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THE EFFECT OF NITROGEN SOURCE AND POPULATION DENSITY ON CORN PRODUCTION
B- YIELD AND ITS COMPONENTS

BY

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ABSTRACT

This investigation was carried out during 1999 and 2000 seasons, at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University at Giza, Egypt to study, the effect of N fertilization treatments (mineral as urea (46.5% N) with farmyard manure (FYM) as cattle manure) and plant population density (20000, 25000 and 30000 plant/fed.) on yield and its components of maize Single cross 10.

The results showed that, the most studied yield components increased by raising the quantity of N from urea. However, the differences between 120 kg N/fed. as urea alone and 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure were insignificant in most cases. However, increasing plant population density from 20000 to 30000 plant/fed. significantly increased grain yield. Meanwhile, the interaction between N fertilization combinations and plant population density had a significant effect on all studied characters. Optimum grain yield/fed. as well as harvest index was obtained by planting 30000 plant/fed. with 120 kg N/fed. as urea, followed by 60-90 kg N as urea combined with 30-60 kg N as organic source (cattle manure).

INTRODUCTION

Maize (*Zea mays* L.) is a major cereal crop in Egypt and all over the world. In Egypt, the total cultivated area of maize reached 1.927 million feddan in 2005 season with an average grain yield of 25.3 ardab/feddan (Statistical and Agricultural Economic Research Institute, Ministry of Agriculture of Egypt, 2005).

Several forms of mineral fertilizers as well as organic nitrogen manure, especially farmyard manure (FYM) and chicken manure are commonly used in Egypt.

Organic matter of the soil is considered to be the magic remedy for all types of soil. The applications of organic manures enrich the soil with nutrient element and humus which is the final product of decomposition of organic matter. Humus has a very vital role in improving soil physical and chemical properties. It increase the water holding capacity of the soil as a result of its colloidal status, and also humus increase the cation exchange capacity of the soil which is a remedy of one weakness of light textured soil. Awad-Allah and Nabila Bassiouny (1993) reported that one cubic meter of FYM contains about 64, 2.4, 3.2 and 9.6 Kg OM, N, P_2O_5 and K_2O, respectively. Most of the nutrient elements in FYM are not in the available form and it takes long time for decomposition and mineralization. Therefore, FYM has a good residual effect on the succeeding crops following the manured crop. In this connection, Fan *et al.*, 2005 reported that balanced fertilization and long term addition of organic material to soil should be encourage to maximize the use of stored soil arrest grain yield decline and ensure sustainable productivity.

As regarding to number of ears/plant, some workers stated that this trait was significantly increased with application either 20 m^3 FYM/fed. (Faisal and Shalaby, 1998) or by using 40 m^3 FYM/fed. (Fatma Nofal, 1999). On the ther hand, Khalil (1992) mentioned that application of 10 to 20 m^3 FYM/fed. had not significant effect on this trait.

Number as well as weight of grains/ear were not significantly increased by application of FYM. (Khalil, 1992). While Tuivavalagi and Silva (1996) noticed that the addition of chicken manure significantly increased kernel weight.

Moreover, 1000-grain weight was significantly increased either with application of 25 m^3 FYM/fed. (Abdel-Hameed, 1997) or by addition of 40 m^3 FYM/fed. (Fatma Nofal, 1999), but, Khalil (1992) reported that 100-grain weight was not significantly increased by increasing FYM from zero to 20 m^3 Fym/fed.

Concerning FYM which had been added with mineral fertilization, some workers found that grain yield was increased by using 10 tons FYM/ha. with 90-135 kg N + 45-67.5 kg P_2O_5 + 20-35 kg K_2O (Suri *et al.*, 1995 and Kamalakumari and Singaram, 1996). On the other hand, Bhajan *et al.* (1985), applied two levels of organic manure (8.5 or 17 tons FYM, 10 or 20 tons cowpea green manure, supplying 60 and 120 Kg N/ha. respectively) and 0, 60, 120 or 180 Kg N/ha. They found that organic manures and N increased grain yield and the green manure was more effective than FYM. While, Sambotin *et al.* (1986) reported that application of 110 Kg N + 60 Kg P_2O_5 + 148 K_2O + 40 t FYM +5 t lime/ha. increased maize grain yield by 5.27 t/ha. over the untreated control. Also, Mohamed and El-Aref (1999) obtained the highest grain yield by application of 20 Kg N (chemical) + 20 m^3 FYM/fed. at planting.

