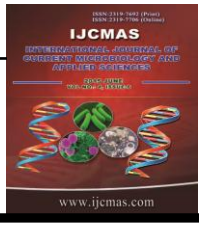
Int.J.Curr.Microbiol.App.Sci (2015) 4(6): 870-877

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 6 (2015) pp. 870-877**
http://www.ijcmas.com



Original Research Article

Maize productivity as affected by plant density and nitrogen fertilizer

Ayman H. A. Mahdi* and Samier. K. A. Ismail

Agronomy Department, Faculty of Agriculture, Fayoum University, 63514-Fayoum, Egypt

**Corresponding author*

Keywords

Maize,
Zea mays L.
Plant density
Nitrogen fertilizer
Correlation

A B S T R A C T

The effect of two plant density (i.e., 20000 and 24000 plant/fed.) and four levels of nitrogen (i.e., 60, 90, 120 and 140 kg/fed.) on yield and yield components of maize (*Zea mays* L.) was investigated in 2013 and 2014 seasons. The experimental arrangement was split plot in a randomized complete block design with three replicates. Plant densities were main factor, while sub-main factor was nitrogen levels. Results indicated that the effect of plant density on plant height, number of grains/row, grain yield and biological yield was significant. But, on ear length, number of rows/ear, 100-grain weight and harvest index was insignificant. Effect of nitrogen fertilizer on plant height, ear length, number of grains/row, grain yield and biological yield was significant. But, on number of rows per ear, 100-grain weight and harvest index was insignificant. Interaction effect of plant density and nitrogen fertilizer on all studied traits was significant. Plant density treatments of 24000 plant/fed. (D_2) produced highest grain yield of 3396.56 kg/fed. Among nitrogen levels, the highest grain yield of 4219.83 kg/fed. was obtained by 140 kg/fed., (N_4). The D_2N_4 (24000 plant/fed. along with 140 kg/fed.) interaction resulted in the highest grain yield of 4305.00 kg/fed. Simple correlation coefficient showed that, grain yield with yield components had a positive and significant correlation under effect of the studied treatments.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops grown principally during the summer season in Egypt. It globally ranks the third position among cereal crops after wheat and rice (Gerpacio and Pingali, 2007). Increasing maize production became one of the most important goals of the Egyptian agricultural policy to face the human and animal demands. This could be achieved through following the proper management systems which could lead to maximize its productivity.

Nitrogen fertilizer is a major nutrient for maize production in Egypt. Ideal N management optimizes grain yield, farm profit and N use efficiency, while it minimizes the potential for leaching of N beyond the crop rooting zone. Egyptian soils are known to be poor in available nitrogen due to their low content of organic matter

and the small amounts of organic manures added annually. Excessive N fertilization may results in low nitrogen use efficiency (NUE) and potentially exerts more pressure on the environment. Therefore, applying the optimum N level and suitable N carrier are most important means for raising yield of maize and improving plant N use efficiency. Alizade *et al.* (2007) found that the highest values grain yield, biological yield, number of grains per ear, number of grains per row, and harvest index were obtained by 450 kg/ha. Mohammadian *et al.* (2010) showed that yield reduction in corn due to nitrogen deficiency is higher than of other elements deficiency. Mekdad (2015) reported that increase in yield as a result of increasing nitrogen fertilizer levels may be due to the importance of nitrogen as one of the macronutrient elements for plant nutrition and its role in increasing vegetative growth through enhancing leaf initiation, increment chlorophyll concentration in leaves which may reflected in improving photosynthesis process. Improved cultural practices can play an important role in augmenting yield of maize crop. For an optimal yield, the nitrogen supply must be available according to the needs of the plant.

Optimum Plant density, controlling water, fertilizer and chemical inputs is essential for improving the growth variables responsible for high yield. Optimum plant density ensure the plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients. Higher plant density than optimum level, resulted in severe competition among plants for light above ground or for nutrients below the ground, consequently the plant growth slows down and the grain yield decreases. Tahmasbi and Mohasel (2009) showed that increase plant density significantly cause to grain yield growth and highest grain yield was recorded from 85000 Plant/ha with 11.13 t/ha. Saadat *et al.* (2010) indicated that the highest number of rows per ear and number of grains per ear was found from 40000 Plant/ha. The aim of this experiment was to study the effect of different plant density and various nitrogen fertilizer levels on yield and yield components of maize as well as to determine the optimum two treatments should be used by farmers.

