Response of Two Maize Hybrids to Spatial Distribution and Nitrogenous Fertilization Rates

Gomaa, M. A., F.I. Radwan, E. E. Kandil and M. A. Emhemmed
Plant Production Department, Faculty of Agriculture (Saba Basha), Alexandria University, Alexandria, Egypt

ABSTRACT: To investigate the response of two maize hybrids to spatial distribution and nitrogen fertilization rates. In this respect, two filed experiments were conducted at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University during 2014 and 2015 seasons in a split- split plot design. Whereas, three factors can be illustrated as follows: the main plot included two maize hybrids (30N11 and 31G98), while, plant spacing (20, 30 and 40 cm) was arranged in the sub plots, while nitrogen fertilization (192, 288 and 384 kg N/ha.) allocated in sub- sub plot. The obtained results cleared that maize hybrid 30N11 recorded higher plant height (cm), ear weight (g), grain weight/ear (g), number of grains /ear, 1000-grains weight (g), number of rows/ear, grain yield (t/ha), biological yield (t/ha), harvest index (%), grains NPK and protein contents than the other hybrid 31G98 in the first and second seasons, respectively. The highest means values of yield and chemical composition characters were obtained using nitrogen fertilizer at rate of 384 kg/ha., in both seasons, while the lowest ones were recorded by application of nitrogen at 192 kg/ha., in both seasons. Wider spacing between plants (40 cm) produced the higher yield and its components and protein content and NPK in the two successive seasons than narrower spacing (20 cm) which produced the lowest mean values of these characters.
Key words: maize; hybrids; spatial distribution; nitrogen rates; yield; chemical composition

INTRODUCTION

Maize (*Zea mays* L.) is the third most important staple food crop in terms of area and production after wheat and rice in Egypt. Also, in the world, it is one of the important cereal crops in the world after wheat and rice (Gerpacio and Pingali, 2007).

Improved cultural practices can play an important role in augmenting yield of corn crop. For an optimal yield, the nitrogen supply must be available according to the needs of the plant. On the other hand, suitable plants spacing for optimum leaf growth by controlling water, fertilizer and chemical inputs is essential for improving the growth variables responsible for high yield. Optimum plant densities ensure the plants to grow in their aerial and underground parts through different utilization of solar radiation and nutrients. When the plant density exceeds an optimum level, competition among plants for light above ground or for nutrients below the ground become severe, consequently the plant growth slows down and the grain yield decreases (Hasanuzzaman *et al*., 2009). Plant population is an improtant factor which affects the crop yield. Yield was increased by 4% with increasing plant density (Shapiro and Wortmann, 2006). Higher plant population produce 25% more grain yield and 38% more biomass as compared with low plant population and early sown crop produce 19% more grain yield and 11% more biomass than late planted crop (Abdul *et al.,* 2007).

Maximum crop production can be achieved by development of improved crop hybrids and suitable growing environment and soil with optimum plant population/ha. Optimum plant population is the prerequisite for obtaining maximum yield (Trenton *et al.,* 2006 and Gustavo *et al.,* 2006).

Hybrids exhibited such variations in their yield attributes as cob length (cm), number of row/cob, number of kernels/row, number of kernels/cob, 100-kernel weight (g), stover yield Mg/ha., grain yield Mg/ha, biological yield ton/ha., and harvest index (%), and protein %. However, plant population 64000 plant/ha., gave the highest mean values for most studied characters and protein %. , and reduced weeds spread. Also, hybrid "TWC 352" recorded the highest values of most studied parameters under Alexandria conditions (Kandil, 2014).

Nitrogen is a key factor for plant photosynthesis, ecosystem productivity and leaf respiration (Johnson, 2001 and Martin *et al.,* 2008). Nitrogen stress may affect the light use efficiency and consequently influence long-term changes in vegetation biomass and carbon sequestration (Peng *et al.,* 2012). Increase nitrogen fertilization levels upto 200 kg ha^{-1} enhanced the plant height, grain yield and straw yield of hybrid maize, whereas increasing nitrogen levels decreased the harvest, grain, and straw ratio (Dawadi and Sah, 2012). The lowest ear weight was related to the lowest nitrogen level, while the highest ear weight was observed by the highest nitrogen level (240 kg N ha^{-1}), while there was no significant difference among nitrogen levels was observed on harvest index (Hoshang, 2012). Nitrogen fertilization levels, maize hybrids and their interactions showed such significant effects on maize growth, crop yield and its components. The maximum plant height, leaf area index (LAI), chlorophyll SPAD unit, number of rows/cob , number of kernels/row, number of kernels cob, 1000 grain weight, stover, grain, biological yields, harvest index and protein content were produced by the application either 429 or 357 kg N/ha (Kandil, 2013). There were gradual and significant increases in all growth parameters and grain yield resulted from foliar spray by raising N- fertilizer upto 288 kg N/ha., in both seasons. The S.C Pioneer 30K09 maize hybrid treated with 288 N/ha., produced the maximum values of plant height and grain yield in both seasons (Faheed *et al*., 2016).