Several researchers stated that FYM alone had a valuable effect on grain yield of corn. Some investigators found that application of 10 to 20 tons FYM/ha. increased grain yield of maize as reported by (Ikombo, 1984; Devarajan *et al.*, 1987; El-Koumey, 1993; Tuivavalagi and Silva, 1996; Suri and puri, 1997 and Khan-Zada *et al.*, 2000). However, Abdel-Hameed (1997), Faisal and Shalaby (1998) and Fatma Nofal (1999) found that grain yield of corn was significantly increased with application of 25-40 m^3 FYM/fed. On the other hand, the highest organic manure rate 540 kg N/ha. as cattle manure produced the same yield as 180 kg N/ha. as urea. (Bocchi and Tano, 1994). El-Naggar *et al.* (1995) reported that mineral and organic fertilizers application significantly increased grain yield. The greater values of grain yield was recorded with urea followed by calcium nitrate and FYM compared with control. They added that FYM had the largest effect in increasing total N and available P and K in soil compared to urea and calcium nitrate. Khalil (1992) reported that FYM had no significant effect on maize grain yield.

Some workers have emphasized the importance of organic manure for improving soil fertility. Accordingly, it was very important to evaluate the two main kinds of nitrogen fertilizer upon plant growth, yield and its components. Corn is one of the most responsive crops for nitrogen fertilization. Therefore, it was chosen for this type of experiments.

Consequently, the present investigation aimed to study the effect of organic and mineral fertilization on yield of maize and its components to decrease the supplied mineral nitrogen sources to the soil which affect the environment and soil.

MATERIALS AND METHODS

The experiments were carried out during 1999 and 2000 seasons at Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, at Giza, Egypt to study the effect of N treatments including specific combination of both mineral sources (urea 46.5% N) and cattle manure ratios, plant population densities and their interaction on growth, grain yield and its components of maize (*Zea mays* L.) single cross 10. The chemical analysis of soil in 1999 and 2000 seasons are presented in Table 1.

Table (1): chemical analysis of upper 50 cm of soil in 1999 and 2000 seasons.

Nutrient	The chemical analysis of soil	
	1999 season	2000 season
N (ppm)	40.0	37.0
P (ppm)	18.0	17.0
K (ppm)	373.0	330.0
Fe (ppm)	1.09	1.16
Mn (ppm)	0.99	0.56
Zn (ppm)	0.66	0.38
Cu (ppm)	0.18	0.44
pH	7.6	7.9
EC (mm/cm)	0.45	0.31
$CaCO_3$ (%)	3.51	2.95
Ca (mg/L)	0.80	0.60

Experimental treatments:

The experiment included 18 treatments which were the combination of 6 treatments for N fertilization combinations (urea 46.5% with cattle manure) and three plant population densities .

A. Treatments for N fertilization combinations:

1. (N_1), Zero kg N/fed. as urea plus zero kg N/fed. As cattle manure (unfertilized control).
2. (N_2), Zero kg N/fed. as urea plus 120 kg N/fed. as cattle manure.
3. (N_3), 30 kg N/fed. as urea plus 90 kg N/fed. as cattle manure.
4. (N_4), 60 kg N/fed. as urea plus 60 kg N/fed. as cattle manure.
5. (N_5), 90 kg N/fed. as urea plus 30 kg N/fed. as cattle manure.
6. (N_6), 120 kg N/fed. as urea plus zero kg N/fed. as cattle manure.

B. Plant population density:

1. 20000 plant/fed. (30cm between plants).
2. 25000 plant/fed. (24cm between plants).
3. 30000 plant/fed. (20cm between plants).

The physical and chemical analysis of the cattle manure are presented in Table 2.

