J. Plant Production, Mansoura Univ., Vol. 10 (1): 53 - 58, 2019

Effect of Nitrogen Rates, Biofertilizers and Foliar Urea Application on Yield and Yield Components of Maize (*Zea mays*, L.)

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ABSTRACT

Two field experiments were conducted at Bahteem region, Kalubiah Governorate during 2011 and 2012 seasons, to study the effect of three nitrogen rates (40, 60, and 80 kg/fed), biofertilizers (control, without biofertilizer application and Azotobacter + Azospirillum) and foliar spraying with four urea concentrations (0,1.5,2.5 and 3.5%) as well as their interactions on yield and yield components of maize (single cross 30 K8). Results indicated that nitrogen fertilizer rates significantly affected on ear length, number of grains/ears, 100-grain weight and grain yield/fed. in the two seasons. Nitrogen at the rate of 80kg/fed. gave the highest values for all studied traits. Also, results showed that the difference between biofertilizer treatments were significant for all studied traits in the two seasons. Inoculation maize seed with Azotobacter + Azospirillum gave the maximum values for all studied attributes in both seasons compared with the control. In the same trend, results indicated that the differences between urea foliar spraying treatments were significant for all studied traits in the two seasons. Foliar maize plants with 3.5 % concentration gave the highest values for all studied traits compared with other treatments in both seasons. The interactions between nitrogen rates x biofertilizers x foliar treatments with urea were significant for all studied attributes in the two seasons. The results showed that foliar maize plants with 3.5 % urea concentration and inoculation with Azotobacter + Azospirillum as well as fertilized with 80 kg N/fed. gave the highest values for the yield and yield components.

Keywords: Nitrogen rates, biofertilizers, Azotobacter, Azospirillum, foliar spraying with urea concentration.

INTRODUCTION

Maize is an important grain crop of the world and it ranked 3rd after wheat and rice in area basis and total production (FAO, 2013). The total area maize was 185. 12 million hectares, the production of maize grain 1018.12 million tons in 2013 (FAO, 2013). Nitrogen is one of the most yield limiting nutrients for maize crop production in the world. It is also the nutrient element applied for most cereal crops and had significant effect on growth, yield and yield components of maize (Huber and Thompson, 2007). Application of nitrogen alone or integrated with biofertilizers or in combination with urea increased growth, yield and yield components. Gheysari *et al.* (2009) indicated that application of nitrogen with rate 250 kg N/ha. increased yield and yield components of maize. Jalali *et al.* (2010) also found that the highest values for number of grains per ear,1000 grain weight, grain yield and harvest index were obtained from rate 250kgN/ha. urea fertilizer of maize. Hammad *et al.* (2011) reported that application of nitrogen with rate 300kgN/ha. increased yield and yield components of maize. Ram *et al.* (1997) indicated that spraying maize plants with urea 3%concentration increased grain yield compared with the control. Moursi *et al.* (1998) showed that foliar urea application at 30 days after sowing with 4% concentration increased chlorophyll, carotenoids content and photosynthetic activity in isolated chloroplasts; Mehrabadi and Mohassel (2000) found that urea foliar application with 2.5% concentration at two weeks before anthesis, two weeks after anthesis increased yield and yield components compared with the control. Sarakhsi *et al.* (2010) showed that spraying maize plants with 3% urea concentration at tasseling stage increased growth, yield and yield components. Also, biological nitrogen fixation is most important alternative for overcoming high costs of N fertilizer input into cropping systems without substantial loss in yield. Laxminarayana (2001) found that application 30 or 40 kg N/ha. rate increased yield and yield components of maize compared with 80 kg N/ha. He added that maize seed inoculation with Azotobacter and Azospirillum decreased nitrogen fertilizer application with 37.5 to 50% compared with 80 kg N/ha. rate. Wu *et al.* (2005) indicated that maize seed inoculation with Azotobacter and Azospirillum can replace 30-50% of total amount of mineral nitrogen. Hagh *et al.* (2010) indicated that maize plants inoculation with *Azospirillum lipaferum* + 140 kg N/ha. increased yield and yield components and decreased nitrogen mineral amount with 25% and reduced pollution rate. Also, Naserirad *et al.* (2011) showed that double-inoculation of Azotobacter and Azospirillum significantly increased yield and yield components of maize compared with other treatments *Azotobacter or Azospirillum* alone.

