Journal of Sustainable Agricultural and Environmental Sciences
https://jsaes.journals.ekb.eg/
JSAES, 2022,1(1): 40 - 47

ISSN-Print: 2735-4377
ISSN-Online: 2785-9878

Effect of Some Agricultural Practices on New Maize Hybrids

Abd El-Razek, U.A.[1*], Abou Elharess, S. M. K.[2] and HamadA. M. S.[3]

[1] Prof., Agronomy Department, Faculty of Agriculture, Tanta University, Tanta, Egypt.
[2] Chief of research maize section A.R.C, Egypt.
[3] Postgraduate student in Agronomy Department, Faculty of Agriculture, Tanta University, Egypt.

*Corresponding Author: Abd elrazek, U. (usama.eldesouky@agr.tanta.edu.eg)

J.Sust.Agri.Env.Sci. (JSAES)

Keywords:
Zea mays; Single cross; Three- way cross; Split – split plot design.

ABSTRACT

This investigation was carried out at Sakha Agricultural Research Station, ARC, in 2020 and 2021 seasons to evaluate three new crosses of maize under three plant densities and three nitrogen levels to identify the best plant density and nitrogen level for each hybrid to give the highest yield. The results indicated that plant height, ear height, weight of 100-kernel was not significantly by planting density in both seasons and combined data. While ear leaf area, ear length, ear diameter, number of rows per ear, grain yield were significantly influenced by plant densities in two years and combined except for ear leaf area in 2021 season, number of rows/ear and number of kernels/row and ear diameter in 2020 season. The low plant density gave the highest value for ear leaf area, ear length, ear diameter, number of rows/ear, number of kernels/row under two years and their combined data. Meanwhile the high plant densityhad the highest value for grain yield under both years and combined data. The high nitrogen levels had the highest values for most study traits in two season and combined data, while the low nitrogen level gave the lowest values in most studied traits in two seasons and combined. New single cross SC180 had surpassed the other hybrids for most traits in both years and combined. The recommended practices of this study were cultivation of three hybrids at a density 30,000 plant/fed and at a rate 148 kg N/fed of nitrogen fertilization.

1. INTRODUCTION

Maize (*Zea mays* L.) is the most important crop among cereals after wheat and rice in respect of area and production. Maize grain contains starch (72%), protein (10%), oil (4.8%), fiber (5.8%), sugar (3.0%), and ash (1.7%) **(Chaudhry, 1983)**. In Egypt, it is grown about 2.8 million feddan, and average yield reached 23.6 ardab/fed. Maize is used in bread making in rural areas of the country. Also, it is used, especially the yellow grains to feed livestock and poultry either as green fodder and silage or as grains for dry feeding. In addition, it is used in several industries to produce starch, fructose and maize oil, etc. To meet present and future needs, productivity per unit area must be

