى البروتين. أدت زيادة الكثافة النباتية من ٢١٠٠٠ إلى ٣٣٦٠٠ ألف نبات للفدان إلى زيادة فى محصول الحبوب قدرها ١٣،٤٤ ، ١٧،٢٧ % خلال موسمى ٢٠١٤ ، ٢٠١٥ .

جميع الصفات تحت الدراسة كانت غير معنوية بين الهجن الفردية عدا صفة طول الكوز ، وكفاءة إستخدام النيتروجين ، ومحصول الحبوب خلال موسم ٢٠١٤ ، حيث أعطى الهجين الفردى ١٧٦ أعلى القيم ٤٢٤٦،٦ كجم/ فدان من محصول الحبوب .

وكانت تأثير التداخلات بين كل من التسميد النيتروجين والكثافات النباتية معنوياً فى صفات طول النبات ، وكفاءة إستخدام النيتروجين خلال الموسمين ، وصفة محصول الحبوب خلال موسم ٢٠١٥ وكان أعلى تداخل لمحصول الحبوب عند إستخدام ١٥٠ كجم نيتروجين وزراعة ٣٣٦٠٠ ألف نبات/فدان (٤٥١٠،٨ كجم/فدان) . وكان تأثير التداخل بين الكثافة النباتية وهجن الذرة الفردية معنوياً لبعض الصفات مثل طول الكوز ومحصول الحبوب وكفاءة إستخدام النيتروجين خلال موسم ٢٠١٤ ووزن ٥٠٠ حبة خلال موسم ٢٠١٥ . كما أوضحت النتائج أن هناك معنوية بين العوامل الثلاث فى صفة محصول الحبوب وكفاءة إستخدام النيتروجين خلال موسم ٢٠١٤ وقطر الساق موسم ٢٠١٥ .

أظهرت القيمة الإقتصادية بإن أعلى عائد نقدى أمكن الحصول عليه من زراعة الهجين الفردى ١٧٦ بكثافة نباتية ٣٣٦٠٠ ألف نبات/فدان مع إضافة ١٥٠ كجم نيتروجين/فدان .