Therefore, this study aimed to investigate the effect of side-dressing nitrogen fertilizer rates, spraying with urea and biofertilizers on growth, yield and yield components of maize (*Zea mayse*, L.) at Bahteem region, Kalubiah Governorate, Egypt.

MATERIALS AND METHODS

Two field experiments were conducted at Bahteem region, Kalubiah Governorate, Egypt during 2011and 2012 seasons, to study the effect of three side-dressing nitrogen rates, bio-fertilization (inoculation with *Azotobacter* + *Azospirillum*), foliar spraying with four urea concentrations and their interactions on yield and yield components of single cross 30k 8 of maize.

Experiment treatments

A. Nitrogen rates

Three side-dressing nitrogen fertilizer rates (40, 60 and 80 kg N/fed.) were applied as ammonium nitrate (33.5% N) in two splits, the first one was added before the first irrigation (21days after sowing) and the second one was added before the second irrigation (36 days after sowing) in both seasons.

B. Biofertilizer treatments

1-Control (without biofertilizer treatment)

2- inoculation maize seed with *Azotobacter chroococcum +Azospirillum brasilense*

The microorganisms of N-fixation were mixture of *Azotobacter chroococcum +Azospirillum brasilense* in ratio 1:1 W/W.

Biofertilizer was used at the rate of 500g/fed., adhesive solution of gum was added to the seed and mixed carefully for 5 minutes until all seed were thoroughly coated, seed were sown directly in the same day and then irrigated.

C. Urea foliar application

Urea was applied as a foliar spraying at the rate of 1.5, 2.5 and 3.5%, in addition to the control (without application of urea) at two times, i.e. 35 and 50 days from sowing date.

Phosphorus fertilizer was added at the rate of 22.5 kg P_2O_5/fed. In the form of Calcium super phosphate (15.5% P_2O_5) during land preparation. Potassium fertilizer was added at the rate of 24kg K_2O/fed. In the form of Potassium sulphate (48% K_2O) in one dose with 1st does of nitrogen fertilizers. Sowing date was 21April and the preceding crop was wheat in the two seasons. All other cultural practices were followed as recommended in maize production.

Every experiment included 24 treatments in three replicates. The experimental design was sub-sub plot design. The main plots were devoted to nitrogen fertilizer rates, the sub-plots were occupied with biofertilizers and foliar spraying with urea concentrations treatments were allocated in sub-sub plots. The experimental unit area was 10.5 m^2 with 5 ridges of 60 cm. wide and 3.5 m long with hill 25cm a part.

Mechanical and chemical analysis of experimental soil in 2011 and 2012 seasons are presented in Table 1.

Mechanical analysis	2011 season	2012 season
Sand %	15	14
Silt %	35	35
Clay%	50	51
Texture	Clay loam	Clay loam
Chemical analysis		
P^H	7.9	7.8
ECe. m mohs /cm.	1.55	1.54
Available N (PPM)	32	31
Available P (PPM)	12.70	12.67
Available K (PPM)	317	314
Available Fe (PPM)	3.19	3.15
Available Mn (PPM)	2.53	2.48
Available Zn (PPM)	2.09	2.01

Studied Attributes

At harvest ten individual plants were taken at random from each plot and the following data were recorded:

1-Ear length, in cm.

2-Number of grains/ear.

3-100-grain weight, in g.

4-Grain yield/fed., in kg.

The obtained data of plant parameters were statistically analyzed according to the methods suggested by Gomez and Gomez (1983). Means were compared by using the L.S.D values at 5%level of significance.

RESULTS AND DISCUSSION

Tables (2,3,4,5 and 6) show the effect of nitrogen rates application on the soil surface, biofertilizers and foliar spray urea on ear length, number of grains/ear, ear weight (g), 100-grain weight (g) and grain yield (kg/fed) of maize in 2011 and 2012 growing seasons.

1- Ear length:

Data recorded in Table (2) show clearly that side dressing nitrogen fertilizer rates significantly affected ear length in both seasons. However, the highest ear length (22.32 cm and 18.34 cm) was obtained under the highest nitrogen rate (80 kg/fed) in 2011 and 2012 seasons, respectively. In 2011, growing season, this nitrogen rate (80 kg/fed) gave 30.22% and 9.36% increase in ear length over those obtained under the application of 40 kg and 60 kg N/fed, respectively. Results in 2012 season followed similar results.