increased grain yield through plant breeding program to develop new hybrids and improved cultural practices, **(Duvick 2005, Lee and Tollenaar 2007)**. Plant density plays an important role in crop productivity where**, Nwogboduhu (2016)**, studied the response of three maize cultivars to planting densities (20000, 40000, 60000 and up to 80000 plant/ha) and found that plant density of 60,000 plant/ha, produced the highest grain yield and also, **Kareem *et al.* (2017)** studied the effect of two population densities (95,556 and 53,333 plant/ha) on growth and yield of two maize cultivars. They found that increasing plant density from 53,333 to 95,556 plant/ha led to significant increase in grain yield/ha. Meanwhile, number of kernels/row, number of kernels/ear, 100-kernel weight and shelling percentage were significantly decreased. **Revathi *et al.* (2017)** found that lower planting density of 66,666 plant/ha recorded the maximum ear length and number of kernels/ear than 83,333 and 100,000 plant/ha, while maximum grain yield/ha was recorded with 83,333 plant/ha and Stover yield/ha was recorded with 100,000 plant/ha. On the other direction, weight of kernels/ear, number of rows/ear and 100-kernel weight were not significantly influenced by planting density. Nitrogen plays an important role in crop growth and yield. It is highly associated with dark green color of stem and leaves, vigorous growth, branching, leaf production and size enlargement. **Yasin (2016)** studied the response of yellow maize to nitrogen fertilizer levels (0, 45, 90 and 135 kg N/fad.). He reported that ear length, ear diameter, 100-kernel weight, kernel weight/ear and grain yield/ fad., were significantly increased with each increase in nitrogen fertilizer level up to 135 kg N/fad. Whereas, plant height and number of kernels/ row were significantly increased by raising nitrogen fertilizer level up to 90 kg N/fed., **El-Shahed *et al.* (2017)** reported that increasing nitrogen fertilizer rate from 100 up to 135 kg N/fad., was accompanied by a significant increase in each of plant height, ear length and diameter, number of rows/ear, number of kernels/row, 100 kernel weight, grain yield/fad. **Begizew *et al*. (2019)**slightly higher plant density and nitrogen level, 53,333 plant/ha with application of 115 kg N ha^{-1} are suitable for the high yield of hybrid maize BH-661 during main seasons.**Wang *et al*. (2020)** found that increasing plant density from 60,000 to 90,000 plants/ha^{-1} and nitrogen levels from 79 to 149 kgN/ha^{-1} increased grain yield.**Gul *et al*. (2021)** Results showed that yield and other traits, i.e. plant height, ear length, ear weight, kernel yield, kernels ear were significantly affected by Nitrogen levels. **Zhang *et al*. (2022)** found that increasing nitrogen levels from 120 to 240 kg N/ha^{-1} increased grain yield. The objectives of this study are:1) Estimate of the effect of plant densities on agronomic yield and yield components traits.2) Estimate of the effect of nitrogen fertilization rates on agronomic yield and yield components traits.3) Identify grain yield for each hybrid and identify the ideal practices for each hybrid to give the highest yield.

2. MATERIALS AND METHODS

This investigation was carried out at Sakha Agricultural Research Station, Agricultural Research Center, Egypt, during 2020 and 2021 seasons to study the effect of plant densities and nitrogen fertilization levels on growth, yield and yield components of three maize hybrids.

Treatments:

Plant density (D): Three plant densities, D_1 = 20,000 plant/fed, D_2 = 25,000 plant/fed and D_3 =30,000 plant/fed. Plot size consisted of three rows, 4m long,0.8 m apart and the distances between hills were (26 cm at D_1, 21 cm at D_2, 17.5 cm at D_3).

Nitrogen fertilization Levels (N): Three nitrogen fertilizer rates, N_1= 100 kg N/fed, N_2=124 kg N/fed and N_3= 148 kg N/fed.

Maize hybrids (H): Three new yellow maize hybrids were used in this experiment: single cross (SC) 178, single cross (SC)180 and three-way cross (Twc) 369.A split-split plot

design was used in this study with three replications. Three plant densities (D) were arranged in main plots, three nitrogen levels (N) were done in sub-plots, while three hybrids (H) were arranged in sub-sub plots, the plot size consisted of three rows, 4m long, 0.8m apart and 26, 21, 17.5cm between hills at plant densities (D_1, D_2, D_3), respectively. Nitrogen fertilizer, according to the each rate, was applied in the form of urea (46.5%) in two equal doses before the first and the second irrigation, respectively. All recommended agricultural practices for growing maize were done in the proper time.

Studied characters:

The data was recorded on the middle row in each plot for plant height (cm), ear height (cm), ear leaf area (dm^2), ear length (cm), ear diameter (cm), number of rows/ear, number of kernels/row, 100 kernel weight(g) and grain yield (ardab/feddan) on 15.5% grain moisture.

Statistical analysis:

Statistical analysis system (SAS,2000 version 8) was used to calculate variances in two years and their combined data.

3. RESULTS AND DISCUSSION

3.1Plant density effect (D):

