Effect of Different Methods for Potassium Fertilizer Application on Maize at Different Planting Population Densities in The Newly Reclaimed Lands

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ABSTRACT

The present investigation was designed to study the response of TWC 310 maize cultivar to three different planting population densities and seventeen different methods for potassium fertilizer application in the newly reclaimed land conditions. Two field experiments were carried out in summer seasons of 2004 and 2005 at EL-Boustan Experimental Farm, Faculty of Agriculture, Damanhour, EL-Behera Governorate.

A split plot design with three replicates, was used. The three planting population densities (36000, 42000 and 48000 plants/ ha) were assigned to the main plots, whereas the seventeen different methods for potassium fertilizer application (control, soil application was added before sowing and foliar application was added in combination between four doses and four plant ages: two, three, four and five weeks form sowing) were randomly distributed in the sub-plots.

Five orthogonal comparison were done i.e., C_1, control vs K application, C_2, soil K application vs foliar K application, C_3, foliar K application (in one dose vs multi doses), C_4, foliar K application (in two doses vs more than two doses) and C_5, foliar K application (in three doses vs four doses).

The results revealed that increasing planting density from 36000 to 48000 plants/ ha. insignificantly affected number of rows/ ear, one hundred kernel weight and shelling % in both seasons. Meanwhile, increasing planting density from 36000 to 42000 plants/ ha. significantly increased plant height in the second season, and ear length and grain yield/ ha. in both seasons, while plant height, in the first season and number of ears/ plant in both seasons were significantly decreased The other studied traits i.e., the upper ear leaf area, stem diameter and ear diameter were significantly affected in both seasons.

Application of K fertilization, either soil or foliar application, significantly increased all studied traits, in both seasons, except both plant height and number of ears/ plant in the first season and shelling % in both seasons. Foliar K application method was superior for upper leaf area, ear length, ear diameter and grain yield/ ha. in both seasons, meanwhile, the differences were insignificant for plant height and stem diameter in the first season, number of rows/ ear in the second season, and shelling % and one hundred-kernel weight in both seasons

INTRODUCTION

Growing maize in marginal lands requires specific cultural practices differing from those applied to the old planted fertile ones. Many factors affect grain yield of maize crop under newly reclaimed soil conditions such

]as plant population density and methods of potassium application. The reports on the response of maize to plant density were inconsistent (**Matta *et al.*, 1990; Ragheb *et al.*, 1993; Ali *et al.*, 1994; Shafshak *et al.*, 1994; Soliman *et al.*, 1995; Faisal *et al.*, 1996 (a&b); Abo-Shetaia *et al.*, 2000(a&b); EL-Wakil, 2002 and Mehasen and Al-Fageh, 2004**). **Salem *et al.* (1983), EL-Agamy *et al.* (1986) and Ahmadi *et al.* (1993)**, reported that increasing plant density significantly increased grain yield per unit area but decreased ear characters and yield components. except number of rows/ ear which was insignificantly affected.

Several investigators (**Beringer, 1980; Montanee, 1989; Oosterhuis *et al.*, 1990 and Abou EL-Defan *et al.*, 1999**) showed that potassium foliar application has attracted considerable attention in recent years because it ensures quick and adequate potassium supply for maize plants at yield formation especially under newly reclaimed land conditions.

K requirement of crops varies depending on the stage of growth, the highest uptake rate often being in the vegetative stage, where in the cereals, K is particularly needed during vegetative growth, and K application during the reproductive stage hardly affects grain yield (**Mengel and Kirkby, 1987**).

Suwanarit and Sestapukdee (1989) reported that grain yield of maize was increased by foliar K fertilization. The increases could be as large as 74% of grain yield from plants without K fertilization where applying K to soil increased grain yield by 23 %. **Ahmed and Mekki (2004)** concluded that application of K fertilization, either soil or foliar application, significantly increased the plant height, leaf area, grain yield and yield components of maize

The present study aimed to investigate the effect of three different plant populations and seventeen methods of potassium fertilizer application on three way cross 310 (TWC 310) maize cultivar under newly reclaimed land conditions.