Table (2): Chemical analysis of the cattle manure applied in 1999 and 2000 seasons.

Fertilizer characteristics	Cattle manure analysis	
	1999 season	2000 season
Organic matter %	70.30	67.70
Total N (%)	0.89	1.01
Total P (%)	0.55	0.81
Total K (%)	1.19	1.34
NO_3-N (ppm)	185.10	182.0
Fe (ppm)	1810.0	1807.2
Mn (ppm)	205.0	415.0
Zn (ppm)	75.0	100.0
Cu (ppm)	140.0	161.0

Grains of maize (Single cross 10) were hand planted on 13 and 8 June in the first and second season, respectively. Thinning to one plant/hill was practiced 21 days from planting. Cattle manure was applied to each sub-plot before planting (The required of cattle manure were calculated according to total N content in cattle manure (Table 2.) and the chemical nitrogen fertilization as urea (46.5% N) was applied in two equal doses, i.e. before the first and second irrigation.

Both organic and chemical N sources were specified to secure a constant 120 kg nitrogen per feddan in both seasons.

Experimental design:

The experimental design was a split-plot with four replications. The main plots were devoted for treatments of N fertilization combinations and the sub-plots were assigned to plant densities.

The plots size of each sub-plot was 16.8 m^2 (4.2 × 4 m), containing 6 rows (4m long and 70 cm apart).

The outer row of each sub-plot was left for vegetative sampling (growth conesquent measurements). Then the next three rows were taken for yield and its components determination and the remaining tow rows were also left for vegetative sampling. The samples were randomly taken after 45, 60 and 75 days from planting (DAS).

Studied characters:

Yield and its components:

1. Stand at harvest per feddan.
2. Number of ears per plant.
3. Number of grains per ear.
4. Grains weight per ear (g).
5. Shelling percentage.
6. 500-grain weight (g).
7. Grain yield per feddan (ardabs).
8. Harvest index (H.I).

Number of grains and grain weight per ear as well as 500-grain weight were estimated on a sample of 20 ears randomly collected from each sub-plot. Yield and its components were estimated on the whole sub-plot basis. Therefore, 500-grain weight and grain yield/fed were adjusted to 15.5% moisture content. Grain yield/plot (kg) was transformed as ardab/feddan (one ardab = 14o kg).

All data were subjected to the statistical analysis according to Steel and Torrie (1980), using the MSTAT-C Program. Test for homogeneity of variance was used to compare between variances over two seasons before deciding the validity of combined analysis.

RESULTS AND DISCUSSION

Yield and its components:

1. Stand at harvest, (per feddan):

The effects of N treatments, plant population density and their interaction on number of plants/fed. at harvest are presented in Table (3).

1.1. Effect of N treatments:

Results indicated that N treatments had a significantly affected number of plants/fed. at harvest. The highest number of plants/fed. at harvest was obtained with using 120 kg N/fed. as urea + zero kg N/fed. as cattle manure (N_6 treatment). Results showed that 120 kg N as urea gave higher stand especially when compared with the unfertilized check.

1.2. Effect of plant population density:

Number of plants/fed. at harvest was increased with increasing plant population density from 20000 to 25000 and 30000 plant/fed.

1.3. Effect of interaction:

Results also, showed that the interaction between N treatments and plant population density had a significant effect on number of plants/fed. at harvest and being highest for 30000 plant density and fertilized with 120 kg N/fed. as urea + zero kg N/fed. as cattle manure (N_6 treatment).

2. Number of ears per plant:

The effects of N fertilization treatments, plant population density and their interaction on number of ears per plant are presented in Table (3).

2.1. Effect of N treatments:

Nitrogen treatments had a significant effect on number of ears per plant. Generally, increasing quantity of N from urea in N combinations caused a slight increase in number of ears per plant. The highest ears number per plant was produced from N_6 treatment, followed by N_5 and N_4.treatments, among which the differences were insignificant. Also, the unfertilized check (N_1) as well as the second (N_2) and third (N_3) treatments produce significantly lower number of ears/plant then the remainder N treatments

Table (3): Means of stand at harvest, per feddan, no. of ears /plant and no. of grains /ear as affected by N-fertilization and plant densities (combined over 1999 and 2000 seasons).