Materials and Methods

Two field experiments were conducted at the experimental farm in Demo village, Faculty of Agriculture, Fayoum University, Egypt, during 2013 and 2014 seasons. The objective of this investigation was to study effect of different plant density and various nitrogen fertilizer levels on yield and yield components of maize cultivar (S.C.Wat.4) which was obtained from the Agricultural Research Center, Ministry of Agricultural, Egypt.

Treatments were randomly arranged in split-plot in a randomized complete block design with three replications where the two levels of plant density as main plots (D_1: 20000 plant/fed. each consisted of 70 x 30 cm and D_2: 24000 plant/fed. each consisted of 70 x 25 cm). Four levels nitrogen as sub plots (N_1: 60, N_2: 90, N_3: 120 and N_4: 140 kg/fed.) from urea source (46% N). The plot area was 10.5 m^2 (3 x 3.5) having 5 ridges of 3 m in length and 70 cm. in width. Planting date was on 13th and 17th of May in 2013 and 2014 growing seasons, respectively. Thinning to one plant per hill was done 30 days after planting. The preceding winter crop was sugar beet (*Beta vulgaris* L.) in both seasons. Physical and chemical analyses of the experimental soil site in both seasons are presented in Table 1.

At full maturity, five guarded plants were randomly taken from each sub plot to record the following traits:

- Plant height (cm).
- Ear length (cm).
- Number of rows per ear.
- Number of grains per row.
- 100-grain weight (g).
- Harvest index (%).

While, grain yield (kg/fed.) and biological yield (kg/fed.) were calculated on the plot bases.

Analysis of the data

Data were statistically analyzed according to the procedures of ANOVA of the Randomized Complete Blocks design in split plot outlined by Snedecor and Cochran (1990). Test of homogeneity of the data was applied and then combined analysis of variance was performed over the two seasons by Bartlett's test (Bartlett, 1937). The Duncan's multiple range tests (DMRT) was used to compare the treatment means at 5% of probability.

Results and Discussions

Analysis of variance

Mean squares of grain yield and its components are presented in Table 2. The effect of plant density on grain yield and biological yield at 1 % and on plant height, number of grains per row and harvest index at 5 % probability level was significant. On the other hand, effect of plant density on ear length, number of rows per ear and 100-grain weight was insignificant. Also, results in Table 2 reveal that the effect of nitrogen fertilizer on plant height, grain yield and biological yield at 1 % and on ear length and number of grains per row at 5 % was significant. Effect of nitrogen fertilizer treatments on number of rows per ear, 100-grain weight and harvest index was insignificant. Mean squares in Table 2 clear that the interaction effect of plant density (A) with nitrogen fertilizer (B) on plant height, grain yield and biological yield at 1 % and on ear length and number of grains per row at 5 % was significant. While, the interaction effect on number of rows per ear, 100-grain weight and harvest index was insignificant. This is in general agreement with the work done by Abuzar *et al.* (2011), Moosavi *et al.* (2012), Moraditochaee *et al.* (2012) and Bahadori *et al.* (2015).

Effect of plant density

Results presented in Table 3 indicate that yield and yield components were increased with the plant density increasing. The highest mean values of plant height (318.92 cm), number of grains per row (39.81), grain yield (3396.56 kg/fed.) and biological yield (9917.53 kg/fed.) were obtained with D_2 (24000 plants per fed.). While, the lowest values of the previously traits were recorded by 20000 plants/fed. (D_1) with 311.39 cm, 36.08, 3054.72 kg/fed. and 8861.03 kg/fed., respectively. Although, the effect of plant density on ear length, number of rows/ear, 100-grain weight and harvest index was insignificant, the higher values of these traits were related to D_2. Similar results were obtained by Lack *et al.* (2006), Gozubenli (2010), Rahmati *et al.* (2012), Karasahin (2014), Sorkhi and Fateh (2014), and Ijaz *et al.* (2015).

Effect of nitrogen fertilizer

Data in Table 3 reveal that increasing nitrogen fertilizer led to increases in yield and yield components. The highest values of plant height (340.33 cm), ear length (21.25 cm), number of grains per row (45.92), grain yield (4219.83 kg/fed.) and biological yield (12144.25 kg/fed.) were obtained by use of 140 kg/fed., (N_4). N_2, N_3 and N_4 showed insignificant values for ear length and number of grains/row with favorable of N_4 which gave 21.25 cm and 45.92 for the two traits, respectively.

