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Impact of urea and potassium foliar application on yield and yield components of two Maize hybrids

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Abstract : Two field experiments were carried out during the two successive summer seasons of 2013 and 2014 at Kom Oshim, Fayoum Governorate, Egypt to study the impact of urea and potassium foliar spray fertilizer on two maize hybrids.

The results showed that there were significant differences between the studied maize hybrids (S.C. National 6 and T.W.329) regarding to growth characters at 70 and 90 days from sowing i.e. (plant height (cm), total dry weight/ plant (g), LA (dm2) and LAI). However, L.A.R. at 90 days from sowing Maize was not significant. S.C national 6 cultivar surpassed the other cultivar T.W. 329 in all growth characters. In addition, there were significant differences between maize hybrids in yield and its components except harvest index % and carbohydrate percentage (i.e. plant height (cm) , ear length (cm). ear diameter (cm), number of rows/ ear, grain index (g), grain yield (g) / plant, straw yield (g) /plant, grain yield (ton)/ fed., straw yield (ton) / fed., biological yield (ton) / fed., and protein percentage). Maize cultivar S.C National 6 surpassed T.W.329 in yield and yield components in both seasons. Foliar spraying with 2% urea and 2% potassium produced the best value of all the previous growth characters, yield and yield components except carbohydrate percentage. The best treatment for growth, yield and yield components was foliar spraying of maize cultivar (S.C. National 6) with urea 2%+ potassium 2%.

Keywords: urea, potassium foliar, Maize hybrids, yield.

Introduction

Maize plant is considered as one of the most important cereal crops used in human consumption, animal feeding, starch industry and oil production. Many attempts were carried out to increasing maize production to face urgent demands of increasing population in Egypt .We can increasing maize production through produce highly productive and qualitative gene forms[1]. Also maize can be grown to reduce the gap between consumption and the local production of oil in Egypt and to decrease the imported oil by Egyptian government. Hence its cultivation was recently expanded in the newly reclaimed sandy soils which characterized with low fertility, high PH value and low organic matter content. Beside high demand of N- fertilizer requirement which led to high leaching of nitrogen fertilizer through its high filtration rates. Application of N-fertilizer as urea and potassium foliar spray may decrease such losses[2]. N-losses from the recommended N- dose for corn as a summer crop was 50% through leaching and denitrification[3]. Potassium also is a very important element for growing maize. Urea and potassium foliar application as a supplement or a partial substitution to soil fertilizer application was studied, efficient and positive response of some field crops due to urea foliar spray were reported by[4,5]. In addition, the important of foliar feeding with N, P and K as mineral form compounds or humic

acid containing N, P and K as a supplemental or a partial substitution to soil application were reported[6] on cotton,[7]on maize,[8] on wheat,[9] on faba bean and[3] on maize cultivars.

Numerous studies confirmed positive response for the foliar application with the complete foliar, fertilizer[10,11,12,13]. The primary objective of foliar application such as nitrogen fertilizer is to allow for maximum absorption of nutrient such as N into the plant tissue. Foliar feeding with nutrients can be preferred because very small amounts of fertilizers are applied per unit area and is also less likely to result in ground water pollution[14,15]. Potassium (K) is a essential macro- element required in large amounts for normal plant growth and development[10]. Potassium increase the photosynthetic rates of crop leaves, Co_2 assimilation and facilitates carbon movement[16].

Thus the objective of this study was to investigate response of two hybrids maize cultivars to foliar spray with urea and potassium fertilizers.

Materials and Methods

Two field experiments were carried out at Kom Oshim, Fayoum Governorate, Egypt during the two successive seasons of 2013 and 2014 to study the effect of foliar spray of urea and potassium fertilizer on two maize hybrids. Soil sample was taken at depth of 30 cm for mechanical and chemical analysis as describe by [17],Table (1).The experimental design was a split plot design with six replications ,where the two maize hybrids (i.e. S.C. S.C.National 6 and T.W.329) occupied the main plot. Foliar spraying with urea and potassium were allocated in sub-plot (i.e. control [without spraying],urea1%,urea 2%,potassium 1%,potassium 2%,urea 1%+ potassium 1%,urea 1%+ potassium 2%, urea 2%+potassium 1%, urea 2%+ potassium 2%).Foliar fertilizers treatments were sprayed on plant foliage twice during maize plant growth period at 25 and 45 days after sowing. The experimental unit consisted of nine ridges 3 meter in length and 80cm between the ridges, the size of each plot was 21m^2 =1 /200feddan. Grains of maize hybrids were sown on 20 and 25 May in both seasons, respectively, in hills spaced 25 cm along,two kernels per hill. After 21 days, before spraying fertilizers plants were thinned to one plant /hill. Phosphorus fertilizer were added to soil before sowing at rate of 200 kg/feddan of calcium superphosphate (15.5 % P_2O_5). Nitrogen fertilizer as ammonium nitrate (33.5 % N) was applied at rate of 120 kg N/ feddan and potassium at rate of 50 kg / feddan potassium sulfate (48 % K_2O).