N fertilization	Stand at harvest/ feddan			
(Urea + cattle manure)	Plant densities / fed.			Mean
Kg N/ fed.	20000	25000	30000	
Zero + Zero (N_1)	18500	23417	27417	23111
Zero + 120 (N_2)	18667	23583	27667	23306
30 + 90 (N_3)	18583	23583	28083	23417
60 + 60 (N_4)	18750	23583	28083	23472
90 + 30 (N_5)	18500	23500	28083	23361
120 + Zero (N_6)	18833	23667	28667	23722
Means of plant densities	18639	23556	28000	
L.S.D.				
(N)				333.2
(P)				227.4
(N×P)				557.0
	No. of ears /plant			
Zero + Zero (N_1)	1.07	1.05	1.05	1.06
Zero + 120 (N_2)	1.62	1.33	1.22	1.39
30 + 90 (N_3)	1.70	1.72	1.28	1.57
60 + 60 (N_4)	1.92	1.83	1.53	1.76
90 + 30 (N_5)	1.85	1.70	1.78	1.78
120 + Zero (N_6)	2.15	1.87	1.77	1.93
Means of plant densities	1.72	1.58	1.44	
L.S.D.				
(N)				0.23
(P)				0.15
(N×P)				0.36
	No. of grains /ear			
Zero + Zero (N_1)	443.6	427.1	440.4	437.0
Zero + 120 (N_2)	536.6	526.3	510.3	524.4
30 + 90 (N_3)	536.4	525.4	536.9	532.9
60 + 60 (N_4)	551.3	522.9	538.9	537.7
90 + 30 (N_5)	592.9	554.9	536.0	561.3
120 + Zero (N_6)	584.1	578.6	560.4	574.4
Mean of plant densities	540.8	522.5	520.5	
L.S.D.				
(N)				28.1
(P)				15.7
(N×P)				38.6

2.2. Effect of plant population density:

Results in Table (3) indicated the significant differences between 20000 and 30000 plant densities. Other differences failed to be significant. Planting 20000 plant density produced the highest number of ears per plant. While, the lowest number of ears per plant was obtained by planting 30000 plant/fed. This could be attributed to good utilization of light, nutrients and water in case of lower densities than the highest ones. Similar results were obtained by El- Hosary and Salwau (1989), Esechie (1992), El-Hariri *et al* (1996), Khalil *et al* (1999) and El-Bana and Gomaa

(2000). In this connection, Al-Shebani (1998) reported that number of ears/plant insignificantly decreased with increasing plant population density from 16000 to 26000 plant/fed. However, Faisal *et al* (1996) found that increasing plant densities from 20000 to 24000 significantly increased number of ears/ plant.

2.3. Effect of interaction:

Results showed, that the interaction between N fertilization treatments and plant population density had a significant effect on number of ears per plant. Being highest for 20000 plant density and fertilized with 120 kg N/fed. as urea + zero kg N/fed. as cattle manure (N_6 treatment).

3. Number of grains per ear:

The effects of N treatments, plant population density and their interaction on number of grains per ear are presented in Table (3) .

3.1. Effect of N treatments:

Results indicated that number of grains per ear was significantly affected by N combination treatments. The highest number of grain per ear was obtained from N_6 treatment, i.e. using 120 kg N/fed. as urea + zero kg N/fed. as cattle manure, followed by N_5 treatment, i.e. 90 kg N/fed. + 30 kg N/fed. as cattle manure. The difference between both treatments was insignificant. Also, the differences between N_2, N_3 and N_4 treatments were insignificant. Moreover, the unfertilized check gave the significant lowest number of grain/ ear.