Table.1 Physical and chemical properties of experimental field soil

Sand	Silt	Clay	Soil texture	PH	ECe dS/m	Organic matter %	Total N (%)	Available P (ppm)	Available K (ppm)
79.17	8.91	11.93	Sandy loam	7.65	4.15	0.95	0.071	4.73	151.51

Table.2 Analysis of variance for the maize traits studied under effect of plant density and nitrogen fertilizer (combined data over 2013 and 2014 seasons)

Source of variance	df	Plant height (cm)	Ear length (cm)	No. of rows/ ear	No. of grains/ row	100-grain weight (g)	Grain yield (kg/fed.)	Biological yield (kg/fed.)	Harvest index (%)
Replicates	2	17.73	39.25	2.03	0.03	21.45	3703.75	5834.21^{ns}	0.05
Plant density (A)	1	207.03*	87.25	9.93	1.07*	2105.13	813485.25**	1163124.94**	171.59*
Error (a)	2	25.91	9.13	1.75	0.05	227.58	7064.21	9154.31	7.35
Nitrogen (B)	3	895.85**	12.27*	1.79	0.29*	13.25	21634.27**	57222.21**	5.23
A x B	6	575.37**	9.09*	1.25	0.25*	1139.25	15596.81**	54175.53**	13.27
Error (b)	9	79.83	2.15	0.59	0.07	822.71	2187.49	5539.42	11.02

*and** = Significant at P ≤ 0.05 and 0.01, respectively.

Table.3 Effect of plant density and nitrogen fertilizer on yield and yield components of maize combined data over 2013 and 2014 seasons

Treatments	Plant height (cm)	Ear length (cm)	No. of rows/ear	No. of grains/row	100-grain weight (g)	Grain yield (kg/fed.)	Biological yield (kg/fed.)	Harvest index (%)
Plant density (D)								
20000 plant/fed. (D_1)	311.39b	18.00a	14.00a	36.08b	20.09a	3054.72b	8861.03b	34.25a
24000 plant/fed. (D_2)	318.92a	18.94a	14.33a	39.81a	21.30a	3396.56a	9917.53a	34.47a
Nitrogen levels (N)								
60 kg/fed. (N_1)	314.33d	17.67b	13.50a	39.92b	21.24a	3620.17c	10493.79c	33.88a
90 kg/fed. (N_2)	321.42c	21.21a	14.50a	45.17a	22.90a	3945.67b	11543.04b	34.18a
120 kg/fed. (N_3)	332.67b	20.92a	14.50a	45.50a	22.90a	3958.50b	11683.70b	34.50a
140 kg/fed. (N_4)	340.33a	21.25a	14.83a	45.92a	22.95a	4219.83a	12144.25a	34.75a

Table.4 Effect of the interaction between plant density (D) and nitrogen fertilizer (N) on yield and yield components of maize (combined data over 2013 and 2014 seasons)

Treatments	Plant height (cm)	Ear length (cm)	No. of rows/ear	No. of grains/row	100-grain weight (g)	Grain yield (kg/fed.)	Biological yield (kg/fed.)	Harvest index (%)
$D_1 \times N_1$	311.17e	18.67c	13.00b	41.67d	41.67d	3626.00d	10511.13e	34.50ab
$D_1 \times N_2$	318.33d	21.83a	14.67a	46.67ab	46.67ab	3689.00d	10901.63d	33.84b
$D_1 \times N_3$	331.17b	19.17bc	14.00ab	42.33d	42.33d	4104.33b	11901.70b	34.49ab
$D_1 \times N_4$	336.17b	22.00a	14.67a	46.50ab	46.50ab	4202.33ab	12196.90a	34.45ab
$D_2 \times N_1$	317.50d	16.67d	14.00ab	38.17e	38.17e	3614.33d	10476.43e	34.50ab
$D_2 \times N_2$	324.50c	20.67ab	15.00a	43.67cd	43.67cd	4134.66b	12116.76a	34.12ab
$D_2 \times N_3$	334.17b	20.50ab	15.03a	45.33bc	48.67a	3812.66c	11465.69c	33.25b
$D_2 \times N_4$	344.50a	22.67a	14.33ab	48.67a	45.33bc	4305.00a	12159.27a	35.41a

Within each column, treatments that carry the same superscript letter are not significantly different at P< 0.05.