The results in Tables 1, 2 and 3 showed that the difference among three maize plant densities were not significant for plant height, ear height and 100 kernels weight in two seasons (2020 and 2021) and their combined data and significant for ear leaf area, number of rows/ear, number of kernels/row, ear length, ear diameter and grain yield in two seasons (2020 and 2021) and combined data except for ear leaf area in 2021 season, number of rows/ear, number of kernels/row and ear diameter in 2020 season. The highest value was obtained at the low plant density (D_1) for ear leaf area, number of rows/ear, number of kernels/row, ear length, ear diameter and at the high plant density (D_3) for grain yield, in two seasons and combined data. Meanwhile the lowest value was obtained at the height plant density (D_3) for ear leaf area, number of rows/ear, number of kernels/row, ear diameter and at low plant density (D_1) for grain yield in two seasons and their combined data, meaning that the low plant density increased most studded traits while high plant density. **Awadalla and Morsy (2016)** suggested that increasing plant density from 21,000 to 33,600 plant/fed increased the grain yield. **Violeta Mandic *et al*. (2016)** found that the plant density was highly significant on morphological traits, yield components and grain yield, **Kareem *et al*. (2017)** found that increasing plant density from 53,333 to 59,556 plant/ha led to increase in grain yield/ha and decreased in number of kernels/row, number of kernels/ear and 100 kernels weight and **Revathi *et al*. (2017)** found that lower plant density recorded the maximum ear length, and number of kernels/ear. Also found that number of rows/ear and 100 kernels weight were not significantly influenced by plant density. **Wang *et al*. (2020)** found that increasing plant density from 60,000 to 90,000 plant/ha^{-1} increased grain yield. **EL-Rouby *et al*. (2021)** found that increasing plant density (65,000 plant/ha^{-1}) gave higher grain yield. **Zhang *et al*. (2022)** found that increasing plant density from 60,000 to 90,000 plant/ha^{-1} increased grain yield.

3.2. Nitrogen Levels Effect (N):

The results in Tables 1, 2 and 3 exhibited that the three nitrogen levels (100, 124 and 148 kg N/fed) were not significantly influenced for ear height and 100 kernels weight in two seasons and their combined data. However it's were significant effects for plant height, ear leaf area, number of rows/ear, number of kernels/row, ear length, ear diameter and grain yield in two seasons and their combined except for plant height and ear leaf area in 2021 season, number of rows/ear, number of kernels/row, ear length, and ear diameter in 2020 season. General the highest value was obtained at N_3(148 kg N/fed) for

most study traits in two season and combined data. Meanwhile
the lowest value was obtained at N_1(100 kg N/fed) for most study traits in two season and combined data, meaning that increased nitrogen fertilization due to increase all study traits and vice versa**. EL-Douby *et al*. (2001)** found that increasing nitrogen level up from 120 to 140 kg N/fed increased plant height, ear height, ear length, ear diameter, number of kernels/row. **Golla *et al*. (2019)** found that increasing nitrogen levels from 69, 92, 115, 138 and 161 kg N/ha^{-1} increased plant height, ear height and grain yield. **Absy and Abdel-Lattif (2020)**found that plant height, ear height, leaf area, number of rows/ear, number of kernels/row, 100 kernel weight and grain yield/plant and grain yield/ha were significantly influenced by nitrogen levels. **Worku *et al*. (2020)** found that plant height and grain yield increased by using nitrogen levels from 120, 240 and 360 kg N/ha^{-1}. **Kripa *et al*. (2021)** found that increasing nitrogen level from 160 to 220 kg N/ha increased plant height and grain yield. **Asibi *et al*. (2022)** found that increasing nitrogen level from 270 to 360 kg N/ha^{-1} increased grain yield. **Zhang *et al*. (2022)** found that increasing nitrogen levels from 120 to 240 kg N/ha^{-1} increased grain yield.

3.3. Cultivar Differences:

Data in Tables 1, 2 and 3 showed that three crosses were significantly differed for all study traits in two seasons and their combined except for 100 kernels weight at 2021 and combined. The SC180 gave the highest values for plant height, ear height, ear leaf area, number of rows/ear, number of kernels/row, 100 kernels weight and grain yield in two seasons and combined data while TWC 369 had the lowest values for most study traits in two seasons and combined data. **Nwogboduhu (2016), Yasin (2016) and Kandil *et al*. (2017)** found that maize cultivars significantly differed in yield parameters. Also found that single crosses were surpassed the three way crosses for grain yield and components except for number of rows/ear.