3.2. Effect of plant population density:

Results indicated that increasing plant population density from 20000 to 30000 plant/ fed. significantly decreased number of grains per ear. The difference between (25000 and 30000 plant densities) was not significant. Superiority of 20000 plant density may be due to the highest performance of such density in ear length and to the reduction of within plant competition for nutrient, water, space and light. The results reported here are in harmony with those obtained by Abdel-Raouf (1973), and Al-Shebani (1998) who found that that number of grain per ear was significantly decreased by increasing plant population density from 15000 to 31000 plant/fed. On the contrary, El-Bana and Gomaa (2000) reported that increasing plant population density from 20000 to 30000 plant/fed. significantly increased number of grains per ear.

3.3. Effect of interaction:

Results showed also, that the effect of interaction between N fertilization treatments and plant population density on grains number/ear was significant (Table 3). In general, the highest number of grains per ear was given by planting 20000 plant/fed. and fertilized with 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure (treatment N_5) or with 120 kg N/fed. as urea without cattle manure (treatment N_6).

4. Grain weight per ear (gm):

Grain weight per ear as affected by N treatments, plant population density and their interaction is presented in Table (4) .

2.4.1. Effect of N treatments:

Results indicated that ear grain weight was significantly increased with N fertilization.

However, the differences between the last three treatments (N_4, N_5, N_6 treatments) were insignificant. Significantly highest ear grain weight was obtained with application of urea N more than 30 kg/fed. These results are in harmony with those obtained by Tuivavalagi and Silva (1996) who indicated that addition of chicken manure combined with mineral fertilizers significantly increased kernel weight/ear.

4.2. Effect of plant population density:

Results showed also, that plant population density had a significant effect on grain weight per ear. This trait decreased significantly by increasing plant population density from 20000 to 30000 plant/fed. Increasing plant density from 20000 plant/fed. to 25000 plant/fed. to 30000 plant/fed. decreased ear grain weight from 171.3 gm to 157.3 gm to 145.8 gm respectively. Such increase in grain weight per ear for 20000 plant density

may be due to light inter-plant competition as reflected above in higher means of ear length and diameter as well as number of grain per ear. These results are in agreement with those obtained by El-Deeb (1990), Al-Shebani (1998) and El-Bana and Gomaa (2000) who reported that weight of grain/ear was significantly decreased with increasing plant population density up to 30000 plant/fed.

Table (4): Means of grains weight /ear, shelling % and 500-grain weight as affected by N-fertilization and plant densities (combined over 1999 and 2000 seasons).

N fertilization	Grains weight /ear			
(Urea + cattle manure)	Plant densities / fed.			Mean
Kg N/ fed.	20000	25000	30000	
Zero + Zero (N_1)	137.9	123.8	98.7	120.1
Zero + 120 (N_2)	155.6	150.4	138.5	148.2
30 + 90 (N_3)	170.4	157.3	155.4	161.0
60 + 60 (N_4)	185.3	167.5	160.0	170.9
90 + 30 (N_5)	190.3	172.6	160.3	174.4
120 + Zero (N_6)	188.4	172.3	161.6	174.1
Means of plant densities	171.3	157.3	145.8	
L.S.D.				
(N)				9.1
(P)				4.0
(N×P)				9.9
	Shelling %			
Zero + Zero (N_1)	78.8	78.6	72.6	76.7
Zero + 120 (N_2)	87.6	88.1	85.9	87.2
30 + 90 (N_3)	87.9	83.9	81.5	84.4
60 + 60 (N_4)	86.6	87.7	86.1	86.8
90 + 30 (N_5)	88.1	86.7	86.4	87.1
120 + Zero (N_6)	88.5	87.4	86.1	87.4
Means of plant densities	86.3	85.4	83.1	
L.S.D.				
(N)				2.18
(P)				1.53
(N×P)				3.74
	500-grain weight			
Zero + Zero (N_1)	166.4	160.3	154.9	160.5
Zero + 120 (N_2)	181.6	173.0	170.1	174.9
30 + 90 (N_3)	180.5	180.6	178.9	180.0
60 + 60 (N_4)	185.5	179.7	176.3	180.5
90 + 30 (N_5)	186.0	184.2	177.9	182.7
120 + Zero (N_6)	185.6	178.7	178.4	180.9
Means of plant densities	180.9	176.1	172.7	
L.S.D.				
(N)				4.29
(P)				2.71
(N×P)				6.66

4.3. Effect of interaction:

Results in Table (4) showed also that the interaction between N treatments and plant population density had a significant effect on the above trait. In general, planting 20000 plant/fed. and applied 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure (N_5 treatment)

5. Shelling percentage:

Effects of N treatments, plant population density and their interaction on shelling percentage are presented in Table (4).