MATERIALS AND METHODS

Two field experiments were carried out, at EL-Boustan Experimental Farm, Faculty of Agricultural, Damanhour branch, EL-Behera Governorate, Alexandria University, Egypt. during 2004 and 2005 summer seasons.

A split-plot design with three replications was used. The three planting population densities, i.e., 36000, 42000 and 48000 plants/ ha were randomly arranged in the main plots, whereas the seventeen different methods for potassium fertilizer application, given in **Table (1)**, were randomly assigned to the sub-plots.

The experimental unit area was 7.2 m^2 including 4 ridges, 60 cm apart and 3 m along. The distances between hills were 46, 40 and 35 cm for the three populations 36000, 42000 and 48000 plants/ ha., respectively. Two to three maize grains were placed in hills on 24^{th} and 14^{th} may in 2004 and 2005 seasons, respectively, and thinned after 13 days to one plant/ hill to obtain these three planting population densities.

Before sowing, a representative surface soil sample (0-30 cm depth) was taken and the mechanical and chemical analysis of the soil are given in **Table (2)**.

Table (1): Methods of potassium fertilizer application:

Method of K application	No. of doses	Frequency and ages of maize plants at application			
		Two weeks	Three weeks	Four weeks	Five weeks
Foliar potassium application at rate of 4.8 liter/ ha	One	*	-	-	-
		-	*	-	-
		-	-	*	-
		-	-	-	*
	Two	*	*	-	-
		*	-	*	-
		*	-	-	*
		-	*	*	-
		-	*	-	*
		-	-	*	*
	Three	*	*	*	-
		*	*	-	*
		*	-	*	*
		-	*	*	*
	Four	*	*	*	*
Soil potassium fertilizer application	Potassium fertilizer at rate of (115.2 kg K_2O/ ha) was broadcast before sowing				
Control	Without potassium application				

Table (2): Physical and Chemical properties of the soil at experimental sites:

Property	Season	
	2004	2005
Texture (%)		
Sand	86	82
Silt	11	16
Clay	3	2
pH (1:2.5)	8.1	7.9
Available N (ppm)	9.3	11.2
Available P (ppm)	2.8	2.99
Available K (ppm)	81.6	89.0
Total nitrogen (%)	0.01	0.02
Organic matter (%)	0.44	0.48

In both seasons, calcium supper phosphate (15.5% P_2O_5) was broadcast pre-sowing at the rate of 74.4 kg P_2O_5/ ha. Ammonium sulphate fertilizer (20.5% N) at the rate of 288 kg N/ ha. was applied in three equal doses; before the first, second and third irrigations. The first irrigation was applied after 15 days from sowing, in both seasons, and all other recommended agriculture practices, according to the location, were performed throughout the two growing seasons. At full tasseling, the upper ear leaf area was calculated as the mean ear leaf area of five plants. The area of the upper leaf was obtained according to the method of Montogomery **(C.F. Shalaby and Omar, 1981)** using the following formula:

Leaf area of blade = Length × maximum width × 0.75

At harvest, samples of ten guarded plants were randomly taken from each sub-plot to calculate the following traits:

(1) Plant height (cm).
(2) Stem diameter (cm).
(3) Ear length (cm).
(4) Ear diameter (cm).
(5) Number of ears/ plant.
(6) Number of rows/ ear.
(7) Shelling percentage (%).
(8) 100-kernels weight (g).

Maize plants in the two inner ridges of each sub-plot were harvested and threshed. Grain yield was recorded in kg, then adjusted, to 15.5% moistures and converted to tons/ ha. The obtained data in this study were subjected to the appropriate statistical analysis according to **Steel and Torrie (1980)**.

Five orthogonal comparisons were done i.e., C_1: control vs K application; C_2: soil k application vs foliar K application; C_3: foliar K application (one dose vs multi doses); C_4: foliar K application (two doses vs more than two doses) and C_5: foliar K application (three doses vs four doses).

RESULTS AND DISCUSSION:

A- Effect of planting population density:

Data in **Table (3)**, showed high mean values for all studied traits in the second season compared to the first one. It is might be due to early sowing date **(Table 2)**.