Keeping in view the importance of plant density and nitrogen fertilization, the study was conducted to find out optimum plant spacing and suitable nitrogen fertilization level for getting higher yield of maize hybrid.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm, Faculty of Agriculture (Saba- Basha), Alexandria University, Egypt, during the two successive growth summer seasons of 2014 and 2015, to study the response of two maize hybrids to spatial distribution and nitrogen fertilization rates in a split-split plot design. Whereas, three factors can be illustrated as follows: the main plot included two maize hybrids (30N11 and 31G98), while plant spacing (20, 30 and 40 cm) was arranged in the sub plots, while nitrogen fertilization (192, 288 and 384 kg N/ha.) allocated in sub- sub plot.

The grains of the tested two hybrids (31G98 and 30N11) were obtained from Maize Research Section Agriculture Research Center, Ministry of Agriculture. The grains were sown on May 8th and 10th 2014 and 2015 seasons, respectively.

Soil texture was clay loam. A surface sample (0-30 cm) was collected before planting to identify some physical and chemical properties of this soil, as shown in Table (1) according to Page *et al.* (1982) and Klute (1986). The preceding crop was Egyptian clover (berseem) in the first season and barley (*Hordium vulgare*, L.) in the second season, respectively.

Each sub sub plot size was 12.60 m^2 included 6 ridges each 3 m in length and 0.70 m in width with the distance between hills as the above treatments mentioned.

Phosphorus fertilizer was added at rate of 100 kg calcium super phosphate (15.5% P_2O_5) just before sowing. Mineral nitrogen fertilizer was fully given the dose in a form of urea (46% N) after thinning before the first irrigation and before the second irrigation.

Table (1).Some Physical and chemical properties of the experimental soil in 2014 and 2015 seasons.

Soil properties	Season	
	2014	**2015**
A) Mechanical analysis :		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
pH (1 : 1)	8.20	8.31
E.C. (dS/m) (1:2)	3.80	3.70
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.52	1.54
Ca^{++}	9.4	8.7
Mg^{++}	18.3	18.5
Na^{++}	13.50	13.8
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.90	2.80
Cl^-	20.4	19.80
SO_4^{--}	12.50	12.60
Calcium carbonate (%)	6.50	7.00
Total nitrogen %	1.00	0.91
Available phosphate (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

Grain yield and yield components as cob length (cm), number of rows cob^{-1}, number of kernels row^{-1}, number of kernels cob^{-1},100- kernel weight (g), stover yield ton ha^{-1}, grain yield ton ha^{-1}, biological yield (ton ha^{-1}) harvest index (H.I.%) are measurements were obtained as an average of 2 ridges from mid of each plot.

Protein percentage was determined by estimating the total nitrogen in the grains and multiplied by 6.25 to obtain the percentage according of grains protein percentage to A.O. A.C. (1990). NPK percentages were determined in the dry grains. Their dry weights were determined following drying in a drying chamber to a constant weight at 75°C for 72 hour according to Tandon (1995). After dryness, the plant samples were milled and stored for analysis as reported. However, 0.5 g of the grains powder was wet-digested with H_2SO_4–H_2O_2 mixture according to (Lowther, 1980) and the following determinations were carried out in the digested solution to determine NPK. Total nitrogen was determined in digested plant material colorimetrically by Nessler`s method (Chapman and Pratt, 1978). Phosphorus was determined by the Vanadomolyate yellow method as given by Jackson (1973) and the intensity of colour developed was read in spectrophotometer at 405 nm. Potassium was determined according to the method described by method Jackson (1973) using Beckman Flame photometer.

Data obtained was exposed to the proper method of statistical analysis of variance as described by Gomez and Gomez (1984). The treatments means were compared using the least significant differences (L.S.D.) test at 5% level probability by using the split- split model as obtained by CoStat 6.311(2005) as statistical program.