Table.5 Simple correlation coefficients of yield and yield components on maize under effect of plant density and nitrogen fertilizer (combined data over 2013 and 2014 seasons)

Traits	Grain yield	Plant height	Ear length	No. of rows/ear	No. of grains/row	100-grain weight	Biological yield	Harvest index
Grain yield	1							
Plant height	0.611*	1						
Ear length	0.963**	0.399	1					
No. of rows/ear	0.581*	0.231	0.245	1				
No. of grains/row	0.803**	0.351	0.897**	0.783**	1			
100-grain weight	0.489	0.279	0.333	0.425	0.353	1		
Biological yield	0.917**	0.521*	0.611*	0.393	0.378	0.419	1	
Harvest index	0.515*	0.331	0.389	0.231	0.289	0.557*	0.327	1

*and** = Significant at $P \leq 0.05$ and 0.01, respectively.

The N_1 treatment (60 kg/fed.) was recorded the lowest values of all studied traits. On the other hand, the effect of nitrogen fertilizer on number of rows/ear, 100-grain weight and harvest index was insignificant. The obtained results may be in line with those detected by El-Gizawy and Salem (2010) and Iqbal *et al.* (2015).

Interaction effects

The interaction effects of plant density with nitrogen fertilizer on yield and yield components are presented in Table 4. The highest values of plant height, ear length, number of grains per row, grain yield, biological yield and harvest index were obtained by D_2N_4 (24000 plants/fed. along with 140 kg/fed.) treatment, respectively, with 344.50 cm, 22.67 cm, 48.67, 4305.00 kg/fed., 12159.27 kg/fed., and 35.41 %. Maximum number of rows/ear and 100-grain weight was produced by D_2N_3 (24000 plants per fed. along with 120 kg/fed.) treatment, respectively, with 15.03 and 48.67 g. The lowest values of plant height (311.17 cm) and number of rows/ear (13.00) were recorded from D_1N_1 (20000 plants/fed. along with 60 kg/fed.). The D_2N_1 (24000 plants/fed. along with 60 kg/fed.) recorded lowest ear length, number of grains per row, grain yield, 100-grain weight and biological yield with 16.67 cm, 38.17, 38.17 g., 3614.33 kg/fed., and 104.76 kg/fed., respectively. On the other hand, the lowest harvest index value (33.25 %) was obtained by D_2N_3 (24000 plants/fed. long with 120 kg/fed.). These results are in agreement with those mentioned by Shoa *et al.* (2009), Bello *et al.* (2010), Rafiq *et al.* (2010) and Dawadi and Sah (2012).

Correlation among traits

The results of correlation among yield and yield components are presented in Table 5. Correlation coefficients showed that grain yield with plant height, ear length, number of grains per row, biological yield, number of rows/ear, 100-grain weight and harvest index had a positive and significant correlation. In addition, number of grains per row was positive and significantly correlated with ear length and number of rows/ear. Biological yield with plant height and ear length showed a positive and significant correlation. The highest positive, direct and significant correlation coefficient (0.963**) was related to correlation between grain yield with ear length indicating its contribution as important yield component. The results of this analysis are in agreement with Shoa *et al*. (2009) and Mohammadian *et al*. (2010).

It could be concluded from the results of this study that, the highest grain yield (4305.00 kg/fed) was achieved from the highest plant density (24000 plant/fed.) and use of 140 kg/fed., nitrogen. Grain yield with yield components had a positive and significant correlation.

References

Abuzar, M.R., Sadozai, G. U., Baloch, A.A., Shah, I. H., Javaid, T., Hussain, N. 2011. Effect of plant population densities on yield of maize. *J. Anim. Plant Sci.*, 21(4): 692-695.

Alizade, O., Majidi, I., Nadian H.A., Nour, G.H. 2007. Effect of drought stress and nitrogen rates on yield and yield components of corn. *I.A.U. J . Agric. Sci.*, 13(2): 427-437.

Bahadori, A., Mobasser, H.R., Ganjali, H.R. 2015. Influence of water stress and plant density on some characteristics in corn. *J. Int. & Biological Forum.* 7(1): 673-678.

Bartlett, M.S. 1937. Properties of sufficiency and statistical tests.

Proceedings of the Royal Society of London Series A. 160, 268-282.

Bello, O.B., Abdulmaliq, S.Y., Afolabi, M.S., Ige, S.A. 2010. Correlation and path coefficient analysis of yield and agronomic characters among open pollinated maize varieties and their F1 hybrids in a diallel cross. *Afr. J. Biotechnol*, 9 (18): 2633-2639.

Dawadi, R., Sah, S.K. 2012. Growth and yield of hybrid maize (*zea mays* l.) in relation to planting density and nitrogen levels during winter season in Nepal. *Tro. Agric. Res., 2*3 (3): 218-227.