Data presented in **Table (3)** indicated that some studied traits were insignificantly affected by increasing planting population density from 36000 to either 42000 or 48000 plants/ ha., i.e., number of rows/ ear, shelling %, and 100-grain weight in both seasons. Meanwhile, increasing planting population density from 36000 to 42000 plants/ ha. significantly increased some traits, i.e., plant height in the second season and ear length and grain yield/ ha. in both seasons. In the same time, number of ears/ plant in both seasons was significantly decreased. The other studied traits i.e. plant height in the first season and the upper ear leaf area, stem diameter and ear diameter in both seasons were insignificantly affected.

On the other hand, increasing planting population density from 42000 to 48000 plants/ ha significantly increased plant height in the first season, however, the upper ear leaf area, stem diameter, ear length, ear diameter, number of ears/ plant and grain yield/ ha, in both seasons, were significantly decreased **(Table 3)**.

The increases in grain yield/ ha. were about 25 and 17% averaged over both seasons, for planting population density 42000 plants/ ha. compared with 36000 and 48000 plants/ ha., respectively. It seems evident that the optimum planting population density under studied conditions is 42000 plants/ ha. This result may be due to the lower interaspecific competition for the edaphic and above ground environmental resources. especially light. This in turn resulted in an increase in studied traits i.e., upper leaf area and hence in photosynthesis and dry matter production: stem diameter, ear length, ear diameter, number of rows/ ear, one hundred kernel weight and shelling %. All these criteria resulted finally in producing more grain yield/ ha compared with another two planting population densities i.e., 36000 and 48000 plants/ ha. Our results are in general agreement with those obtained by several investigators **(Younis *et al.*,**

1990; Soliman *et al.*, 1995; Abdel-Gawad and EL-Batal, 1996; EL-Hariri *et al.*, 1996; Faisal *et al.*, 1996 (a&b); Shams EL-Din and Habbak, 1996; Abdel-Gawad *et al.*, 1998; Tantawy *et al.*, 1998; EL-Bana and Gomma, 2000; Norwood, 2001; Sarhan, 2002 and Mehasen and AL-Fageh, 2004).

B- Effect of methods of potassium application:

Concerning the first comparison C_1: control vs K application, the results indicated that potassium fertilizer application significantly affected all studied traits, in both seasons, except plant height and number of ears/ plant in the first season and shelling % in both seasons **(Tables 4 and 5)**. Such results may be attributed to the favorable effects of K application on plant growth and productivity of maize. This means that K soil content was not enough to meet the requirements of maize under such conditions. Such beneficial effect of K fertilizer could be attributed to its essential role in growth and establishment of maize plants in addition to its activity in the physiological functions such as carbohydrates metabolism and formation, breakdown of starch and translocation of sugars. In addition, potassium my control and regulate the activities of various essential elements and activate many enzymes, which lead to increase grain yield **(Zhunusov and Baimaganova, 1976)**. These results are in general agreement with those reported by **Montanee (1989), Suwanarit and Sestapukdee (1989), Bordoli and Mallarinc (1998), Abu EL-Defan *et al.* (1999), Borges and Mallarino (2001) and Ahmed and Mekki (2004)**.

Regarding the second comparison C_2: soil K application vs foliar K application, data in **Tables (4 &5)** revealed that there were significant differences between the two methods of K application for most studied traits. It is obvious from the results that the foliar K application method significantly surpassed soil K application method in the upper ear leaf area, ear length, ear diameter and grain yield/ ha. in both studied seasons. The increases in the above mentioned traits were 17.9, 14.2, 15.9 and 11.3% as an average of both seasons, respectively. In spite of the insignificant differences, for the other studied traits i.e., plant height and stem diameter in the first season, number of rows/ ear in the second season and shelling % and one hundred kernel weight in both seasons, the foliar K application method recorded the higher means.

It is obvious from the results that applying potassium fertilizer as a foliar to maize plants under sandy soil conditions is better than soil application method. This may by related to the proportion of potassium element in soil solution that become inavailable to roots of maize plants.