The following growth characters were recorded on two samples of five guarded plants were taken randomly at 70 and 90 days from sowing i.e., plant height, total dry weight / plant (g), leaf area / plant dm^2 (LA) was computed as described by[18], leaf area index (LAI) was determined according to[19] and leaf area ratio dm^2/g (LAR) (Blade leaf area in dm^2/ the whole plant dry weight in grams).

Table (1): Physical and Chemical analysis of the experimental site at Kom Oshim , Fayoum.

Physical analysis									
Coarse sand %	**Fine sand %**		**Silt %**	**Clay%**		**Organic matter %**		**Ca Co3 %**	**Texture class**
10.0	**32.0**		**20.0**	**27.5**		**0.84**		**0.03**	**Sand clay loam**
Chemical analysis									
Soluble anions –meq /L (1:5 soil water extract)			**Soluble cations –meq /L (1:5 soil water extract)**			**Available nutrients (ppm)**		**EC. mmhos /cm at 25 oc (1:5 soil water extract)**	**PH (1:2.5 soil water suspension)**
Co3 – + Hco3-	**Cl-**	**So4-**	**Ca++ + Mg++**	**Na+**	**K+**	**N**	**p**	**2.9**	**8.02**
4.04	**13.0**	**13.0**	**14.4**	**15.62**	**0.28**	**74**	**4**		

At harvest, ten guarded plants were taken out at random from the middle five ridges of each plot to determine; plant height (cm), ear length (cm), ear diameter (cm), number of rows / ear, grain index (g), grain

yield (g)/plant and straw yield (g)/plant. All plants of each plot were harvested to estimate; grain yield (ton) /fed., straw yield (ton)/fed., biological yield (ton) /fed., and harvest index%.

Also protein percentage and carbohydrate percentage were determined in grains as described in[20] and according to[21], respectively. Statistical analysis was performed according to[22].Treatment means were compared by L.S.D. test at 5% level. Combined analysis was made for the two growing seasons as results followed similar trend.

Results and Discussion

Growth characters:

Hybrid differences : It is clear from Table (2) that hybrid differences were found among the two maize hybrids under study in growth characters at 70 and 90 days from sowing except leaf area ratio at 90 days from sowing i.e., plant height(cm), total dry weight / plant (g), leaf area /plant (LA) dm^2, leaf area index (LAI) and leaf area ratio (LAR) at 70 days from sowing. It is clear that maize hybrid S.C. S.C.National 6 surpassed maize hybrid T.W. 329 in all growth characters under study. It is not worthy to mention that hybrid differences in growth characters are in a harmony with the results obtained by[3,23.24] .

The differences between the two hybrid in growth characters under this study may be due to the differences in genetic structure, and the hybrid differences in glucose required for synthesis of different chemical constituents at different plant organs, in carbon equivalent and in partitioning of photosynthates among the plants[25], and to the differences between genotypes for their mineral element concentrations[26]. Similar finding were reported by[1,27,28,29,30.]

Foliar spraying: Data in Table (2) showed that foliar application with urea or potassium or urea and potassium caused significant increases in growth character compared with the control. Data revealed that there were significant differences between treatments in both season, it is clear from data that the highest values were obtained by spraying urea 2%+spraying potassium 2%,followed by spraying urea 2%+ spraying potassium1%. The increase in these growth characters by spraying urea and potassium could be due to the positive role of these elements in stimulating dry mass production through enhancement of cell division and chlorophyll accumulation which leads to higher photosynthetic activity and accumulating of dry matter and in turn reflected on the increasing in translocation and accumulation of microelements in plant organs and these in turn on their growth characters. In this respect, positive responses of urea and potassium foliar spraying on various agronomic crops were recorded,[6]on cotton,[3,28,31].

Table 2: Effect of cultivars and foliar fertilizer on growth characters of maize hybrids plant at 70 and 90 days after sowing. (Average of 2013and 2014 seasons).