RESULTS AND DISCUSSIONS

Results recorded in Tables (2 and 3) revealed that plant height (cm), ear weight (g), grain weight/ear (g), number of grains/ear, 100-grains weight (g), number of rows/ear, grain yield (t/ha), biological yield (ton/ha) and harvest index (%) of two maize hybrids were, significantly, affected by plant spacing and nitrogen fertilizer rates in both seasons.

Results presented in the same tables demonstrated that maize hybrid "30N11" had higher value for the yield and its components i.e. plant height (cm), ear weight (g), grain weight/ear (g), number of grains /ear, 100- grains weight (g), number of rows/ear, grain yield (t/ha), biological yield (ton/ha) and harvest index (%) than the other hybrid "31G98" in the first and second seasons, respectively. The difference may be attributed to genetically differences between two maize hybrids which play an important role for make up the available nutrients and yield for the maize hybrids. These findings are in harmony with those obtained by Kandil (2014).

Results, also demonstrated that spacing between hills (40 cm), significantly, increased the yield and its components than narrower spacing (20 cm). These results are in agreement with those reported by Ahmad *et al.* (2010), Saadat *et al.* (2010), Peykarestan and Seif (2012), Moosavi *et al.* (2012), Lyocks *et al.* (2013) and Kandil (2014) who showed that there was a significant difference among plants spacing on maize characters.

On the other side, results presented in Tables (2 and 3) revealed that increasing nitrogen fertilizer level up to 384 kg/ha., significantly, increased plant height (cm), and yield components of maize i.e. ear weight (g), grain weight/ear (g), number of grains /ear, 100- grains weight (g), number of rows/ear, grain yield (t/ha), biological yield (t/ha) and harvest index (%) than application of 192 kg N/ha. It can be noticed generally that grain yield and its components affected by nitrogen fertilizer which play an important role in plant growth and finally appeard in gigher grain yield for two hybrids of maize. These finding were consistent with those obtained by Kumar (2008), Khan *et al.* (2012), Moraditochaec *et al.* (2012), Nemati and Sharifi (2012) and Kandil (2013).

The interaction between maize hybrids and plant and plant spacing reveal that the highest mean values of straw, and biological yield and harvest index were obtained with 30N11 hybrid at 40 cm. In the contrast, growing 31G98 at 20 cm produced the lowest ones during two cropping seasons (Table 4).

With regard to maize hybrids x nitrogen level interaction, results in Table (5) showed that the maize hybrid “30N11hybrid” with 288 kg N/ha., recoded the highest mean value of grain yield in the second season.

Considering interaction among maize hybrids x spacing x nitrogen fertilization level were significant for yield and its components characters in both seasons as cleared in Table (6). However, results revealed that wider spacing of “30N11” hybrid plants at (40 cm) and fertilized with 384 kg N/ha., produced the highest mean value of grain and straw and biological yield in the two respective seasons.

Table (2). Plant height, yield and its components as affected by two maize hybrids, plant spacing and nitrogen fertilizer rates in 2014 and 2015 seasons.

Treatments	Plant height (cm)		Ear weight (g)		Grain weight/ear (g)		Number of grains /ear		100-grain weight (g)	
	Season									
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Maize hybrids (H)										
31G98	210.59b	211.30b	225.12b	224.43b	170.86b	172.91b	511.81b	518.11b	39.79b	40.37b
30N11	217.33a	219.18a	286.07a	293.90a	223.88a	227.32a	556.07a	564.44a	47.09a	47.56a
LSD at 0.05	0.84	1.50	26.13	0.61	0.65	1.62	2.29	5.38	0.20	0.25
Plant spacing (cm): (S)										
20	209.11c	210.40c	225.91c	222.57c	166.54c	168.35c	507.33c	515.94c	40.55c	40.94c
30	214.66b	216.40b	249.36b	254.63b	189.63b	192.44b	526.55b	532.72b	43.97b	44.63b
40	218.11a	218.94a	291.51a	300.29a	235.94a	239.55a	567.94a	575.16a	45.81a	46.33a
LSD at 0.05	1.85	1.28	13.53	0.75	2.10	0.72	4.21	3.99	0.21	0.20
N- fertilizer levels (kg/ha.)										
92	209.88c	207.78c	222.49c	214.39c	163.83c	165.69c	446.27c	451.16c	40.46c	41.02c
288	211.94b	215.92b	258.66b	267.46b	196.37b	198.67b	524.33b	533.83b	43.43b	43.96b
384	220.05a	222.03a	285.64a	295.64a	231.92a	235.99a	631.22a	638.83a	46.45a	46.91a
LSD at 0.05	1.49	1.20	18.87	0.64	2.00	0.74	3.71	3.71	0.64	0.24
Interaction										
H x S	*	*	*	*	*	*	*	*	*	*
H x N	*	*	*	*	*	*	*	*	*	*
S x N	*	ns	*	*	*	*	*	*	*	*
H x S x N	*	*	ns	*	*	*	*	*	*	*