These results might be attributed to that nitrogen is an essential nutrient element for many physiological processers in plants. One of these is chlorophyll and carotenoids synthesis (Hammad *et al.* 2011), resulting in increasing photosynthesis rates which subsequently increase vegetative growth of corn plants i.e. leaf area per plant, number of leaves per plant and in turn increased ear length.

Table (2) show that biofertilizer treatments significantly affected ear length in both seasons. However, the highest ear length (20.67 cm and 18.39 cm) was obtained under Azotobacter + Azospirillum treatment in 2011 and 2012 seasons, respectively. In 2011, growing seasons, inoculation maize seed with Azotobacter + Azospirillum gave 7.43% increase in ear length over that obtained under control (without biofertilizer treatment).

Results in 2012 season gave similar results. These results are in agreement with those of Naseri *et al.* (2013) indicated that inoculation with *Azotobacter* and *Azospirillum* gave the maximum values for ear length of maize compared with other treatments under deficit irrigation conditions.

Data recorded in Table 2 indicate that urea foliar application significantly affected ear length in both seasons. However, the highest ear lengths (21.97 cm and 18.71 cm) were recorded under the highest urea foliar rate (3.5%) in 2011 and 2012 seasons, respectively. In 2011, growing seasons, this urea foliar rate (3.5%) gave 21.24%, 13.59% and 7.74% increase in ear length over those obtained under control, 1.5% and 2.5%, respectively. Data obtained in 2012 season followed similar trend. These findings are in agreement with those of Sarakhsi *et al.* (2010) who showed that spraying maize plants with 3% concentration at tasseling stage increased ear length (cm) and Moursi *et al.* (1998).

The interaction between nitrogen rates, biofertilizer treatments and urea foliar application significantly affected ear length in both seasons. Data presented in Table 2 show that, the highest ear lengths (24.35 cm and 19.78 cm) were obtained under the interaction between nitrogen rates (80 and 60 kg/fed) with Azotobacter + Azospirillum treatment and urea foliar application of 3.5% in 2011 and 2012 seasons, respectively.

Table 2. Effect of side-dressing nitrogen rates, bio-fertilizers and foliar application of urea on ear length (cm), of maize in 2011 and 2012 seasons.

Treatments		2011 Season					2012 Season				
Nitrogen rates	Bio fertilizers	Urea foliar 0.0%	1.5%	2.5%	3.5%	Mean	Urea foliar 0%	1.5%	2.5%	3.5%	Mean
	Control	14.23	15.60	16.25	18.60	16.17	15.00	15.65	16.90	16.90	16.11
40 kg/fed.	Azot + Azospi *	16.25	17.15	18.64	20.36	18.10	16.00	17.12	17.92	18.30	17.34
	Mean	15.24	16.38	17.45	19.48	17.14	15.50	16.39	17.41	17.60	16.72
	Control	17.63	19.32	20.20	21.51	19.67	16.32	17.50	18.60	19.00	17.86
60 kg/fed.	Azot + Azospi	18.62	20.28	22.36	23.35	21.15	17.20	18.32	19.64	19.78	18.74
	Mean	18.13	19.80	21.28	22.43	20.41	16.76	17.91	19.12	19.39	18.30
	Control	20.36	21.35	22.23	23.64	21.90	16.90	17.23	17.52	18.62	17.57
80 kg/fed.	Azot + Azospi	21.65	22.32	22.65	24.35	22.74	18.60	18.96	19.20	19.65	19.10
	Mean	21.01	21.84	22.44	24.00	22.32	17.75	18.10	18.36	19.14	18.34
Bio. Fertilizer	Control	17.41	18.76	19.56	21.25	19.24	16.07	16.79	17.67	18.17	17.18
Means	Azot + Azosp.	18.84	19.92	21.22	22.69	20.67	17.27	18.13	18.92	19.24	18.39
General means		18.12	19.34	20.39	21.97	19.95	16.67	17.46	18.30	18.71	17.78
LSD at 5%											
Nitrogen (N)		**0.14**					**0.16**				
BF (B)		**0.23**					**0.22**				
Urea (U)		**0.45**					**0.40**				
N X B		**0.64**					**0.59**				
N x U		**1.00**					**0.98**				
B x U		**0.98**					**0.88**				
N x B x U		**1.12**					**1.10**				