Concerning the third comparison C_3: foliar K application in one dose vs multi doses, potassium fertilizer in multi doses foliar application had significant or highly significant effect on most studied traits i.e., upper ear leaf area, plant height, ear length, ear diameter, number of rows/ ear, one hundred kernel weight and grain yield/ ha. in both seasons, and stem diameter in the second season. Moreover, adding potassium in multi doses spray tended to give slight improvement in the other studied traits i.e., number of ears/ plant as well as shelling percentage in both seasons and stem diameter in the first season **(Tables 4 and 5)**. The favorable effect of K on growth, grain yield and yield components could be attributed to the longer period of adding K fertilization in multi doses as compared to one dose.

With respect to the fourth comparison C_4: foliar K application in two doses vs more than two doses, data in **Tables (4 and 5)** revealed significant or highly significant differences in favor of foliar K application in more than two doses. That treatment produced higher upper ear leaf area, longer plants, thicker stems, longer and thicker ears as well as higher number of rows/ ears, one hundred kernel weight and grain yield/ ha. compared to adding K fertili~~r by foliar in two doses. However, the differences among the two treatments did not reach the level of significance for plant height and stem diameter in the first season, number of ears/ plant as well as shelling % in both seasons and number of rows/ ear in the second season. Such favorable effects on growth and yield attributes could be attributed to the longer period of adding K fertilization that extended to the age of about five weeks.

Regarding the fifth comparison C_5: foliar K application in three doses vs foliar K application in four doses, data in Tables **(4 and 5)** indicated that foliar K application in four doses was superior as compared with foliar K application with three doses. Significant differences were obtained between the two t eatments in upper leaf area as well as stem diameter in the second season, ear length as well as number of rows/ ear in the first season and ear diameter and grain yield/ ha. in both seasons. However, the differences did not reach the level of significance regarding upper leaf area as well as stem diameter in the first season, number of rows/ ear in the second season and plant height, number of ears/ plant, shelling % and 100-kernel weight in both seasons.

C- Effect of interactions:

The results in **Table (4)** revealed insignificant effect of interaction between maize plant density and methods of potassium application for some studied traits i.e., plant height, ear length, number of ears/ plant, number of rows/ ear, shelling %, 100-grain weight and grain yield in both seasons and upper ear leaf area in the second season. These results indicated that the aforementioned traits showed similar response to the applied seventeen K application treatments at the three maize planting densities.

On the other hand, the significant interactions recorded for the other studied traits (upper ear leaf area in the first season and stem diameter and ear diameter in both seasons) indicated that the two studied factors i.e., plant density and methods of potassium application were not independent in their effect on these traits.

With regard to upper ear leaf area and stem diameter, the low planting population (36000 plants/ ha) gave the highest mains when plants were fertilized by potassium using foliar method in multi doses **(Tables 6, 7, 8 and 9)**. These results were expected, where in low plant population, competition among plants is decreased and wider spacing gave plants a good chance to grow and produce higher total leaf area.

Ear diameters were the highest when maize plants were grown under plant density of 42000 plants/ ha and foliar fertilized with potassium in multi doses more the two times and maximized when number of doses was four doses **(Tables 8, 9 and 10)**.

Table (3): Vegetative traits, grain yield and yield components for the three way cross 310 maize hybrid as affected by three different planting densities over different seventeen methods of potassium fertilizer application in 2004 and 2005 summer seasons:

Planting densities	Upper ear leaf area (cm²)		Plant height (cm)		Stem diameter (cm)		Ear length (cm)		Ear diameter (cm)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
36000	460.00 a[1]	540.00 a	227.70 b	238.8 b	2.31 a	2.82 a	20.38 b	22.22 b	5.25 a	5.62 a
42000	420.00 a	500.00 a	240.10 b	264.2 a	2.21 a	2.63 a	23.46 a	25.44 a	5.45 a	5.99 a
48000	200.00 b	350.00 b	268.50 a	280.3 a	1.82 b	2.10 b	18.35 b	19.11 c	4.18 b	4.32 b
Mean	360.00	463.33	245.43	261.1	2.11	2.52	20.73	22.26	4.96	5.41

(1) Means followed by the same letter, are not significantly different, according to L.S.D.$_{0.05}$

Table (3): Cont.