Means at the same column followed by the same letter are significantly different according to L.S.D. at 0.05 value, ns: not significant and *: significant difference at 0.05 level of probability.

Table (3). Yield and its components as affected by two maize hybrids, plant spacing and nitrogen fertilizer rates in 2014 and 2015 seasons.

Treatment	Number of rows/ear		Straw yield (ton/ha)		Grain yield (ton/ha)		Biological yield (ton/ha)		Harvest index (%)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Maize hybrids (H)										
31G98	13.47b	13.70b	9.46b	9.49b	6.39 b	7.08b	15.86b	16.57b	40.20a	42.62a
30N11	14.41a	14.58a	11.43a	11.47a	7.69 a	8.32a	19.12a	19.80a	40.12a	42.00b
LSD at 0.05	0.45	0.11	0.745	0.633	0.395	0.609	1.14	1.24	0.306	0.586
Plant spacing (cm): (S)										
20	13.24c	13.53c	9.11c	9.04c	6.37 c	6.91c	15.48c	15.95c	41.16a	43.26a
30	14.04b	14.19b	10.65b	10.67b	7.08 b	7.71b	17.74b	18.39b	39.67a	41.90b
40	14.54a	14.70a	11.58a	11.73a	7.67 a	8.48a	19.25a	20.21a	39.65a	41.77b
LSD at 0.05	0.07	0.07	0.503	0.426	0.384	0.405	0.697	0.785	1.57	0.806
N- fertilizer levels (kg/ha.)										
92	13.21c	13.45c	9.66b	9.71b	6.17b	6.86c	15.83b	16.57c	38.81b	41.27b
288	13.96b	14.24b	10.59a	10.67a	7.41a	7.78b	17.99a	18.46b	41.15a	42.15b
384	14.46a	14.73a	11.10a	11.06a	7.55a	8.47a	18.65a	19.52a	40.51a	43.52a
LSD at 0.05	0.09	0.10	0.551	0.541	0.541	0.448	0.962	0.909	1.60	1.11
Interaction										
H x S	*	*	*	*	n.s.	*	*	*	*	*
H x N	*	*	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	*
S x N	*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	*
H x S x N	*	n.s.	n.s.	n.s.	*	*	*	*	*	*

Means at the same column followed by the same letter are statistically significantly different to L.S.D. at 0.05 value, ns: not significant and *: significant difference at 0.05 level of probability.

Table (4). Interactions between maize hybrids and plant spacing for grain yield (ton/ha.), straw yield and biological yield and H.I % in 2014 and 2015 seasons.

Hybrid	Plant spacing	Grain yield (ton/ha)	Straw yield (ton/ha)		Biological yield (ton/ha)		Harvest index (H.I %)	
		Season						
		2015	2014	2015	2014	2015	2014	2015
31G98	20	6.16	7.45	7.47	13.28	13.63	43.32	44.70
	30	6.89	9.66	9.51	15.98	16.40	39.12	41.64
	40	8.20	11.28	11.50	18.31	19.70	38.15	41.52
30N11	20	7.66	10.77	10.61	17.69	18.28	38.99	41.82
	30	8.54	11.64	11.84	19.49	20.38	40.21	41.91
	40	8.77	11.88	11.97	20.18	20.73	41.16	42.28
LSD at 0.05		0.573	0.711	0.602	0.986	1.11	2.22	1.14

Table (5). Interactions between maize hybrids and nitrogen fertilizer levels for grain yield (ton/ha) and H.I % in 2014 and 2015 seasons.

Hybrid	N levels(Kg/ha.)	Grain yield (t/ha)	Harvest index (%)	
		Season		
		2015	2014	2015
31G98	192	5.95	38.11	40.71
	288	6.95	40.82	41.91
	384	8.35	41.66	45.24
30N11	192	7.77	39.52	41.82
	288	8.62	41.49	42.39
	384	8.59	39.36	41.80
LSD at 0.05		0.634	2.26	1.56

Table (6). Interactions among maize hybrids, plant spacing, and nitrogen fertilizer levels for grain yield (t/ha), biological yield and harvest index (HI %) in 2014 and 2015 seasons.