Table1: Effects of plant density, nitrogen fertilization on three maize hybrids and their interactions for plant height, ear height and ear leaf area in 2020 and 2021 seasons and their combined data

Main effects andinteractions	Plant height (cm)			Ear height (cm)			Ear leaf area (dm^2)		
	2020	2021	Comb.	2020	2021	Comb.	2020	2021	Comb.
Planting density (D)									
20,000 plant/fed (D_1)	326.85	316.92	321.88	188.63	176.59	182.61	8.33	9.67b	9.04c
25,000 plant/fed (D_2)	329.33	309.63	319.48	186.07	175.44	180.75	8.26	9.36ab	8.81b
30,000 plant/fed (D_3)	326.07	311.63	318.85	192.29	178.33	185.31	8.16	9.01a	8.59a
F-test	NS	NS	NS	NS	NS	NS	NS	*	**
Nitrogen fertilization (N)									
100 kg N/fed (N_1)	324.63a	309.48	317.05a	186.48	175.29	180.88	8.21a	9.28	8.74a
124 kg N/fed (N_2)	327.51ab	311.33	319.42ab	189.03	176.77	182.90	8.12a	9.39	8.75a
148 kg N/fed (N_3)	330.11b	317.37	323.74b	191.48	178.29	184.88	8.43 b	9.47	8.95 a
F-test	**	NS	**	NS	NS	NS	*	NS	*
Hybrids (H)									
SC 178 (H_1)	328.22b	307.29b	317.75b	183.63a	168.11a	175.87a	8.17b	8.98 a	8.57b
SC 180 (H_2)	355.11c	341.81c	348.46c	199.37b	190.14b	194.75b	9.06c	10.20b	9.63c
Twc 369 (H_3)	298.92a	289.07a	294.00a	184.00a	172.11a	178.05a	7.52a	8.95a	8.23a
F-test	**	**	**	**	**	**	**	**	**
Interactions.									
D x N	NS	NS	NS	NS	NS	NS	NS	NS	NS
D x C	NS	NS	NS	NS	NS	NS	NS	NS	NS
N x C	NS	NS	NS	NS	NS	NS	NS	NS	NS
D x N x C	NS	NS	NS	NS	NS	NS	NS	NS	NS

*,** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

Table2: Effects of plant density, nitrogen fertilization on three maize hybrids and their interactions for number of rows/ear, number of kernels/row and 100-kernel weight in 2020, 2021 seasons and their combined data

Main effects and interactions	Number of rows/ear			Number of kernels/row			100-kernel weight, g		
	2020	2021	Comb.	2020	2021	Comb.	2020	2021	Comb.
Planting density (D)									
20,000 plant/fed (D_1)	15.90a	15.28	15.59a	46.23a	46.86	46.55a	45.07	44.24	44.65
25,000 plant/fed. (D_2)	15.51ab	15.15	15.33ab	42.40b	44.03	43.22b	46.14	43.17	44.66
30,000 plant/fed. (D_3)	15.11b	14.96	15.04b	39.85c	44.03	42.01c	46.07	42.96	44.52
F-test	*	NS	*	**	NS	**	NS	NS	NS
Nitrogen fertilization (N)									
100 kg N/fed (N_1)	15.45	14.92a	15.19a	42.80	43.23a	43.23a	46.59	43.62	44.30
124 kg N/fed (N_2)	15.63	15.11ab	15.37a	42.50	44.12a	43.31a	45.51	43.34	44.43
148 kg N/fed (N_3)	15.43	15.39b	15.41a	43.20	47.71b	45.45b	45.18	43.41	45.10
F-test	NS	*	*	NS	**	**	NS	NS	NS
Hybrids (H)									
SC 178 (H_1)	15.30a	14.59a	14.94a	44.01b	44.42a	44.21b	44.37a	43.53	43.95
SC 180 (H_2)	15.78c	15.54c	15.66c	43.65a	46.72b	45.19b	46.70b	43.60	45.15
Twc 369 (H_3)	15.43b	15.29b	15.36b	40.83a	43.92a	42.37a	46.22b	43.24	44.73
F-test	*	**	**	**	**	**	*	NS	NS
Interactions.									
DxN	NS	NS	NS	NS	NS	NS	NS	NS	NS
DxC	NS	**	*	NS	NS	NS	NS	NS	NS
NxC	NS	NS	NS	*	NS	NS	NS	NS	NS
DxNxC	NS	NS	NS	NS	NS	NS	NS	NS	NS

*, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively

Table3: Effects of plant density, nitrogen fertilization on three maize hybrids and their interactions for ear length, ear diameter and grain yield in 2020, 2021 seasons and their combined data