5.1. Effect of N treatments:

Results clearly indicated that the effect of N treatments on shelling percentage was significant either in the combined analysis or in both growing seasons. The highest value of shelling percentage was obtained from N_6 treatment followed by N_5, N_2 and N_4 treatments among which differences were not significant. While the lowest shelling percentage was obtained from control or treatment N_3. In this connection, Ponsica *et al.* (1983) indicated that shelling percentage was significantly increased by application of FYM combination with mineral fertilizers.

5.2. Effect of plant population density:

Results indicated that shelling percentage was significantly affected by plant population density. The significantly lowest shelling percentage was obtained from the highest density (30000 plant/fed.). Whereas the differences between the first two densities were insignificant. These results are in general agreement with those obtained by Bedeer (1984), Gomaa (1985), Abdel-Aal *et al.* (1997), Al-Shebani (1998) and Said and Gabr (1999). However, Tantawi *et al.* (1994) found that plant population density had no significant effect on shelling percentage.

5.3. Effect of interaction:

Results clearly indicated that the interaction between N combinations and plant population density had a significant effect on shelling percentage Table (4). The highest shelling percentage was about (88.47%) and obtained by planting 20000 plant/fed. which fertilized by 120 kg N/fed. as urea + zero kg N/fed. as cattle manure (N_6 treatment), followed by planting 20000 plant/fed. which fertilized with 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure (N_5 treatment).

6. 500-grain weight:

The effects of N treatments, plant population density and their interaction on 500-grain are presented in Table (4).

6.1. Effect of N treatments:

The effect of N treatments on 500-grain weight was significant. However, the differences within the last four treatments (N_3, N_4, N_5 and N_6 treatments) were insignificant. Whereas, 500-grain weight was significant higher for any of the above treatments than for N_2 treatment or the unfertilized check. The heaviest 500-grain weight was obtained from N_5 treatment, followed by N_6 treatment. These results clearified the importance manure application even with lower amount (30 kg N as cattle manure). The results may be due to the fact that FYM improve the availability of nutrients and the capacity of organic materials to supply with more than one nutrient during the time of grain filling. Saleh and Abd El-Fattah (1997) showed that the slow release of nutrients from FYM makes timing on nutrient availability more suitable than that from chemical fertilizer. Mohamed and El-Aref (1999) reported that adding 20 or 10 kg N (chemical) combined with 20 or 40 m^3 FYM/fed. and also, adding 40 m^3 FYM/fed. at planting increased 1000-grain weight more than those obtained by adding 40 kg N (chemical) at planting. Madhavi *et al.* (1995) reported that 1000-grain weight was significantly increased by application of 50 or 100% recommended rate of NPK (120 kg N + 60 kg P_2O_5 + 60 kg K_2O/ha.) with 4.5 tons/ha. Poultry manure.

6.2. Effect of plant population density:

Results indicated that 500-grain weight was significant increased with decreasing plant population density from 30000 to 20000 plant/fed. This increment may be due to highest mean performance in ear length and diameter, number of grain per ear and ear grain weight for the above plant densities. The same trend was previously obtained by several investigators such as Faisal *et al.* (1996), Abdel-Aal *et al* (1997), Al-Shebani (1998), Khalil *et al.* (1999) Said an Gabr (1999), El-

Bana and Gomaa, (2000) and Hassan, (2000) who found that either, 1000- grain weight and 500-grain weight or 100-grain weight was significantly increased with decreasing plant population density per unit area.

6.3. Effect of interaction:

Results in Table (4) clearly indicated that the interaction between N fertilization and plant population densities had a significant effect on 500-grain weight. The highest 500-grain weight was obtained by planting 20000 plant/fed. fertilized with 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure (N_5 treatment)

7. Grain yield ardab per feddan:

Results of the effects of N treatments, plant population and their interaction on grain yield of maize (ardab per feddan) are presented in Table (5).