Hybrids	Plant spacing	N levels (kg/ha.)	Grain yield (ton/ha)		Biological yield (ton/ha)		Harvest index (H.I. %)	
			Season					
			2014	2015	2014	2015	2014	2015
31G98	20	192	4.12	4.56	10.38	11.12	39.69	41.03
		288	5.92	5.88	13.46	13.24	43.76	44.40
		384	7.44	8.04	16.00	16.52	46.50	48.67
	30	192	4.66	5.50	13.11	13.83	35.51	39.75
		288	6.16	6.16	16.28	15.76	37.74	39.11
		384	8.16	9.00	18.56	19.60	44.10	46.05
	40	192	6.96	7.80	17.76	18.84	39.12	41.35
		288	8.13	8.80	19.85	20.84	40.95	42.22
		384	6.00	8.00	17.33	19.41	34.39	40.99
30N11	20	192	6.14	6.70	16.09	16.46	38.04	40.99
		288	7.52	8.36	18.28	19.36	40.98	43.05
		384	7.10	7.94	18.70	19.02	37.96	41.77
	30	192	7.64	8.25	18.88	19.57	40.46	42.16
		288	8.48	9.12	20.60	21.48	41.17	42.46
		384	7.42	8.26	19.00	20.08	39.01	41.10
	40	192	7.52	8.36	18.77	19.61	40.05	42.64
		288	8.24	8.36	19.48	20.07	42.32	41.65
		384	9.16	9.58	22.29	22.52	41.11	42.54
LSD at 0.05			1.32	1.09	2.36	2.23	3.92	2.71

Results recorded in Table (7) revealed that percentage of nitrogen, phosphorus, potassium and protein in maize grains were, significantly, influenced by adding high level of nitrogen.

Maize hybrid 30N11 recorded higher grains NPK and protein content than the other hybrid 31G98 in the first and second seasons, respectively.these results can be concluded that the ability to transport enough absorbed nitrogen, phosphorus, and potassium percentages in grains plant. These results agreed with those obtained by Amin *et al.* (2003) and Atia and Abdel- Azeem (2005).

The highest values of all chemical compositions character were obtained using nitrogen fertilizer at rate 384 kg/ha., in both seasons, while, the lowest ones was recorded by application nitrogen at 192 kg/ha., as shown in (Table 7) in both seasons. These results indicate that N- fertilization rate increased the capacity of plant in absorbing nutrients. These results are in agreement with others results were reported by Martin *et al.* (2008), El- Gizawy and Salem (2010) and Dawadi and Sah (2012).

Results in Table (7) revealed that wider spacing between plants (40 cm) produced higher protein content and NPK in the two successive seasons than narrower spacing (20 cm) that produced the lowest mean values of these characters.

On the other side, increasing nitrogen fertilizer from 192 to 384 kg N/ha., significantly, increased grain NPK and protein contents in 2014 and 2015 seasons as shown in Table (7). These results are in agreement with those obtained by Sahoo and Mahapatra (2004), Oktem and Oktem (2005), Kar *et al*. (2006), Melkonian *et al*. (2008), El-Gizawy and Salem (2010) and Tang *et al*. (2015).

Table (7). Macronutrients (N, P and K) and protein percentages as affected by maize hybrids, plant spacing and nitrogen fertilizer rates in 2014 and 2015 seasons.