***Azotobacter + Azospirillium**

2- Number of grains/ear:

Results presented in Table (3) show clearly that side-dressing nitrogen fertilizer rates significantly affected number of grains/ear of maize in both seasons. The obtained results show that, the highest number of grains/ear (672.61 and 671.17) were obtained under the highest nitrogen rate (80 kg/fed) in 2011 and 2012 seasons, respectively. In 2011, growing season, this nitrogen rate (80 kg/fed) gave 25.01% and 12.62% increase in number of grains/ear over those obtained under the application of 40 kg and 60 kg N/fed, respectively. Results in 2012 season followed similar results. These results might be attributed to the favourable effect of nitrogen on ear length (Table 2).

Table (3) also show that biofertilizer treatments significantly affected number of grains/ear in both seasons. However, the highest number of grains/ear (618.70 and 616.11) were obtained under Azotobacter + Azospirillum treatment in 2011 and 2012 seasons, respectively. In 2011, growing season, inoculation maize seed with Azotobacter + Azospirillum treatment gave 5.48% increase in number of grains/ear over that obtained under control (without biofertilizer treatment). Data recorded in 2012 season followed similar trend.

Table 3. Effect of side-dressing nitrogen rates, bio fertilizers and foliar application of urea on number of grains/ear of maize in 2011 and 2012 seasons.

Treatments		)11 Season					2012 Season				
Nitrogen rates	Bio fertilizers	Urea foliar 0.0%	1.5%	2.5%	3.5%	Mean	Urea foliar 0%	1.5%	2.5%	3.5%	Mean
	Control	500.12	520.30	540.80	560.20	530.36	470.52	490.20	499.62	510.00	492.59
40 kg/fed.	Azot + Azospi*	512.50	530.70	550.50	589.00	545.68	505.50	512.36	545.50	555.69	529.76
	Mean	506.31	525.50	545.65	574.60	538.02	488.01	501.28	522.56	532.85	511.17
	Control	553.30	579.30	586.60	599.40	579.65	564.63	578.60	594.62	612.32	587.54
60 kg/fed.	Azot + Azospi	586.62	600.20	620.28	652.00	614.78	620.22	632.00	645.35	652.23	637.45
	Mean	569.96	589.75	603.44	625.70	597.21	592.43	605.30	619.99	632.28	612.50
	Control	633.50	645.60	650.22	668.90	649.56	632.25	655.50	676.50	680.63	661.22
80 kg/fed.	Azot + Azospi	675.36	689.32	698.65	719.31	695.66	658.65	675.65	690.63	699.58	681.13
	Mean	654.43	667.46	674.44	694.11	672.61	645.45	665.58	683.57	690.11	671.17
Bio. Fertilizer	Control	562.31	581.73	592.54	609.50	586.52	555.80	574.77	590.25	600.98	580.45
Means	Azot + Azosp.	591.49	606.74	623.14	653.44	618.70	594.79	606.67	627.16	635.83	616.11
General means		576.90	594.24	607.84	631.47	602.61	575.30	590.72	608.70	618.41	598.28
LSD at 5%											
Nitrogen (N)		**1.65**					**1.79**				
BF (B)		**0.89**					**0.96**				
Urea (U)		**1.45**					**1.59**				
N X B		**1.62**					**1.34**				
N x U		**3.16**					**3.30**				
B x U		**2.33**					**2.06**				
N x B x U		**3.98**					**4.25**				

***Azotobacter + Azospirillium**

Results presented in Table (3) indicate that urea foliar application significantly affected number of grains/ear in both seasons. However, the highest number of grains/ear (631.47 and 618.41) were obtained under the highest urea foliar rate (3.5%) in 2011 and 2012 seasons, respectively. In 2011, growing season, this urea foliar rate (3.5%) gave 9.45%, 6.26%, 3.88% increase in number of grains/ear over those obtained under control, 1.5% and 2.5%, respectively. While, in 2012 season it were 7.49, 4.68 and 1.60%. These results are in accordance with those obtained by Ram *et al.* (1997).

The interaction between nitrogen rates, biofertilizer treatments and urea foliar application significantly affected number of grains/ear in both seasons. However, the highest number of grains/ear (719.31 and 699.58) were obtained under the interaction between nitrogen rate (80 kg/fed) with Azotobacter + Azospirillum treatment and urea foliar application of 3.5% in 2011 and 2012 seasons, respectively.

