Research Journal of Agriculture and Biological Sciences, 2(4): 156-161, 2006

Effect of N-Fertilizer and Plant Density on Yield and Quality of Maize in Sandy Soil.

Zeidan, M.S., Amany A. Bahr El-Kramany, M.F.

Department of Field Crops Research, National Research Center Dokki, Giza, Egypt

Abstract: Two field experiments were conducted during the two seasons of 2004and 2005 in a private farm at El-Nagah village, south El-Tahrir provience, Al-Behaira. Governorate, Egypt to study the effect of N-fertilizer rates (i. e. 0, 100, 120and 140 kg N/fed.) and row spacing of (15, 20 and 25cm) on yield, selected plant parameters and nutrient content of maize (Zea mays L.). The experiment was arranged in a split-plot design in three replicates. The results indicated that the ear height, ear length, ear weight, grain number/ear, 100grain weight, grain yield ardab/fed, N, P% and Mn, Cu ppm contents in leaves, N, protein% in grains. Results also indicated that row spacing had significant effects on silking date, plant height, stem width and height, length, ear weight, grain number/ear, 100 grain weight, grain yield ardab/Bed, N% and Fe ppm in leaves and (N and protein%) in grains. Data also indicated that the interaction between N rates and row spacing had significant effect in ear height and weight, grain N and protein%.

Key words: Maize-N-Fertilizer-row spacing.

INTRODUCTION

Maize is one of the major cereal crops grown in Egypt. It ranks the third position among cereal crops after wheat and rice, which ranked as first and the second, respectively, many factors affect grains yield of maize such as genetic constitution, fertilization and plant population. Maize grain yield is a result of grain yield per plant and number of plant per unit area. Therefore, studying the effect of plant density on grain yield is necessary for a wide range of conditions. The trend towards higher N fertilizer rates, modern hybrid respond more favourably to high plant densities in part because of a higher Leaf Area Index (L A I) at silking, which results in more interceptiono f photosynthetic active radiation and have a higher radiation use efficiency during grain filling[21]. Many investigator found that N application increased grain yield and its components of maize.

Samira *et al.*,[17] and Torbert *et al*.,[22] found that yield and yield component of maize were increased by increasing the rate of applied nitrogen, El-Sheikh[7] reported that applying 160KgN/Fed. significantly increased ear characters and grain yield of maize. Ali *et al.*,[1] reported that the competition between maize plants for light, soil fertility and other environment factors was markedly increased in case highest population. Tantawy *et al*.,[20] reported the same trend Ulger *et al.*,[23] found that 25cm row spacing gave the highest grain yield of maize[9] stated the opposite trend.

The purpose of the present investigation was to study the effect of three row spacing and four nitrogen rates on yield and its quality of maize in new reclaimed sandy soil under sprinkler irrigation system.

MATERIALS AND METHODS

Two field experiments were carried out at El-Nagah village, South El-Tahrir Province, Al-Behaira Governorate, Egypt during two successive summer growing seasons of 2004 and 2005 to study the response of maize plants single hybrid 10(S.H.10) to row spacing and levels of nitrogen fertilization in newly reclaimed land.

The physico-chemical properties of the soil are shown in Table 1. The treatments were arranged in a split plot design with three replicates N levels treatment (80, 100, 120 and 140 Kg N/Fed.) as ammonium nitrate in the main plots (Control = 80kgN/fed.), while row spacing (15, 20 and 25 cm) were allocated at random in the sub-plots.

The plot size was 3x3 5m Each treatment received 60 kg P_2O_5/fed. as single super phosphate and 50 kg k_2O/fed as potassium sulphate as soil application before sowing. Maize grains were sown at 15, 18 May.

Random samples of ten guarded plants in each plot were taken to estimate the following characters,

1-Silking date 2-Plant height (cm)
3-Stem width (cm) 4-Ear height (cm)
5-Ear length (cm) 6-Ear weight (g)

Corresponding Author: M.S. Zeidan, Department of Field Crops Research, National Research Center Dokki, Giza, Egypt.

Table 1: Physical and chemical analysis of the soil in experimental site.

								Available		
Sand (%)	Silt (%)	Clay (%)	Soil texture	pH	EC	O.M (%)	CaCo3	N ppm	P ppm	K ppm
94.0	2.35	3.65	Sandy	7.84	1.43	1.32	2.35	60	15.0	106.0

7-Grain number/ear 8-100-grain weight (g)
9-Grain yield ardab/fed. (ardab = 140kg).