7.1. Effect of N treatments:

Results indicated that grain yield/fed. was significantly affected by N fertilization treatments. In general, grain yield/fed. increased by raising the quantity of N from urea in the combination N fertilization.

Table (5): Means of grain yield ardab/feddan, and harvest index as affected by N-fertilization and plant densities (combined over 1999 and 2000 seasons).

N fertilization	Grain yield ardab/feddan				Harvest index			
(Urea + cattle manure)	Plant densities / fed.			Mean	Plant densities / fed.			Mean
Kg N/ fed.	20000	25000	30000		20000	25000	30000	
Zero + Zero (N_1)	15.52	16.21	13.82	15.18	28.8	28.0	24.2	27.0
Zero + 120 (N_2)	18.34	21.34	22.61	20.76	29.7	31.1	29.1	30.0
30 + 90 (N_3)	19.92	22.7	25.35	22.66	30.8	30.7	30.1	30.5
60 + 60 (N_4)	22.46	24.9	26.77	24.71	31.4	31.1	30.6	31.0
90 + 30 (N_5)	24.16	26.08	27.50	25.91	32.5	31.8	29.8	31.3
120 + Zero (N_6)	24.56	27.41	28.95	26.98	33.8	32.5	29.7	32.0
Means of plant densities	20.82	23.11	24.17		31.2	30.8	28.9	
L.S.D.								
(N)				1.71				1.47
(P)				1.18				1.28
(N×P)				2.89				3.14

Results also indicated that the differences between N_4 and N_5 or between N_5 and N_6 were not significant.

The vital role of N on maize grain yield is clearly demonstrated. The effect of N on maize grain yield is the outcome of its effect on leaf area per plant, increasing each of maize prolificacy, ear size, number and weight of grains per ear, 500-grain weight, and shelling percentage. In general, Blaga *et al.* (1993), Bocchi and Tano (1994), El-Naggar *et al.* (1995), Scherer (1995), Suri *et al.* (1995), Madhavi *et al.* (1996), Kamalakumari and Singaram, (1996). Tuivavalagi and Silva (1996) found that grain yield per unit area increased with application of animal manure combination with mineral fertilizers. Also, Mohamed and El-Aref (1999) obtained that the highest grain yield by application of 20 Kg N (chemical) + 20 m^3 FYM/fed. at planting.

7.2. Effect of plant population density:

Plant densities significantly affected grain yield per unit area, but this effect on this character gave insignificant difference between 25000 and 30000 plant/fed. Plant density of 30000 plant/fed. gave the highest grain yield/fed. followed by 25000 plant/fed. and 20000 plant/fed. However, such increase was more pronounced with increasing plant density from 20000 to 30000 plant/fed. in both seasons as well as in their combined average . This increase may be due to greater number of

plants per unit area in case of the dense planting and consequently increased grain yield/fed. The results reported here are in harmony with those obtained by El-Bially *et al.* (1991) Gouda *et al.* (1993), Tantawi *et al.* (1994), El-Hariri *et al.* (1996), Faisal *et al.* (1996), Al-Shebani (1998), Said and Gabr (1999), El-Bana and Gomaa (2000) and Hassan (2000), who found that grain yield /fed. was increased significantly with increasing plant population density from 16000 to 30000 plant/fed. While, increasing plant population density over 35000 plant/fed. caused a significant reduction in grain yield/fed. (Abdul-Galil *et al*, 1990; and Bedeer *et al*, 1992).

7.3. Effect of interaction:

Results also, showed that the interaction between N fertilization and plant population density had a significant effect on grain yield/fed. The highest grain yield/fed. (28.95 ardab/fed.) was obtained by planting 30000 plant/fed. with 120 kg N/fed. as urea + zero kg N/fed. cattle manure (N_6 treatment). But, the treatment which realize the aim of this research is the N_5 treatment (90 kg N/fed. as urea + 30 kg N/fed. cattle manure) because, the difference in grain yield between N_5 and N_6 was not significant.