3-100-grain weight (g):

Data recorded in Table (4) show clearly that nitrogen fertilizer rates significantly affected 100-grain weight (g) of maize in both seasons. However, the highest 100-grain weight (g) (31.61g and 29.02 g) were obtained under the highest nitrogen rate (80 kg/fed) in 2011 and 2012 seasons, respectively. This nitrogen rate (80 kg/fed) gave 25.83% and 12.49% increase in 100-grain weight (g) over those obtained under the application of 40 kg and 60 kg N/fed, respectively. Results in 2012 season followed similar results. These results might be attributed to the effect of nitrogen on delaying leaf presence of the plants resulting in increasing this photosynthesis rates after silking and increasing grain filling periods as well as increasing accumulation of assimilates in the grains which in turn to increasing grains weight. These results are in agreement with those of Jalali *et al.* (2010) who found that the highest values for 100 grain weight were obtained from rate 250kgN/ha.

Table (4) show that biofertilizer treatments significantly affected 100-grain weight (g) in both season. However, the highest 100-grain weight (g) (29.68 g and 26.34 g) were obtained under Azotobacter + Azospirillum treatment in 2011 and 2012 season, respectively. In 2011, growing seasons, inoculation maize seed with Azotobacter + Azospirillum gave 10.41% increase in 100-grain weight (g) over that obtained under control (without biofertilizer treatment). Data recorded in 2012 season followed similar trend. Come to similar results, Naserirad *et al.* (2011) who showed that double-inoculation of Azotobacter and Azospirillum significantly increased 100-grain weight (g) in both seasons compared with other treatments *Azotobacter or Azospirillum* alone.

Table 4. Effect of side-dressing nitrogen rates, bio fertilizers and foliar application of urea on 100-grain weight (g) of maize in 2011 and 2012 seasons.

Treatments		2011 Season					2012 Season				
Nitrogen rates	Bio fertilizers	Urea foliar				Mean	Urea foliar				Mean
		0.0%	1.5%	2.5%	3.5%		0%	1.5%	2.5%	3.5%	
40 kg/fed.	Control	22.25	23.21	24.50	25.60	23.89	20.20	21.40	22.50	22.98	21.77
	Azot + Azospi*	24.60	25.90	26.59	28.30	26.35	21.60	22.79	24.00	24.02	23.10
	Mean	23.43	24.56	25.55	26.95	25.12	20.90	22.10	23.25	23.50	22.44
60 kg/fed.	Control	25.62	27.30	28.54	29.20	27.67	20.80	22.75	24.25	24.76	23.14
	Azot + Azospi	26.11	28.25	29.57	30.21	28.54	22.20	23.89	26.32	27.00	24.85
	Mean	25.87	27.78	29.06	29.71	28.10	21.50	23.32	25.29	25.88	24.00
80 kg/fed.	Control	27.60	28.42	29.30	30.96	29.07	24.00	25.65	28.90	29.28	26.96
	Azot + Azospi	31.20	33.25	34.78	37.35	34.15	27.14	29.32	33.60	34.25	31.08
	Mean	29.40	30.84	32.04	34.16	31.61	25.57	27.49	31.44	31.58	29.02
Bio. Fertilizer Means	Control	25.16	26.31	27.45	28.59	26.88	21.67	23.27	25.22	25.67	23.96
	Azot + Azosp.	27.30	29.13	30.31	31.95	29.68	23.65	25.33	28.19	28.21	26.34
General means		26.23	27.72	28.88	30.27	28.28	22.66	24.30	26.70	26.94	25.15
LSD at 5%											
Nitrogen (N)		**1.00**					**1.20**				
BF (B)		**0.92**					**1.00**				
Urea (U)		**1.34**					**1.34**				
N X B		**1.45**					**1.45**				
N x U		**1.10**					**1.30**				
B x U		**1.02**					**1.00**				
N x B x U		**1.23**					**1.28**				

***Azotobacter + Azospirillium**

Results presented in Table (4) indicate that urea foliar application significantly affected 100-grain weight (g) in both seasons. However, the highest 100-grain weight (g) (30.27g and 26.94g) was obtained under the highest urea foliar rate (3.5%) in 2011 and 2012 seasons, respectively. In 2011, growing season, this urea foliar rate (3.5%) gave 15.40%, 9.19% and 29.81% increase in 100-grain weight (g) over those obtained under control, 1.5%, 2.5%, respectively. Data obtained in 2012 season followed similar trend. These results are in agreement with those of Sarakhsi *et al.* (2010) who showed that spraying maize plants with 3% concentration at tasseling stage increased 100-grain weight (g). Also, biological nitrogen fixation is most important alternative for overcoming high costs of N fertilizer input into cropping systems without substantial loss in yield.