Treatment	N (%)		P (%)		K (%)		Protein (%)	
	Season							
	2014	2015	2014	2015	2014	2015	2014	2015
Maize hybrids (H)								
31G98	1.27b	1.34b	0.634b	0.638b	1. 67b	1.68b	7.79b	8.37b
30N11	1.32a	1.36a	0.713a	0.720a	1. 86a	1.90a	8.28a	8.51a
LSD at 0.05	0.01	0.01	0.003	0.003	0.01	0.05	0.07	0.11
Plant spacing (cm): (S)								
20	1.22c	1.28c	0.648c	0.652c	1.60c	1.61c	7.65c	8.03c
30	1.31b	1.36b	0.673b	0.681b	1.74b	1.76b	8.22b	8.52b
40	1.36a	1.40a	0.699a	0.704a	1.95a	1.99a	8.51a	8.78a
LSD at 0.05	0. 02	0. 01	0. 002	0.003	0. 02	0. 02	0. 13	0. 07
N- fertilizer levels (kg/ha.)								
92	1.21c	1.25c	0.545c	0.551c	1.57c	1.58c	7.57c	7.82c
288	1.30b	1.35b	0.682b	0.685b	1.76b	1.80b	8.14b	8.46b
384	1.38a	1.44a	0.793a	0.800a	1.96a	1.99a	8.67a	9.04a
LSD at 0.05	0.01	0.01	0.001	0.001	0. 01	0. 02	0.09	0.09
Interaction								
H x S	ns	ns	*	*	*	*	ns	ns
H x N	*	ns	*	*	*	*	*	ns
S x N	*	ns	*	*	*	*	*	ns
H x S x N	*	*	*	*	ns	*	*	*

Means at the same column followed by the same letter are statistically equaled according to L.S.D. at 0.05 value, ns: not significant and *: significant difference at 0.05 level of probability.

CONCLUSIONS

Considering the obtained results, it can be concluded that application of 384 kg N ha^{-1} and with wider spacing (40 cm) between plants to the maize hybrid '30N11' is an optimal for obtaining higher grain yield of maize under the agro-metrological conditions of Alexandria, Egypt.

REFERENCES

A.O.A.C. (1990). Official Methods of Analysis of Association of Official Analytical Chemists, 12th edition. Washington, D.C.

Abdul, A., H. Rehman and N. Khan (2007). Maize cultivar response to population density and planting date for grain and biomass yield. Sarhad J Agric 23: 25-30.

Ahmad, M., A. Khaliq, R. Ahmad and A. M. Ranjha (2010). Allometery and productivity of autumn planted maize hybrids under narrow row spacing. Int. J. Agric. Biol., 12: 661–667.

Amin, Amal, Z. H. A. Khalil and R. K. Hassan (2003). Correlation studies and relative importance of some plant characters and grain yield in maize single crosses. Arab. Univ. J. Agric.Sci. Ain. Shams Univ. Cario 11(1):181-190.

Atia, A. A.M. and M.E. M. Abd El- Azeem (2005). Correlation, plath coefficient and regression analysis to determine the relative conttributions of some gronomictrils with grain yield in the maize (*Zea mays* L.) genotypes J. Agric. Sci. Mansoura Univ., 30(11):6503-6510.

Chapman, H. D. and P.F. Pratt (1978). Method of Analysis for Soil and Water. 2nd Ed., Chapter, 17pp 150-161. Uni. Calif. Div. Agric. Sci. USA**.**

CoStat, 6.311, copyright (c). (2005). Cohort software798 light house Ave. PMB320, Monterey, CA93940 and USA. Email: info@cohort.com and Website: http://www.cohort.com/DownloadCoStatPart2.html.

Dawadi, D. R. and. S. K. Sah (2012). Growth and yield of hybrid maize (*Zea mays,* L.) in relation to planting density and nitrogen levels during winter season in Nepal. Trop. Agri. Res., 23 (3): 218 – 227.

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

Faheed, Fayza A., E.I. Mohamed and Huda M. Mahmoud (2016). Improvement of maize crop yield (*Zea mays* L.) by using of nitrogen fertilization and foliar spray of some activators. J. Eco. Heal. Env., 4(1):33-47.

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

Gomez, A. K. and A. A. Gomez (1984). Statistical procedures for agricultural research. (2nd edition). John Wiley and Sons. New York.

Gustavo, A.M., G.C. Alfredo and M. E. Otegui (2006). Row width and maize grain yield. Agron. J., 98: 1532-1543.

Hasanuzzaman, M., M. L. Rahman, T. S. Roy, J.U. Ahmed and A.S.M. Zobaer (2009). Plant characters, yield components and yield of late transplanted aman rice as affected by plant spacing and number of seedling per hill. Advances in Biol. Res., 3(5-6): 201-207.

Hoshang, R. (2012). Effect of plant density and nitrogen rates on morphological characteristics grain maize. J. Basic. Appl. Sci. Res., 2(5): 4680-4683.

Jackson, M.L. (1973). Soil chemical analysis, Prentice Hall of India private limited, New Delhi, P. 498.

Johnson, L. F. (2001). Nitrogen influence on fresh-leaf NIR spectra. Remote Sens. Environ., 78:314–320.