Leaf and grain chemical analysis: Leaf samples were collected from each plot at silking stage[11]. The samples were washed with tap water, dried at 70°C 24 h. then grounded. Total leaf tissue N was determined by a Semimicro-kjeldahl procedure[3], P measured using the colorimetric molybdenum blue procedure[14] and Cu, Fe, Mn and Zn by atomic absorption spectrometry. Potassium was determined by a flame photometer. Representative grain samples from randomly selected ears of each plot at harvest were dried ground similar the preparation of leaf samples and analyzed.

Statistical analysis: the data were analyzed for the analysis of variance[19] using the MSTAT-C program

RESULTS AND DISCUSSION

Growth characters, grain yield and its component
Response to N application: Table 2 indicate clearly that nitrogenous fertilizer had a significant effect on ear height, ear length, ear weight, grain number/ear, 100-grain weight and grain yield ardab/fed. during 2005 season, except ear height and grain yield ardab/fed. were significant only during 2004 and 2005 seasons respectively.

Maize grown in soil amended with 140 kg N/fed gave the highest traits compared with the control, the increase might be due to increased availability of N, causing accelerated photosynthetic rate and thus leading to the production of more carbohydrates[4] reported that applied N tended to improve plant growth and development of yield attributes which in turn resulted in increasing seed yield. Heuberger[10] stated that nitrogen stress delayed siliking, increased the interval between anthesis and silking and decreased the duration of grain filling by 3-4 days and reduce skin capacity and grain yield of maize. Mi *et al.*,[12] reported that, when the N status of the soil is high N application can effect on the grain yield of maize. Increased grain yield and yield components due to application of high N were reported by[7,9,17,18,23].

Effect of row spacing: The influence of row spacing on selected plant parameters, namely silking date, plant height, stem width, ear height, ear length, ear weight, grain number/ear, 100-grain weight and grain yield ardab/fed are presented in Table 3. Row spacing had significant effects on the number of days from planting to silking in 2005 season only, the differences between the two seasons in terms of silking may be attributed the differences in climatic factors. In 2005 plant height and stem width in both years were significantly decreased as the row spacing increased from 15 to 25 cm, all the other yield characters studied ear height in both years ear weight, in 2004, grain number/ear in 2004 and 100-grain weight in 2004 were increased significantly by increasing row spacing from 15 to 25 cm. row spacing of 25 cm gave the highest grain yield/fed compared with 15 and 20 cm. The decrease in ear weight, grain number/ear, 100-grain weight and grain yield under 15cm row spacing may be due to the lower amounts of metabolites in leaves as a results of high competition for light, water and minerals. Yao and Shaw[24] found that the use of narrow rows will result in a higher efficiency of light interception and water utilization. Prine and Schroeder, (1964)stated that increasing plant population resulted in reduction of grain yield per plant. Griesh and yakout[9] reported that increasing plant population density of days to tussling and similar findings were recorded by[8,16,20,23].

Leaf nutrient content
Effect of N levels: Table 4 show significant increase in N, P%, Mn and Cu ppm in leaves of maize with increasing the application rates of nitrogen fertilizer. The highest values of N, P, Mn and Cu were 3.5, 0.33, 88.7 and 15.0 in leaves were obtained under the application rates of 140 kg N/fed. Whereas the lowest content were observed with the lowest rates of N fertilizer. Ashour and Salah[2] indicated that the increase in nitrogen concentration in leaves of maize plant with increasing the levels of nitrogen might be attributed to the supplemental amounts of nitrogen applied to plants. Olgunlela *et al*.,[15] found that Mn concentration increased as N rate was increased. Many factors have been found to be involved in the simulation of P absorption by plants, these being (1) increased root growth, (2) a decrease in the rhizosphere pH and increased solubility of soil P and (3) an increased physiological capacity of the root to absorb P Miller[13] and El-Tapey[5] found the same results.

Effect of row spacing: Table 5 shows N, P, K%, Fe, Mn, Zn and Cu ppm contents in leaves as affected by row spacing 20 cm row spacing gave the highest N, Mn and

Table 2: Growth characters , grain yield and its components of maize as affected by N rates during 2004 and 2005 seasons.