Main effects and interactions	Ear length (cm)			Ear diameter (cm)			Grain yield (ard/fed.)		
	2020	2021	Comb.	2020	2021	Comb.	2020	2021	Comb.
Planting density (D)									
20,000 plants/fed (D_1)	24.51a	24.52a	24.51a	5.08a	5.03	5.06a	33.12a	33.67a	33.39a
25,000 plants/fed (D_2)	21.77b	23.06b	22.41b	4.99a	4.94	4.96b	37.04b	35.60b	36.32b
30,000 plants/fed D_3)	19.97c	23.00b	21.49c	4.88b	4.94	4.92b	37.74b	36.67c	37.21b
F-test	**	*	**	*	NS	**	*	**	**
Nitrogen fertilization (N)									
100 kg N/fed (N_1)	22.08	22.46a	22.27a	5.00	4.96a	4.98a	34.18a	33.64a	33.91a
124 kg N/fed (N_2)	22.12	23.09a	22.61a	4.99	4.97a	4.98a	36.59b	36.03b	36.31b
148 kg N/fed (N_3)	22.04	25.03b	23.54b	4.97	5.05b	5.01a	37.14b	36.27b	36.70b
F-test	NS	**	**	NS	*	*	**	*	**
Hybrids. (H)									
SC 178 (H_1)	22.43	23.76b	23.09b	4.91a	4.89a	4.90a	35.82b	35.27b	35.54b
SC 180 (H_2)	21.89	23.82b	22.85ab	5.03b	4.98b	5.01b	38.53c	40.09c	39.31c
Twc 369 (H_3)	21.93	23.01a	22.47a	5.00b	5.05b	5.03b	33.56a	30.58a	32.07a
F-test	NS	*	**	**	**	**	**	**	**
Interactions.									
D x N	*	NS	*	NS	NS	NS	NS	NS	NS
D x C	*	NS	NS	NS	NS	NS	NS	NS	NS
N x C	*	*	**	*	NS	NS	NS	NS	NS
D x N x C	NS	NS	NS	NS	NS	NS	NS	*	*

*,** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

3.4. The Interaction Effects:

The interaction between studied factors (D x N, D x H, N x H and D x N x H) were not significant for all studied traits in two seasons and their combined. Except for D x N for number of rows/ear in 2021 and combined and ear length in 2020 and combined, D x C for ear length in 2020, N x C for number of kernels/row in 2020, ear length in two seasons and combined and ear diameter in 2020 and D x N x H for grain yield in 2021 and combined data.

Table 4 showed that the highest value for grain yield was obtained under high plant density (D_3) and high nitrogen were (N_3) for SC180, 42.83 ardab/fed and 42.31 ardab/fed in 2020 and combined data, respectively followed by SC178, 39 ard/fed and 39.28 ardab/fed in 2021 and combined, respectively and for Twc 369, 34.39 ard/fed in combined data. Meanwhile the lowest value was obtained under low plant density D_1 and low nitrogen level N_1 for all hybrids in 2021 and combined data. General, across two years the high grain were obtained at the highest plant density (D3) and the highest nitrogen level (N3) for all hybrids, this study recommended planting these new hybrid SC180, SC178, Twc369 under plant density 30,000 plant/fed and nitrogen fertilization 148 kg N/fed.

Table 4: The effects of the interaction between plant density x nitrogen levels x maize hybrid for grain yield in 2021 and combined data

Plant densities	Nitrogen levels	2021			Comb.		
		SC187	SC180	Twc 369	SC187	SC180	Twc 369
D1	N1	32.03	37.46	28.60	32.34	35.96	28.03
D1	N2	33.26	38.43	29.53	32.76	37.63	30.06
D1	N3	34.06	39.30	29.33	33.98	38.91	30.86
D2	N1	33.60	38.90	29.96	34.80	38.21	31.03
D2	N2	35.50	40.73	31.43	35.93	40.38	33.49
D2	N3	36.20	41.46	32.63	37.13	41.38	33.54
D3	N1	35.70	38.16	29.40	35.68	37.56	31.60
D3	N2	39.00	41.56	31.73	37.95	40.44	34.58
D3	N3	39.00	42.83	31.60	39.28	42.31	34.93
$LSD_{0.05}$			3.73			2.00	

4. REFERENCES

Abebe, W.; Bitwoded, D.; Yayeh, B.; Gobezie, Ch. and Meqanint, A. (2020). Response of maize (*Zea mays* L.) to nitrogen and planting density in Jabitahinan district, Western Amhara Region, Cogent Food, Agriculture, 6:1.