Kandil, E. E. (2014). Determine independent population density for each maize hybrid (*Zea mays*, L.).Inter. Proc. Chemi. Biol. & Enviro., 79 (6): 30 -35. 2nd Inter. Conf. on Agric. and Biotech., IPCBEE , IACSIT Press, Singapore, 27- 28 Dec. in Thailand.

Kandil, E. E. E. (2013). Response of some maize hybrids (*Zea mays* L.) to different levels of nitrogenous fertilization. J. Appl. Sci. Resh., 9(3): 1902-1908

Kar, P.P., K.C. Barik, P.K. Mahapatra, L.M. Garnayak, B.S. Rath, D.K. Bastia and C.M. Khanda (2006). Effect of planting geometry and nitrogen on yield, economics and nitrogen uptake of sweet corn *(Zea mays*). Ind. J. Agron. 51 (1): 43-45.

Khan, N. W., N. K. Ijaz and A. Khan (2012). Integration of nitrogen fertilizer and herbicides for efficient weed management in maize crop. Sarhad J. Agric., 28(3).

Klute, A. (1986). Methods of soil analysis part 1,2nd ed., Agron. Monor G. ASA and SSSA, Medison, W.I.

Kumar, A. (2008). Productivity, economics and nitrogen- use efficiency of specialty corn (*Zea mays*) as influenced by planting density and nitrogen fertilization. Ind. J. Agron. 53 (4): 306-309.

Lowther, G.R. (1980). Using of a single H_2So_4 - H_2O_2 digest for the analysis of Pinus radiate needles. Commun.Soil Sci. pl.Analysis, 11: 175-188

Lyocks, S. W. J., J. Tanimu, D. L. Zamani and O. D. Ayodeji (2013). Evaluation of the effects of intra-row spacing on the growth and yield of maize (*Zea mays* l.) in maize-ginger intercrop in samaru, northern Guinea savanna of Nigeria. Agric. Biol. J. N. Am., 4(3): 175-180.

Martin, M. E., L. C. Plourde, S. V. Ollinger, M. L. Smith, B. E. A. Mcneil (**2008).** Generalizable method for remote sensing of canopy nitrogen across a wide range of forest ecosystems. Remote Sens. Environ., 112: 3511–3519.

Melkonian, J.J., H.M. Van Es, A.T. DeGaetano and L. Joseph (2008). ADAPT-N: Adaptive nitrogen management for maize using high-resolution climate data and model simulations. In: R. Kosla (Ed.). Proceedings of the 9th Int. Conference on Precision Agric., July 20-23, Denver, CO (CD-ROM).

Moosavi, S. G.; M. J. Seghatoleslami and A. Moazeni (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. and Basic Sci., 3 (1): 57-63.

Moraditochaee, M., M. K. Motamed, E. Azarpour, R. K. Danesh and H. R. Bozorgi (2012). Effects of nitrogen fertilizer and plant density Management in corn farming. ARPN Journal of Agricultural and Biological Science, 7(2): 133-137.

Nemati, A. R. and R. S. Sharifi (2012). Effects of rates and nitrogen application timing on yield, agronomic characterstics and nitrogen use efficiency in corn. Intl J. Agric. Crop Sci., 4(9): 534-539.

Oktem, G.A and A. Oktem (2005). Effect of nitrogen and intra row spaces on Sweet corn (*Zea mays sachharata sturt*) ear characteristics. Asian J. Pl. Sci., 4 (4): 361-364.

Page, A. L., R. H. Miller and D. R. Keeny (1982). Methods of soil analysis part 2 Amer. Soc. Agric. Inc. Madison W.19:595.

Peng, D. L., B. Zhang and L.Y. Liu (2012). Comparing spatiotemporal patterns in Eurasian FPAR derived from two NDVI-based methods. *Int.* J. Digit. Earth, 5: 283–298.

Peykarestan, B. and M. Seify (2012). Impact of sowing date on growth and yield attributes of pop corn grown under different densities. Int. Res. J. Appl. and Basic Sci., 3(1): 85-91.

Saadat, S. A., H. R. Miri and B. J. Haghighi (2010). Study effect of density on yield and yield components in corn hybrids. Proceeding of 11th Iranian Crop Sci. Congress. pp. 2914-2917.

Sahoo, S. C. and P.K. Mahapatra (2004). Response of sweet corn (*Zea mays*) to nitrogen levels and plant population. Ind J. Agric. Sci., 74 (6): 337-338.