N Kg/fed.	Silking date	Plant height (cm)	Stem width (cm)	Ear height (cm)	Ear length (cm)	Ear weight (g)	Grain number /ear	100-g weight (g)	Grain yield ardab/fed
1st season 2004									
Control	49.3	232	21.3	111.0	20.3	194.7	563.7	28.7	21.3
100	50.1	234.3	22.1	111.7	20.4	199.3	576.3	29.3	22.0
120	51.0	234.7	22.3	115.3	21.3	219.3	584.0	31.0	22.3
140	50.7	236.5	23.0	119.7	21.8	216.3	602.3	30.3	22.7
F. Test	Ns	Ns	Ns	0	0	0	0	0	Ns
2ndseason 2005									
Control	55.7	221.3	22.3	110.0	20.7	216.7	621.0	32.3	20.7
100	57.3	228.7	22.7	115.3	20.7	219.0	631.7	63.7	21.3
120	56.7	229.3	23.3	116.7	21.3	250.0	677.7	38.0	22.3
140	57.0	229.4	24.3	118.7	22.0	255.9	685.0	38.7	23.0
F. Test	Ns	Ns	Ns	Ns	**	0	**	**	**

*= significant at 0.05, **= significant at 0.01, NS= Not significant

Table 3: Growth characters, grain yield and its components of maize as effected by row spacing during 2004 and 2005 seasons.

Row spacing (cm)	Silking date (day)	Plant height (cm)	Stem width (cm)	Ear height (cm)	Ear length (cm)	Ear weight (g)	Grain number /ear	100-g weight (g)	Grain yield ardab/fed
1st season 2004									
15	51.3	236.02	21.02	117.3	19.3	178.3	535.0	29.0	21.0
20	50.3	324.3	22.0	109.5	21.8	223.3	583.3	30.5	23.3
25	50.3	232.8	23.5	109.0	21.5	220.8	626.5	30.0	23.9
	Ns	Ns	0	**	**	**	**	0	**
2ndseason 2005									
15	57.3	228.8	21.3	121.0	21.0	228.8	634.5	36.7	21.0
20	55.8	226.0	23.5	115.0	21.3	234.0	644.3	37.3	21.8
25	57.0	222.8	24.5	109.5	21.0	243.3	682.8	35.3	22.8
F. Test	0	**	**	**	Ns	Ns	Ns	Ns	**

* = Significant at 0.05, ** Significant at 0.01, NS= Not significant

Cu content, while 25 cm row spacing gave the highest P, Fe, Zn contents. 15cm within gave the highest K%. This may be due to the few plants per unit area, they may be able to receive from relatively large volume of soil available to the individual plant an a adequate supply of plant nutrients. There were significant differences in N% and Fe ppm only. Olgunlela *et al*.,[15] reported that increasing planting density did not influence the concentration of Mn, Zn, Cu and Fe in the ear leaf. Ulger *et al*.,[23] found the same results.

Table 4: Macro and micro nutrient contents in leaves of maize as affected by different N rates (combined of 2004 and 2005 seasons).

N kg/fed	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Control	2.5	0.26	2.10	1223	73.7	177	9.0
100	3.3	0.29	2.06	126.0	877	18.7	9.3
120	3.3	0.32	2.08	136.0	87.7	18.7	9.7
140	3.5	0.33	2.37	139.0	88.7	19.3	15.0
F test	0	0	Ns	Ns	0	Ns	**

Table 5: leaves N P K % and Mn ,Zn, Fe and Cu ppm as affected by row spacing (combined of 2004 and 2005 seasons).

Row spacing (cm)	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
15	2.95	0.29	2.21	124.8	85.3	17.3	12.0
20	3.35	0.30	2.13	133.8	87.8	19.0	12.3
25	3.13	0.30	2.13	135.9	80.3	19.3	11.75
F Test	0	Ns	Ns	0	Ns	Ns	Ns

Macro-nutrients and protein content in maize grain

Effect of N rates: Table 6 show the effect of N rates on the chemical contents of maize grain N, P, K and protein%. Increasing nitrogen rates from 80 to 140 kg N/fed to maize plant caused a significant increase in N, P, K, content (P=0.05) and protein content (P=0.05). El-Sersawy *et al*.,[6] mentioned that nitrogen has positive effect on root growth and the absorbing sites which enhance absorption of nutrients especially p having low mobility. When the N status of the soil is low the application of N will affect the grain protein content and when the soil N is high N application can affect both grain protein content and the grain yield[12].

El-Tapey[5] found that higher values of N, P and K% were observed in grain when maize fertilized with higher N rates.