Planting densities	No. of ears/ plant		No. of rows/ ear		Shelling (%)		100- grain weight (g)		Grain yield (t/ ha)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
36000	1.22 a[1]	1.31 a	11.63 a	12.11 a	79.26 a	80.41 a	31.59 a	33.10 a	5.25 b	5.54 b
42000	1.18 b	1.25 b	11.82 a	12.81 a	84.56 a	85.11 a	32.91 a	35.50 a	6.57 a	6.91 a
48000	1.15 c	1.18 c	11.35 a	11.75 a	79.16 a	79.79 a	30.90 a	32.01 a	5.59 b	5.89 b
Mean	1.19	1.25	11.6	12.22	80.99	81.77	31.80	323.54	5.80	6.02

(1) Means followed by the same letter, are not significantly different, according to L.S.D.$_{0.05}$

Table (4): Significance of mean squares for vegetative traits, grain yield and yield components of maize as affected by different plant densities and different methods of potassium fertilizer application in 2004 and 2005 summer seasons:

S.O.V.	d.f.	Traits and seasons									
		Upper ear leaf area (cm^2)		Plant height (cm)		Stem diameter (cm)		Ear length (cm)		Ear diameter (cm)	
		2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Replications	2	**	*	*	**	*	*	*	**	*	*
Plant densities (A)	2	**	**	*	*	**	*	**	**	**	**
Error (a)	4	5715 36	8578 40	2151 68	2047 44	0 16	0 50	17 05	25 00	1 10	1 30
Methods of K fertilizer application (B)	16	**	**	ns	**	**	**	**	**	**	**
C_1	1	**	**	ns	**	*	**	**	**	**	**
C_2	1	**	**	ns	*	ns	**	**	**	**	**
C_3	1	**	**	*	**	ns	**	**	**	**	**
C_4	1	**	**	ns	**	ns	**	**	**	**	**
C_5	1	ns	*	ns	ns	ns	**	*	ns	**	**
Remainder	11	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
AB	32	**	ns	ns	ns	*	*	ns	ns	**	**
AC_1	2	*	ns	ns	ns	ns	**	ns	ns	ns	ns
AC_2	2	ns	*	ns	ns	ns	**	ns	ns	ns	ns
AC_3	2	**	ns	ns	ns	ns	**	ns	ns	**	**
AC_4	2	*	ns	ns	ns	ns	**	*	ns	*	**
AC_5	2	ns	ns	ns	ns	ns	ns	*	ns	**	ns
Remainder	22	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Error (b)	96	2251.31	3572 40	841 57	930 20	0.14	0.10	2.84	2 54	0 10	0.07

ns. not significant at 5% level of probability.
*, **. significant at 5 % and 1 % levels, respectively.

Table (4): Cont.:

S.O.V.	d.f.	No. of ears/ plant 2004	No. of ears/ plant 2005	No. of rows/ ear 2004	No. of rows/ ear 2005	Shelling % 2004	Shelling % 2005	100-grian weight (g) 2004	100-grian weight (g) 2005	Grain yield (t/ ha) 2004	Grain yield (t/ ha) 2005
Replications	2	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Plant densities (A)	2	ns	ns	ns	ns	ns	ns	ns	ns	**	*
Error (a)	4	0.18	0.21	3.16	4.22	147.38	151.31	19.59	47.65	0.98	1.31
Methods of K fertilizer application (B)	16	**	**	**	**	ns	ns	ns	**	**	**
C_1	1	ns	*	**	*	ns	ns	*	**	**	**
C_2	1	ns	*	**	ns	ns	ns	ns	ns	*	**
C_3	1	ns	ns	**	*	ns	ns	*	**	**	**
C_4	1	ns	ns	**	ns	ns	ns	**	**	**	**
C_5	1	ns	ns	**	ns	ns	ns	ns	ns	*	*
Remainder	11	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
AB	32	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
AC_1	2	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
AC_2	2	*	*	ns	ns	ns	ns	ns	ns	ns	ns
AC_3	2	*	ns	ns	ns	ns	ns	ns	ns	ns	ns
AC_4	2	ns	ns	ns	ns	ns	ns	ns	*	ns	ns
AC_5	2	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Remainder	22	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Error (b)	96	0.01	0.05	0.52	0.66	44.11	35.92	5.10	4.99	0.36	0.51

ns: not significant at 5% level of probability

*, **: significant at 5 % and 1 % levels, respectively

Table (5): Means of vegetative traits, maize grain yield and its components as affected by different plant densities and different methods of potassium fertilizer application in 2004 and 2005 seasons:

Traits	Seasons	Control vs K application (C_1)		Soil K application vs. foliar K application (C_2)		Foliar K application in (one dose vs. multi doses; C_3)		Foliar K application in (two doses vs. more than two doses; C_4)		Foliar K application in (three doses vs. four doses; C_5)		Mean
		Control	K application	Soil K application	Foliar K application	One dose	Multi doses	Two doses	More than two doses	Three doses	Four doses	
Upper ear leaf area (cm^2)	2004	247.51b(1)	367.03a	288.93b	372.24a	310.30b	394.76a	376.0b	417.27a	410.76a	443.33a	360.0
	2005	276.87b	474.99a	413.03b	442.08a	314.11b	488.62a	465.03b	516.91a	505.43b	562.84a	403.33
Plant height (cm)	2004	234.10a	246.16a	235.17a	246.87a	238.43b	249.94a	245.13a	255.71a	254.89a	259.0a	245.43
	2005	221.1b	263.6a	238.23b	265.29a	246.6b	272.09a	261.00b	285.39a	282.23a	298.07a	261.1
Stem diameter (cm)	2004	2.03b	2.12a	2.07a	2.12a	2.09a	2.13a	2.11a	2.15a	2.15a	2.19a	2.11
	2005	1.97b	2.55a	2.15b	2.58a	2.43b	2.63a	2.57b	2.70a	2.68b	2.80a	2.52
Ear length (cm)	2004	16.98b	20.96a	18.56b	21.12a	19.53b	21.70a	21.0b	22.55a	22.18b	24.01a	20.73
	2005	17.84b	22.53a	19.82b	22.71a	20.90b	23.37a	22.42b	24.51a	24.30a	25.37a	22.26
Ear diameter (cm)	2004	3.96b	5.02a	4.41b	5.06a	4.61b	5.23a	5.04b	5.46a	5.33b	5.98a	4.96
	2005	4.07b	5.49a	4.73b	5.54a	5.10b	5.69a	5.37b	6.09a	5.98b	6.50a	5.41
No. of ears/ plant	2004	1.14a	1.19a	1.16a	1.19a	1.17a	1.20a	1.18a	1.22a	1.21a	1.24a	1.19
	2005	1.15b	1.25a	1.20b	1.26a	1.24a	1.26a	1.25a	1.27a	1.26a	1.30a	1.25
No. of rows/ ear	2004	10.03b	11.72a	10.40b	11.81a	10.73b	12.17a	11.38b	13.11a	12.92b	13.91a	11.80
	2005	10.93b	12.30a	11.86a	12.33a	12.10b	12.24a	12.30a	12.56a	12.48a	12.86a	12.22

(1) Means followed by the same letter, between columns within each comparison were insignificantly different at 0.05 level at probability.

Table (5): cont:

Traits	Seasons	Control vs K application (C1)		Soil K application vs foliar K application (C2)		Foliar K application in (one dose vs. multi doses; C3)		Foliar K application in (two doses vs. more than two doses; C4)		Foliar K application in (three doses vs. four doses; C5)		Mean
		Control	K application	Soil K application	Foliar K application	One dose	Multi doses	Two doses	More than two doses	Three doses	Four doses	
	2005	10.93b	12.30a	11.86a	12.33a	12.10b	12.24a	12.30a	12.56a	12.48a	12 86a	12 22
Shelling %	2004	77.30a	81 23a	79 10a	81 34a	79.94a	81 89a	80.93a	83 03a	82.89a	83.60a	80 99
	2005	76.93a	81 95a	80 83a	82 02a	81 50a	82 21a	81 84a	82 66a	82 56a	83 07a	81 77
100-grain weight (g)	2004	29.95b	31 92a	30 93a	31 98a	31 26b	32 25a	31 63b	32 98a	32.85a	33 50a	31 80
	2005	31.26b	33 68a	32.32a	33 77a	32 82b	34 12a	33.33b	35 06a	34.91a	35 63a	33 54
Grain yield (t/ ha)	2004	5 62b	5.85a	5 36b	5 88a	5 51b	6 02a	5 78b	6 31a	6.22b	6 66a	5 80
	2005	5.08b	6 08a	5 40b	6 10a	5 57b	6 33a	5 84b	6 92a	6.82b	7 26a	6 02