Characters / Treatments	Plant height(cm)		Total dry weight/plant (g)		LA $(dm)^2$		LAI		LAR	
	70	90	70	90	70	90	70	90	70	90
Cultivars										
National 6	272.12	286.56	256.64	270.96	47.19	58.52	2.36	2.92	18.33	21.56
T.W. 329	263.34	278.71	248.26	256.33	44.78	55.59	2.24	2.78	17.98	21.62
L.S.D. at 5%	1.67	1.03	1.01	0.64	0.42	0.16	0.04	0. 02	0.27	n.s
Foliar Fertilizer										
Control	251.55	276.85	230.87	244.00	38.33	50.17	1.92	2.49	16.59	20.41
Urea 1%	258.10	273.40	237.67	246.67	40.50	52.00	2.03	2.60	17.04	21.08
Urea 2%	263.74	278.17	2436.67	254.83	42.83	54.50	2.14	2.73	17.58	21.39
Potassium 1%	261.20	277.35	247.50	258.67	43.83	55.67	2.20	2.78	17.72	21.53
Potassium 2%	267.52	283.86	251.67	262.17	46.33	57.50	2.31	2.88	18.34	21.93
Urea 1% + Potassium 1%	267.89	284.56	258.00	269.00	48.00	57.50	2.40	2.88	18.60	21.37
Urea 1% + Potassium 2%	276.82	289.08	263.50	274.50	49.50	59.50	2.48	2.98	18.79	21.67
Urea 2% + Potassium 1%	278.03	292.42	267.00	279.33	51.50	61.50	2.58	3.07	19.29	21.96
Urea 2% + Potassium 2%	284.74	297.02	272.17	283.67	53.00	65.17	2.65	3.26	19.47	22.97
L.S.D. at 5%	3.43	1.09	1.06	0.90	0.60	0.28	0.03	0.02	0.20	0.21

Interaction: As for interaction effect between maize hybrids and spraying urea and potassium Table (3) showed that plant height at 90 days from sowing, total dry weight, LA, LAI and LAR were significantly influenced by the interaction between maize hybrids and foliar spraying with urea and potassium treatments**.** The plants of both maize hybrids that received foliar spraying had more total dry weight, LA, LAI and LAR, beside had taller plants at 90 days from sowing. It is obvious that the plants of both hybrids had more plant height at 90 days from sowing ,total dry weight, LA, LAI and LAR when they spraying with urea 2%+potassium2%. On the other hand maize hybrid S.C. National 6 with spraying urea 2 % + potassium 2 % gave the highest value of growth characters followed by urea 2%+potassium1 % in both seasons. The difference between the two maize hybrids with urea 2%+potassium 2% was not significant in LAR at 70 days from sowing.

Table 3: Effect of interaction between cultivars x foliar fertilizer on growth characters of maize hybrids plant at 70 and 90 days after sowing. (Average of 2013 and 2014 seasons).

Characters / Treatments		Plant height		Total dry weight/plant (g)		LA $(dm)^2$		LAI		LAR	
		70	90	70	90	70	90	70	90	70	90
Cultivars x Foliar Fertilizer											
National 6	Control	256.50	272.79	236.07	251.67	40.33	52.33	2.02	2.62	17.09	20.79
	Urea 1%	261.19	277.64	242.67	254.33	42.00	54.00	2.10	2.70	17.31	21.23
	Urea 2%	268.51	283.58	248.67	264.00	44.00	56.00	2.20	2.80	17.69	21.21
	Potassium 1%	266.61	282.52	251.00	268.67	45.00	57.00	2.25	2.85	17.93	21.22
	Potassium 2%	271.86	288.88	254.67	270.00	48.00	59.00	2.38	2.95	18.72	21.85
	Urea1%+Potassium 1%	272.95	286.22	262.00	275.33	49.00	58.00	2.45	2.90	17.70	21.05
	Urea1%+Potassium 2%	279.50	290.17	268.67	280.33	50.33	60.00	2.52	3.00	18.74	21.40
	Urea2%+Potassium 1%	282.86	295.50	270.33	285.67	52.00	63.00	2.60	3.13	19.24	21.94
	Urea2%+Potassium 2%	289.15	301.70	275.67	288.67	54.00	67.33	2.70	3.37	19.59	23.32
T.W. 329	Control	246.60	262.90	225.67	236.33	36.33	48.00	1.82	2.37	16.10	20.03
	Urea 1%	255.01	269.17	232.67	239.00	39.00	50.00	1.95	2.50	16.76	20.92
	Urea 2%	258.96	272.75	238.67	245.67	41.67	53.00	2.08	2.65	17.46	21.57
	Potassium 1%	255.79	272.17	244.00	248.67	42.67	54.33	2.15	2.72	17.50	21.85
	Potassium 2%	263.18	278.83	248.67	254.33	44.67	56.00	2.23	2.80	17.96	22.02
	Urea1%+Potassium 1%	262.82	282.90	254.00	262.67	47.00	57.00	2.35	2.85	18.50	21.70
	Urea1%+Potassium 2%	274.14	288.00	258.33	268.67	48.67	59.00	2.43	2.95	18.84	21.93
	Urea2%+Potassium 1%	273.21	289.33	263.67	273.00	51.00	60.00	2.55	3.00	19.34	21.98
	Urea2%+Potassium 2%	280.33	292.33	268.67	278.67	52.00	63.00	2.60	3.15	19.35	22.61
L.S.D. at 5%		n.s	1.55	1.50	1.27	0.85	0.40	0.04	0.03	0.37	0.30