Table 6: Grain N, P, K and protein % as affected by N rates (combined of 2004 and 2005 seasons).

Grain content				
N kg/fed	N%	P%	K%	Protein%
Control	1.47	0.25	1.25	9.6
100	1.59	0.28	1.34	10.0
120	1.61	0.30	1.47	9.7
140	1.64	0.36	1.97	10.5
F Test	0	0	0	0

* = Significant at 0.05, ** Significant at 0.01, NS=Not significant

Table 7: N ,P, K% and protein contents in maize grain as affected by row spacing (combined of 2004 and 2005 seasons)

Row spacing (cm)	N%	P%	K%	Protein%
15	1.49	0.26	1.35	9.65
20	1.53	0.28	1.49	10.08
25	1.71	0.36	1.69	10.13
F Test	**	NS	NS	0

*=Significant at 0.05, **=Significant at 0.01, NS = Not Significant

Table 8: Effect of interaction between nitrogen levels and row spacing on ear height, ear weight, grain N and protein % (Combined of 2004 and 2005 seasons).

Treatments N kg /fed	Row spacing	Ear height (cm)	Ear weight (g)	Grain N (%)	Protein (%)
	15	119.0	189.0	1.20	8.3
80	20	111.0	214.0	1.50	10.3
	25	105.0	195.0	1.80	10.4
	15	126.0	193.0	1.46	9.8
100	20	111.0	227.0	1.44	9.8
	25	106.0	207.0	1.81	12.4
	15	128.0	169.0	1.43	9.7
120	20	110.0	242.0	1.41	9.8
	25	108.0	250.0	1.32	9.4
	15	116.0	185..0	1.60	10.8
140	20	106.0	235.0	1.56	10.4
	25	107.0	234.0	1.51	10.2
F. Test		**	**	**	**

** Indicate the significant at 0.01 probability level.

Effect of row spacing : Table 7 show that N% and protein% in grains of maize were significantly (p=0.05) affected by row spacing. On the other hand neither P nor K% affected by row spacing. Maize grains took up the lowest N and Protein from the narrow row spacing of 15cm on the other hand, the highest N and protein in grains were recorded when maize planted at 25 cm row spacing, results were in accordance with Ulger *et al*.,[23] and Ragheb *et al*.,[16] found the same result.

Effect of interaction: Nitrogen fertilizer levels, row spacing interaction (Table 8) was significant for ear height, ear weight, grain N and protein% content, on the other hand, other studied characteristics had not significant effects by the interaction. Row spacing of 15 cm with 120 kg N/fed gave the highest ear height. B-

25 cm row spacing with 120 kg N/fed gave the highest ear weight. C-25 cm row spacing with 100kg N/fed gave the highest N% and protein content in grain of maize in 2004 season.