(1) Means followed by the same letter, between columns within each comparison were insignificantly different at 0 05 level at probability.

Table (6): Means of upper ear leaf area (cm^2) in 2004 season and stem diameter (cm) in 2005 season as affected by planting density (A) × (C_1 comparison) interaction:

Trait	C_1 comparison	Plant densities (plants/ ha)			$L.S.D._{0.05}$ for interaction
		36000	42000	48000	
Upper ear leaf area (cm^2) in 2004 season	Control vs	311.00	280.61	150.93	77.09
	K application	469.31	428.71	203.07	
Stem diameter (cm) in 2005 season	Control vs	2.21	2.00	1.71	0.51
	K application	2.86	2.67	2.12	

Table (7): Means of upper ear leaf area (cm^2) and stem diameter (cm) in 2005 season as affected by planting density (A) × C_2 comparison (soil K application vs. foliar K application) interaction:

Trait	C_2 comparison	Plant densities (plants/ ha)			$L.S.D._{0.05}$ for interaction
		36000	42000	48000	
Upper ear leaf area (cm^2) in 2005 season	Soil K application vs	419.10	490.00	330.00	97.11
	Foliar K application	561.37	513.99	361.99	
Stem diameter (cm) in 2005 season	Soil K application vs	2.26	2.20	2.00	0.51
	Foliar K application	2.90	2.70	2.13	

Table (8): Means of upper ear leaf area (cm^2) in 2004 season, stem diameter (cm) in 2005 season and ear diameter (cm) in 2004 and 2005 seasons as affected by planting density (A) × C_3 comparison (foliar K application in one dose vs foliar K application in multi doses) interaction:

Trait	C_3 comparison	Plant densities (plants/ ha)			L.S.D.$_{0.05}$ for interaction
		36000	42000	48000	
Upper ear leaf area (cm^2) in 2004 season	One dose vs	391.2	350.4	189.3	77 09
	Multi doses	506.28	467.0	211.0	
Stem diameter (cm) in 2005 season	One dose vs	2.70	2.50	2.10	0.51
	Multi doses	2.97	2.77	2.14	
Ear diameter (cm) in 2004 season	One dose vs	4.93	4.91	3.99	0.51
	Multi doses	5.48	5.83	4.37	
Ear diameter (cm) in 2005 season	One dose vs	5.20	5.70	4.50	0.43
	Multi doses	5.99	6.28	4.82	

Table (9): Means of upper ear leaf area (cm^2) in 2004 season, stem diameter (cm) in 2005 season, ear length (cm) in 2004 season, ear diameter (cm) in 2004 and 2005 seasons and 100-kernel weight (g) in 2005 season as affected by planting density (A) × C_4 comparison (foliar K application in two doses vs foliar K application in more than two doses) interaction:

Trait	C_4 comparison	Plant densities (plants/ ha)			$L.S.D._{0.05}$ for interaction
		36000	42000	48000	
Upper ear leaf area (cm^2) in 2004 season	Two doses vs More than two doses	480.00 537.82	440.00 499.40	208.00 214.59	77.09
Stem diameter (cm) in 2005 season	Two doses vs More than two doses	2.91 3.04	2.66 2.91	2.13 2.16	0.51
Ear length (cm) in 2004 season	Two doses vs More than two doses	20.90 21.62	23.60 25.91	18.50 20.11	2.74
Ear diameter (cm) in 2004 season	Two doses vs More than two doses	5.20 5.83	5.65 6.05	4.26 4.49	0.51
Ear diameter (cm) in 2005 season	Two doses vs More than two doses	5.50 6.57	5.90 6.73	4.70 4.97	0.43
100-kernel weight (g) in 2005 season	Two doses vs More than two doses	33.00 34.70	34.90 38.07	32.10 32.39	3.63