Shapiro, C. A. and C. S Wortmann (2006). Corn response to nitrogen rate, row spacing and plant density Eastern Nebraska. Agron. J., 98: 529-535.

Tandon, H. (1995). Methods of Analysis of soil, plants, waters and ferilizer, p: 144. Fertilizers development and consultation organization, New Delhi, India.

Tang, J. H., Y. P. Wang, Y. M. Hu, C. L. Wang, G. W. Tian and Z. H. Liu(2015). Effect of low N- stress to N, P, K contents and quantitative trait locus (QTL) analysis in maize kernels and stalks. Afr. J. Agric. Res. 10(27): 2633-2641.

Trenton, F., S. Stanger and G. L. Joseph (2006). Optimum plant population of *Bacillus thuringiensis* and non *Bacillus thuringiensis* corn in Wisconsin. Agron. J., 98: 914-921.

الملخص العربي

استجابة بعض هجن الذرة الشامية للتوزيع الفراغي ومعدلات التسميد النتيروجيني

محمود عبد العزيز جمعة   فتحي إبراهيم رضوان عصام إسماعيل قنديل   محمد عبد الله أمحمد حسين

قسم الانتاج النباتي – كلية الزراعة سابا باشا – جامعة الاسكندرية – الاسكندرية – مصر

أجريت تجربتان حقليتان بالمزرعة البحثية بكلية الزراعة سابا باشا بمنطقة أبيس جامعة الإسكندرية خلال الموسمين ٢٠١٤ و ٢٠١٥ ،وذلك لدراسة تأثير المسافات بين النباتات ومستويات السماد النيتروجيني علي نمو ومحصول بعض هجن الذرة الشامية. وإستخدام في تصميم القطع المنشقة مرتين في ثلاث مكررات في تنفيذ التجربتان ، حيث احتلت الهجن (30N11) ، (31G98) القطع الرئيسية ، ووزعت المسافات بين النباتات (٢٠ سم، ٣٠ سم،٤٠ سم) فى القطع تحت الرئيسية ، مستويات السماد النيتروجيني (١٩٢ ، ٢٨٨ ، ٣٨٤ كجم/هكتار) كانت فى القطع تحت تحت الرئيسية.

ولخصت أهم النتائج فيما يلي:

- تفوق هجين الذرة الشامية30N11 علي الهجين 31G98 معنوياً في معظم الصفات المدروسة في كلا الموسمين.
- زراعة النباتات علي مسافة ٤٠سم حققت أعلى قيم للصفات تحت الدراسة ، بينما المسافة ٢٠ سم بين نباتات الذرة الشامية أدت لأقل قيم بالنسبة لارتفاع النبات ولصفات المحصول ومكوناته في موسمي الزراعة.
- وأدى معدل التسميد الأعلى من السماد النتروجينى (٣٨٤ كجم/هكتار) للحصول على أعلى قيم لمحصول الذرة الشامية ، ومكوناته مقارنة بباقى معدلات التسميد ، بينما المعدل الأقل (١٩٢ كجم/هكتار) أعطى أقل القيم لهذه الصفات خلال موسمى الدراسة.
- أدى زراعة هجين 30N11علي مسافة ٤٠ سم بين النباتات الذرة الشامية للحصول على أعلى القيم للصفات المحصولية المدروسة خلال موسمى الذرة ، مقارنة بين بالصنف الأخر (31G98) الذى سجل أقل القيم خاصة مع مسافة زراعة ٢٠ سم بين النباتات.
- سجل الهجين 30N11 أعلى استجابة لمعدل التسميد النتروجينى ٣٨٤ كجم/هكتار حيث حقق أعلى قيم لمحصول الحبوب والقش والمحصول البيولوجى خلال موسمى الزراعة.

- زراعة الذرة الشامية على مسافة ٤٠ سم بين النباتات مع معدل التسميد ٣٨٤ كجم نتروجين للهكتار سجل أعلى قيم لمحصول الحبوب ، والقش والمحصول البيولوجى ودليل الحصاد فى الموسمين ٢٠١٤ ، و٢٠١٥.
- أدت إضافة السماد النيتروجيني بمعدل ٣٨٤ كجم/هكتار مع الزراعة علي مسافة ٤٠سم بين النباتات للهجين30N11 إلي الحصول علي أعلي القيم للمحصول (محصول الحبوب، والقش البيولوجي (طن/هكتار) وأيضاً دليل الحصاد (%) في كلا الموسمين.