El-Gizawy, N.Kh.B. Salem, H.M. 2010. Influence of nitrogen sources on yield and its components of some maize varieties. *World J. Agric. Sci.,* 6 (2): 218-223.

Gerpacio, V. R. and Pingali, P. L. 2007. Tropical and subtropical maize in Asia: production systems, constraints and research priorities. CIMMYT, Mexico, ISBN: 978-970-648-155-9. p. 93.

Gozubenli, H. 2010. Influence of planting patterns and plant density on the performance of maize hybrids in the eastern Mediterranean conditions. *Int. J. Agric. Biol.,* 12: 556-560.

Ijaz1, M.M., Raza, A. S., Ali, S., Ghazi, K. Yasir, T.A., Saqib, M. Naeem, M. 2015. Differential planting density influences growth and yield of hybrid maize (*Zea mays* L.). *J. Environ. & Agric. Sci.* 2: 1-4.

Iqbal, M.A., Ahmad, Z., Maqsood, Q., Afzal1, Sh., Ahmad, M.M. 2015. Optimizing nitrogen level to improve growth and grain yield of spring planted irrigated maize (*Zea mays* L.). *J. Advanced Botany & Zoology* 2: 1-4.

Karasahin, M. 2014. Effects of different irrigation methods and plant density on silage yield and yield components of PR 31Y43 hybrid corn cultivar. *Turk. J. Agric. For.,* 38: 159-168.

Lack. SH., Naderi, A., Siadat, S. A., Ayenehband, A., Noor, G.h. 2006. Effect of different levels of nitrogen and plant density on grain yield, its components and water use efficiency in maize (*Zea mays* L.) cv. SC. 704 under different moisture conditions in Khuzestan. *Iran J. Agron. Sci.,* 8: 153-170.

Mekdad, A.A.A. 2015. Sugar beet productivity as affected by nitrogen fertilizer and foliar spraying with boron. *Int. .J. Curr. Microbiol. App. Sci*., 4(4): 181-196.

Mohammadian R., Sadeghi, N., Azarpour, S.M., Bozorgi, E. H.R., Moradi, M. 2010. Study effect of different levels of nitrogen fertilizer and planting density on yield and yield components of corn cultivar SC704. Proceeding of 11th Iranian Crop Science Congress. 24-26: 2758-2761.

Moosavi, S.G., Seghatoleslami, M.J., Moazeni, A. 2012. Effect of planting date and plant density on morphological traits, LAI and forage corn (Sc. 370) yield in second cultivation. *Int. Res. J. Appl. Basic. Sci.,* 3 (1): 57-63.

Moraditochaee, M., Motamed, M.K., Azarpour, E., Danesh, R.K. and Bozorgi, H.R. 2012. Effects of nitrogen fertilizer and plant density management in corn farmingarpn. *J. Agric. & Biol. Sci.,* 7(2): 132-137.

Rafiq, M.A., Ali, A., Malik, M. A. and Hussain M. 2010. Effect of fertilizer levels and plant densities on yield and protein contents of autumn planted maize. *Pak. J. Agri. Sci.,* 47(3): 201-208.

Rahmati, H. 2012. Effect of plant density and nitrogen rates on morphological

characteristics grain Maize. *J. Basic. Appl. Sci. Res.*, 2(5): 4680-4683.

Saadat, S.A., Miri, H.R., Haghighi, B. 2010. Study effect of density on yield and yield components in corn hybrids. Proceeding of 11th Iranian Crop Science Congress, 24-26:.2914-2917.

Shoa, M.M., Golbashy, M., Farsi, S., Khorasani, M., Beirag, A. 2009. Evaluation of correlation between yield and its dependent trait in single cross corn hybrids under drought stress. Abstract book of 1st regional conference on tropical crops production under environmental stresses condition. Islamic Azad Univ., Khozestan Sci. & Research Branch. p. 72.

Snedecor, G.W., Cochran, W.G. 1990. Statistical Methods 8th Ed. Iowa State Univ. Press Ames, Iowa, U.S.A.

Sorkhi, F., Fateh, M. 2014. Effect of density on grain yield, biological yield and harvest index on corn hybrids of SC 301 and SC 320. *Int. J. Biosci.*, 5(6): 21-26.

Tahmasbi, A., Mohasel, M.H. 2009. The effect of density and planting pattern on yield and yield components of two corn hybrids (KSC700 and KSC704) in Kurdistan. *J. Iran Agron. Res.*, 7(1): 105-113.