Table (10): Means of ear length (cm) and ear diameter (cm) in 2004 season as affected by planting density (A) × C_5 comparison (foliar K application in three doses vs foliar K application in four doses) interaction:

Trait	C_5 comparison	Plant densities (plants/ ha)			$L.S.D._{0.05}$ for interaction
		36000	42000	48000	
Ear length (cm) in 2004 season	Three doses vs Four doses	21.50 22.10	25.63 27.00	19.41 22.93	2.74
Ear diameter (cm) in 2005 season	Three doses vs Four doses	5.60 6.73	5.99 6.30	4.39 4.90	0.51

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الملخص العربى

تأثير طرق مختلفة من إضافة السماد البوتاسى على الذرة الشامية عند كثافات نباتية مختلفة فى الأراضى المستصلحة الجديدة

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صممت الدراسة الحالية لدراسة استجابة صنف الذرة الشامية هجين ثلاثى ٣١٠ لثلاثة كثافات نباتية وسبعة عشر طريقة مختلفة من طرق إضافة السماد البوتاسى فى الأراضى المستصلحة الجديدة وقد نفذت تجربتان حقليتان فى صيف ٢٠٠٤ و ٢٠٠٥ فى مزرعة البستان بكلية الزراعة بدمنهور محافظة البحيرة.

استخدم تصميم القطع المنشقة بثلاث مكررات وقد شغلت القطع الرئيسية بالكثافات النباتية (٣٦، ٤٢، ٤٨ ألف نبات/ هكتار) بينما شغلت القطع الفرعية بطرق إضافة السماد البوتاسى السبعة عشر (كونترول، إضافة أرضية قبل الزراعة، إضافة بالرش كتوافيق بين عدد مرات الإضافة (واحدة، إثنين، ثلاث، أربعة) وأعمار مختلفة من النبات (أثنين، ثلاثة، أربعة، خمسة أسابيع من الزراعة)).

أجريت خمسة مقارنات مستقلة وهى:

١- بدون إضافة سماد مقارنة بالتسميد البوتاسى. ٢- الإضافة الأرضية مقارنة بالإضافة بالرش.

٣- الرش مرة واحدة مقارنة بالرش ٤ مرات ٤- الرش مرتين مقارنة بالرش ثلاث مرات.

٥- الرش ثلاث مرات مقارنة بالرش ٤ مرات.

وقد أوضحت النتائج أن زيادة الكثافة النباتية من ٣٦ ألف إلى ٤٨ ألف نبات/ هكتار لم تؤثر معنوياً على عدد الصفوف فى الكوز ووزن المائة حبة ونسبة التفريط فى كلا الموسمين، بينما أدت زيادة الكثافة النباتية من ٣٦ إلى ٤٢ ألف نبات/ هكتار إلى زيادة معنوية فى طول النبات فى الموسم الثانى وفى طول الكوز ومحصول الحبوب/ هكتار فى كلا الموسمين، بينما نقص معنوياً كل من طول النبات فى الموسم الأول وعدد الكيزان/ نبات فى كلا الموسمين كذلك فقد تأثرت كل من مساحة الورقة للكوز العلوى، قطر الساق، قطر الكوز فى كلا الموسمين.

إضافة البوتاسيوم إلى التربة أو بالرش أدى إلى زيادة كل الصفات المدروسة فـــى الموســـمين ماعدا طول النبات وعدد الكيزان/ نبات فى الموسم الأول والنسبة المئوية للتفريط فـــى الموســـمين، وقـــد تفوقت طريقة الرش على الإضافة الأرضية فى مساحة الورقة للكوز العلوى، طول الكوز، قطر الكـــور، محصول الحبوب/ هكتار في الموسمين بينما لم تكن الاختلافات معنوية لصفة طول النبات وقطر الـــساق في الموسم الأول وعدد الصفوف/ الكوز فى الموسم الثانى ونسبة التفريط ووزن المائة حبة فى الموسمين.