REFERENCES

1. Ali, A.A., G.M.A. Mohgoub and A.M. Awad, 1994. Response of white-maize hybrid (S.C.10) to nitrogen at different plant density distributions. J. Agric. Sci. Mansoura Univ., 19: 3597-3605.
2. Ashour, N.I. and S.A. Salah, 1973. Effect of foliar nutrition with urea on growth, nitrogen content and yield of wheat plant. Black (Ed.), Methods of Agronomy, Madison, W I. Egypt J. Bot., 16: 37-42.
3. Bremmer, J.M., 1965. Total Nitrogen, In C.A. pp: 1149-1176.
4. Chauhan, D.R., S. Paroda, O.P. Kataria and K.P. Singh, 1995. Response of Indian mustard (*Brassica Juncea*) to bio-fertilizers and nitrogen. Indian. J. Agron. 40: 86-90.
5. El-Tapey, H.M.A., 2002. Effect of farmyard manure, N-fertilizer and bio fertilization on growth, yield and chemical composition of maize plant grown on calcareous soil Egypt J. Appl. Sci; 17: 363-374.
6. El-Sersawy, M.M., B.F. El-Ghany, K.W. Khalil and S.Y. Awadalla, 1997. Interaction between organic manure mixtures, applied N-level and bio fertilization on calcareous soil properties and wheat production in Wadi Sidre, South Sinai. Egypt, J. Soil Sci. 37: 376-39
7. El-Sheikh, F.T., 1998. Effect of soil application of nitrogen and foliar application with manganese on grain yield and quality of maize (*Zea mays*, L) proc. 8th Conf. Agron., Suez Canal Univ., Ismailia, Egypt, 28-29 Nov., pp: 182-189.
8. Farnham, D.E., 2001. Row spacing, plant density and hybrid effect on corn grain yield and moisture. Agronomy J. 39: 1049-1053.
9. Griesh, M.H. and G.M. Yakout, 2001. Effect of plant population density and nitrogen fertilization on yield components of some, white and yellow maize hybrids under drip irrigation system in Sandy soil. In W. J. Horst, W.J., M.K. Schenk, A. Buerkert *et al.,* (Eds.) plant Nutrition. Food Security and Sustainability of Agro Ecosystems. Kluwer Academic publishers, the Netherlands, Dordrecht, the Netherlands, pp: 810-811.
10. Heuberger, H., 1998. Nitrogen efficiency in tropical maize: indirect selection criteria with special emphasis on morphological root characteristics. Verlag Ulrich E. Grauer, Stuttgart, Germany.
11. Jones, Jr. J.B. and W.J.A. Steyn, 1973. Sampling, handling and analyzing plant tissue samples, In: Wash L.M. and J.D. Beaten (Eds.). Soil Tests and Plant Analysis. Revised ed. Soil Science Society of America, Madison, W I. pp: 249-270.
12. Mi, G., J. Li, F. Chen, F. Zhang, Z. Cui and X. Liu, 2001. Nitrogen uptake and remobilization in maize hybrids differing in leaf senescence. In: Horst, W.J. M.K. Schenk and A. Buerkert, *et al.,* (Eds.) Plant Nutrition. Food Security and Sustainability of Agro Ecosystems. Kluwer Academic Publishers. Dordrecht, The Netherlands, pp: 68-69.
13. Miller, M.H., 1974. Effects of nitrogen and phosphorus absorption by plants, In: Carson E.W. (Eds.), The plant root and its Environment, Univ. Press of Virginia, Charlottesville. VA. pp: 643-668.
14. Murphy, J. and J.P. Riley, 1962. A modified single solution method for the determination of phosphate in natural waters. Anal. Chim Acta, 27: 31-36.
15. Olgunleia, V.B., G.W. Amoruwa and Ologunde 1988. Growth yield components and micronutrient nutrition of field grown mazie (*Zea mays L.*) as affected by N fertilization and plant density. Fert. Res., 17: 189-196.
16. Ragheb. M.M.A., A.A. Bedeer and A.Sh. Gouda, 1993A. Effect of row spacing and plant population density on grain yield of some maize hybrids. Zagazig J. Agric. Res., 20: 581-594.
17. Samira M., A. Hussein, M.A. Haikel and M.A. El-Masry, 1998. Effect of some preceding crops, hill spacing and nitrogen fertilization on yield attributes and grain yield of maize under. reclaimed sandy soil conditions in East Delta. proc. 8th Conf. Agron., Suez Canal Univ., Ismailia, Egypt, 28-29 Nov. pp: 174-181.
18. Satchithanantham, S. and D.C. Bandara, 2001. Effects of nitrogen fertilizer and irrigation on growth performance of maize *(Zea mays L.*) in the mid country of Sirilanka Tropical Agric. Res., 13: 431-434.
19. Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics ;A Biometrical Approach 2nd Ed. Me Graw Hill Book Company, New York, NY.
20. Tantawy, A.A., M.A. Yousef and M.S. Meky, 1998. The effect of plant population and weed control treatments on yield, yield components and chemical contents of some maize varieties (*Zea mays L.*). Proc. 8th Conf. Agron., Suez Canal Univ., Ismailia, Egypt, 28-29 Nov., pp: 190-200.
21. Tollenaar, M. and A. Aguilera, 1992. Radiation use efficiency of an old and a new maize hybrid. Agron, J., 84: 536-541.

22. Torbert, H.A., K.N. Potter and J.E. Morrison, 2001. Tillage system, fertilizer nitrogen rate and timing effect on corn yields in the Texas Blackland prairie. Agron. J., 93: 1119-1124.
23. Ulger, A.C., H. Ibrikei, B. Cakir and N. Guzel, 1997. In: flounce of nitrogen rates and row spacing on corn yield, protein content and other plant parameters. J. plant Nutrition, 20: 1696-1709.
24. Yao, A.Y.M. and R.H. Shaw, 1964. Effect of plant population and planting pattern of corn on the distribution of net radiation. Agron. J., 56: 165-169.