The interaction between nitrogen rates, biofertilizer treatments and urea foliar application significantly affected 100-grain weight (g) in both seasons. Table (4) indicate that, the highest 100-grain weight (g) (37.35g and 34.25g)

were obtained under the interaction between nitrogen rate (80 kg/fed) with Azotobacter + Azospirillum treatment and urea foliar application of 3.5% in 2011 and 2012 seasons, respectively.

4- Grin wield/fadden

Data recorded in Table (5) show clearly that side dressing nitrogen fertilizaer rates significantly affected grain yield (kg/fed) of maize in both seasons. However, the highest grain yield (kg/fed) (4064 and 3961 kg/fed) were obtained under the highest nitrogen rates (80 kg/fed) in 2011 and 2012 seasons, respectively. In 2011, growing season, this nitrogen rate (80 kg/fed) gave 50.85% and 15.48% increase in grain yield (kg/fed) over those obtained under the application of 40 kg and 60 kg N/fed, respectively. Increasing grain yield under higher nitrogen fertilizer rates could be attributed to the favorable effect of higher nitrogen rates on 100 grain weight (Table 4), and number of grains per ear (Table 3). These results are in agreement with those of Jalali *et al.* (2010)

Table (5) show that bio-fertilizer treatments significantly affected grain yield (kg/fed) in both season. However, the highest grain yield (3608 and 3475kg/fed) were obtained under Azotobacter + Azospirillum treatment in 2011 and 2012 seasons, respectively. In 2011 and 2012 growing seasons, inoculation maize seed with Azotobacter + Azospirillum gave 11.25% and 7.79% increase in grain yield (kg/fed) over that obtained under control (without biofertilizer treatment), respectively. These results are in harmony with those obtained by Naserirad *et al.* (2011) and Soleimanzadeh and Ghooshchi (2013) found that inoculation with *Azotobacter chrococum* and *Azospirillum lipaferum* in combination of mycorrhiza increased yield and yield components of maize with 20% compared with the control.

Table 5. Effect of side-dressing nitrogen rates, bio fertilizers and foliar application of urea on grain yield (kg/fed) of maize in 2011 and 2012 seasons.

Treatments		2011 Season					2012 Season				
Nitrogen rates	Bio fertilizer	Urea foliar				Mean	Urea foliar				Mean
		0.0%	1.5%	2.5%	3.5%		0%	1.5%	2.5%	3.5%	
40 kg/fed.	Control	2300	2408	2644	2700	2513	2580	2420	2604	2684	2572
	Azot + Azospi*	2772	2800	2880	3044	2874	2700	2780	2916	3016	2853
	Mean	2536	2604	2762	2872	2694	2640	2600	2760	2850	2713
60 kg/fed.	Control	3148	3312	3456	3504	3355	3084	3152	3252	3352	3210
	Azot + Azospi	3580	3656	3728	3764	3682	3416	3492	3572	3680	3540
	Mean	3364	3484	3592	3634	3519	3250	3322	3412	3516	3375
80 kg/fed.	Control	3788	3816	3888	3948	3860	3776	3832	3940	4012	3890
	Azot + Azospi	4132	4220	4280	4436	4267	4100	4136	3868	4024	4032
	Mean	3960	4018	4084	4192	4064	3938	3984	3904	4018	3961
Bio. Fertilizer Means	Control	3079	3179	3329	3384	3243	3147	3135	3265	3349	3224
	Azot + Azosp.	3495	3559	3629	3748	3608	3405	3469	3452	3573	3475
General means		3287	3369	3479	3566	3425	3276	3302	3359	3461	3350
LSD at 5%											
Nitrogen (N)		**30.46**					**29.20**				
BF (B)		**26.18**					**21.54**				
Urea (U)		**24.65**					**22.73**				
N X B		**40.69**					**34.54**				
N x U		**62.32**					**59.30**				
B x U		**53.46**					**46.89**				
N x B x U		**110.35**					**103.28**				