Finally, it could be concluded that under the condition of this study the best grain yield/fed. could be produced by planting 30000 plant/fed. from single cross 10 with application of cattle manure at not less than 30 kg N/fed. up to 60 kg N/fed. of organic source. The remainder amount of nitrogen from ammonium source as urea (60-90 kg N/fed.).

Such recommendation is logic as no significant differences between N_4, N_5 and N_6 treatments were obtained in both seasons. The improvement role of organic manure on soil properties could not neglected.

8. Harvest index (H.I):

Harvest index as affected by N fertilization, plant population density and their interaction is presented in Table (5).

8.1. Effect of N treatments:

The effect of N treatments on harvest index was significant. It seams that harvest index increase with raising the quantity of N as urea in the combination N fertilization. Fertilized plots with 120 kg N/fed. as urea + zero kg N/fed. as cattle manure (N_6 treatment), followed by using 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure (N_5 treatment) produced the highest harvest index. The difference between both treatments was not significant. Kagata *et al.* (1999) showed that harvest index was stable and high in FYM and FYM + NPK treatments, but gradually decreased with NPK or without fertilizers.

8.2. Effect of plant population density:

Results showed also, that harvest index was significantly decreased by increasing plant population density. However, the difference between the first and second plant densities (20000 and 25000 plant/fed.) was insignificant. These results were agreement with those obtained by Al-Shebani (1998)who found that increasing plant density per unit area was accompanied by decreasing harvest index .On the contrary, and Assey *et al.* (1992) found that increasing plan density from 20000 to 30000 plant/fed. caused a significant increase in harvest index.

8.3. Effect of interaction:

Results showed that the interaction between N fertilization combination treatments and plant density, significantly affected harvest index. The highest value of harvest index (33.84) was obtained by planting 20000 plant/fed. which fertilized with 120 kg N/fed as urea + zero kg N/fed as cattle manure (N_6 treatment), followed by using 90 kg N/fed. as urea + 30 kg N/fed. as cattle manure (N_5 treatment). The difference between both treatments was not significant.

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تأثير مصدر النتروجين والكثافة النباتية على الذرة الشامية
٢. المحصول ومكوناته

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أجريت هذه الدراسة فى موسمى ١٩٩٩ و٢٠٠٠ فى محطة البحوث والتجارب الزراعية – كلية الزراعة – جامعة القاهرة لدراسة تأثير التسميد النتروجينى المعدنى (يوريا ٤٦,٥%) والعضوى (سماد الماشية) عند استخدامها فى توافيق خاصة بنسب مختلفة من كل منهما وكذلك ثلاثة كثافات نباتية (٢٠ و٢٥ و٣٠) الف نبات / فدان على محصول الحبوب ومكوناته فى الذرة الشامية (هجين فردى ١٠) واتضح من النتائج بصفة عامة ان محصول الحبوب وكثير من مكوناته قد زادت بزيادة معدل النتروجين المعدنى المضاف. الا انه فى الوقت نفسه لم تكن الفروق معنوية بين كل من معاملة التسميد ١٢٠ كجم N معدنى فى صورة يوريا والمعاملة التى استبدل فيها ربع الكمية (٣٠ كجم N) فى صورة عضوية (سماد الماشية) عند النظر إلى محصول الحبوب وكذلك معظم مكونات محصول الحبوب وأتضح أيضا أن زيادة كثافة النباتات من ٢٠ الى ٣٠ الف نبات / فدان زادت المحصول بصورة معنوية. وكان التفاعل بين العاملين تخت الدراسة معنويا في كل مكونات المحصول.

واستخلص من الدراسة أفضلية استخدام الكثافة النباتية ٣٠ الف نبات / فدان والتسميد اما بـ ١٢٠ كجم N فى صورة يوريا اوبـ ٦٠-٩٠ كجم N (يوريا) مع ٣٠-٦٠ N (سماد ماشية) وهواكثر ملائمة للتوصية من ناحية تحسين التربة وعدم نقص المحصول ومكوناته وكذلك تقليل التلوث.