Absy, R. and M. H. Abd EL-Lattif (2020). Response of maize (*Zea mays* L.) hybrids to different levels of nitrogen fertilizer and plant density on yield and its components. Plant Archives, 20(2):7669-7679.

Adhikari, K.; Bhandari, S.; Aryal, K.; Mahato, M.and Shrestha, J. (2021). Effect of different levels of nitrogen on growth and yield of hybrid maize (*Zea mays* L.) varieties. Journal of Agriculture and Natural Resources, 4(2):48-62.

Asibi, A. E.; Falong, Hu; Zhilong, Fan and Qiangchia (2022). Optimized Nitrogen Rate, plant Density, and Regulated Irrigation Improved Grain, Biomass yields, and Water Use Efficiency of maize at the Oasis Irrigation Region of China. Agriculture,12-234.

Awadalla, A. and A. S.M. Morsy (2016). Response of some yellow maize crosses to N-fertilizer rates and plant densities at Toshka region. Egypt. J. Agron., 38(3):337-354.

Begizew, G.; Muhidin B. and Lemi, Y. (2019). Effect of plant density and nitrogen fertilizer rate on grain yield of late maize hybrid BH661. Acad. J. Agri. Sci. Res., 7(7):577-588.

Chaudhry, A.R. (1983). Maize in Pakistan. Punjab Agri. Res. Coordination Board, Univ. Agric., Faisalabad, Pak.

Duvick D N. (2005).The contribution of breeding to yield advances in maize (*Zea mays* L.) Adv. Agronomy, 86:83-145.

El-Douby, K.A.; E.A. Ali; S.E.A. Toaima and A.M. Abdel-Aziz (2001). Effect of nitrogen fertilizer, defoliation and plant density on maize grain yield. Egypt. J. Agric. Res., 79(3):965-982.

EL-Rouby, M.M.; Omar, M.A.; Nawar, A.I.; EL-Shafei, A.A. and Zakaria, O. E. (2021). Determination of grain yield inputs of the maize hybrid Giza168 using a six-factor central composite design in Mediterranean regions under irrigation (2021). Journal of Desert and Environmental Agriculture, 1(1):1-15.

EL-Shahed, H.M., S.A. Mowafy, M.M.A. Osman and N.Z. El-Naggar (2017). Physiological response of maize hybrids to nitrogen and phosphorus fertilization. Zagazig J. Agric. Res., 44(1):41-69.

HaiYan Zhang, Cheng Ran Zhang, Peng Sun, XuWen Jiang, GuangHai Xu and JinZhong, Yang (2022). Optimizing planting density and nitrogen application to enhance profit and nitrogen use of summer maize in Huanghuaihai region of China. Scientific Reports,12:2704.

Kareem, I.; O.B. Jawando; E.K. Eifediyi; W.B. Bello and Y. Oladosu (2017). Effect of poultry manure and plant population on growth and yield of maize. Cercetări Agronomiceîn Moldova, 4(172):51-64.

Lee E. A. and M. Tollenaar (2007). Physiological basis of successful breeding strategies for maize grain yield. Crop Science, 47:5202-5215.

Nwogboduhu, N.G. (2016). Response of maize (*Zea mays* L.) varieties to planting densities. J. Agric. and Vet. Sci., 9(10):1-6.

Omar, A.E.A. (2014). Effect of FYM and phosphorus fertilization on yield and its components of maize. Asian J. Crop Sci., 6:15-26.

Revathi, K.; M.S. Rekha; M.K. Sheshama and G. Sharma (2017). Growth and yield of rabi maize (*Zea mays* L.) at different planting densities and N-levels. Int. J. Curr. Microbiol. App. Sci., 6(12):2047-2053.

Violeta, M.; B. Zorica; K.Vesna and T. Zorica (2016). The effect of crop density on maize grain yield. Biotechnology in Animal Husbandry, 32(1):83-90.

Xiukang, W.; G. Wang; C.T. Niel; M.L.Yingying and Tao Guo (2022). Determining optimal mulching, planting density, and nitrogen application to increase maize grain yield and nitrogen translocation efficiency in northwest china. BMC Plant Biology, 20:282.

Yasin, M.A.T. (2016). Response of two yellow maize hybrids to irrigation intervals and nitrogen fertilizer levels. J. Plant Prod., Mansoura Univ., 7(12):1465-1472.