Results presented in Table (5) indicate that urea foliar application significantly affected grain yield (kg/fed) in both seasons. However, the highest grain yield (kg/fed) (3566 and 3461 kg/fed) were obtained under the highest urea foliar rate (3.5%) in 2011 and 2012 seasons, respectively. In 2011, growing season, this urea foliar rate (3.5%) gave 8.68%, 5.84%, 2.50% increase in grain yield (kg/fed) over those obtained under control, 1.5% and 2.5%, respectively. Data obtained in 2012 season followed similar trend. These results are in harmony with those obtained by Mehrabadi and Mohassel (2000). The interaction between nitrogen rates, biofertilizer treatments and urea foliar application significantly affected grain yield (kg/fed) in both seasons. However, the highest grain yield (4436 and 4024 kg/fed) were obtained under the interaction between nitrogen rate (80 kg/fed) with Azotobacter + Azospirillum treatment and urea foliar application of 3.5% in 2011 and 2012 seasons, respectively. The results showed that urea foliar maize plants with 3.5 % urea concentration and inoculation with Azotobacter + Azospirillum as well as fertilized with 80 kg N/fed. gave the highest values for the yield and yield components. Came to similar results, Gheysari *et al.* (2009) who found that application of nitrogen alone or integrated with bio fertilizers or in combination with urea increased growth, yield and yield components.

Generally, it could be recommended that fertilized maize plants with nitrogen fertilizer at the rate of 80 kg N/fed., treated by Azotobacter + Azospirillum and spraying with urea at a concentration of 3.5% increased yield and yield components of maize in Kalyubia governorate, Egypt.

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تأثير معدلات النيتروجين والسماد الحيوى و الرش باليوريا على المحصول ومكوناتة فى الذرة الشامية

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أقيمت تجربتان حقليتان خلال موسمى الزراعه 2011 و2012 وذلك فى منطقة بهتيم- محافظة القليوبية لدراسة تأثير معدلات السماد النيتروجينى (80,60,40 كجم / الفدان) و اضافة السماد الحيوي (كنترول ، بدون اضافة سماد حيوي – اضافة الأزوتوباكتر + الأزوسبيريللم) والرش الورقى باليوريا بتركيزات (صفر , 1.5 , 2.5, 3.5%) على المحصول و مكوناته لمحصول الذرة الشامية (هجين فردى 30K8) فى ثلاث مكررات حيث وضعت معدلات السماد النيتروجينى فى القطع الرئيسة ومعاملات السماد الحيوي فى القطع الشقية الأولى ومعاملات الرش الورقي باليوريا في القطع الشقية الثانية ويمكن تلخيص أهم نتائج هذة الدراسة كما يلى :1- أظهرت النتائج تأثيرا معنويًا لمعدلات السماد النيتروجينى على جميع الصفات المدروسة وهى طول الكوز ، عدد حبوب الكوز، وزن ال 100 حبة ومحصول الحبوب للفدان . وسجل معدل السماد 80كجم ن/فدان زيادة معنوية لهذة الصفات فى الموسمين بالمقارنة بمعدل 40 و60 كجم ن /ف.2- اوضحت النتائج ايضًا تأثيرا معنويًا لمعاملات السماد الحيوي على كل الصفات المدروسة فى كلا الموسمين. حيث أدى التلقيح بخليط من بكتريا الأزوتوباكتر و الأزوسبيريللم الى زيادة معنوية موجبة لمعظم الصفات المدروسة فى كلا الموسمين.3- اظهرت النتائج ايضًا تأثيرًا معنويًا لمعاملات الرش الورقي بسماد اليوريا على كل الصفات فى كلا الموسمين.حيث أدى الرش بتركيز 3.5 % الى أعلى قيم لمعظم الصفات المدروسة فى كلا الموسمين.4- اظهرت النتائج ايضًا تأثيرًا معنويا موجبًا لكل التفاعلات الممكنة بين عوامل الدراسة على كل الصفات فى كلا الموسمين. ولقد اظهرت النتائج المتحصل عليها انه يمكن الحصول على اعلى محصول من الذرة الشامية صنف هجين فردى 30K8 باستخدام 80 كجم ن/فدان ومعاملة التقاوى ببكتريا الآزوتوباكتر و الآزوسيريلم مع رش النباتات باليوريا بتركيز 3.5%.