Yield and yield components:

Hybrid differences: Data in Table (4) showed that yield and yield components were significantly affected by hybrid differences, meanwhile, differences in harvest index and carbohydrate percentage failed to reach significant level at 5 %. Data revealed that hybrid S.C. National 6 gave the highest mean value from plant height, ear length, ear diameter, No. of rows /ear, grain index, grain yield / plant**,** straw yield / plant, grain yield / fed., straw yield / fed., biological yield / fed., and protein percentage in both seasons. The superiority of S.C. National 6 over T.W. 329 in yield /fed., may be due to that high yielding hybrid had a more vigorous system for generating reducing potentials during plant growth than did the less productive hybrid and the higher yielding cultivar has a higher photosynthetic electron transport chain potential[23]. Changes in LAI caused a variation in Co_2 uptake and the differences in kernels yield from anthesis onwards were correlated with LAI and CO_2 uptake[32].

Hybrid differences in yield and its components may be due to the differences in genetic structure between the two hybrids and the widely differences between maize hybrids for mineral concentrations[33]. Hybrid differences in yield and its components in this study are in harmony with the results obtained by[1,3,23,24,25,27,28.29,30,34,35,36,37].

Foliar spraying : Data presented in Table (4) revealed that the two maize hybrids were affected by foliar spraying with urea or potassium significantly in all characters, while the differences between treatments in carbohydrate percentage was not reached to the level of significant as compared with control. Data indicated that the highest values of yield and yield components were obtained by foliar spraying urea 2 % + potassium 2 % followed by urea 2 % + potassium 1 % compared with control. Many investigator reported the same results[14,15,23].

Interaction : Table (5) showed the effect of interaction between maize hybrids and foliar spraying with urea and potassium fertilizer on plant height (cm), ear length(cm), ear diameter (cm), number of rows /ear, grain index, grain and straw yields / plant (g), grain and straw yields(ton)/fed., biological yield(ton)/fed., harvest index%, protein percentage and carbohydrate percentage. Data revealed that the differences between treatments were significant in both seasons in all characters except the values of harvest index and carbohydrate percentage were not reached to the level of significant in both seasons. Data indicated that S.C. S.C. National 6 cultivar with the application of urea 2% + potassium 2% gave the highest values of plant height, ear length, ear diameter, number of rows /ear**,** grain index, grain and straw yields / plant and per fed., biological yield/ fed., and protein percentage followed by S.C. National 6 cultivar with urea 2% + potassium 1% in both seasons.

It is clear from data that the differences between S.C. National 6 cultivar with urea 2% + potassium 1% and T.W. 329 cultivar with urea 2% + potassium 2 % were not significant in plant height, grain yield / plant and/ fed., and biological yield / fed., in both seasons. These results are in a harmony with those obtained by[10,11,12.23].

Table 4: Effect of cultivars and foliar fertilizer on yield and its components of maize hybrids. (Average of 2013 and 2014 seasons).

Characters / Treatments	Plant height (cm)	Ear length (cm)	Ear diameter (cm)	Number of rows / ear	Grain index (g)	Grain yield (g)/plant	Straw yield (g)/plant	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index %	Protein %	Carbohydrate %
Cultivars													
National 6	291.48	19.280	5.474	20.280	26.324	137.59	243.22	3.023	5.350	8.374	36.13	10.386	80.299
T.W. 329	282.52	19.179	5.385	20.179	26.204	134.33	236.52	2.955	5.200	8.141	36.31	10.286	80.213
L.S.D. at 5%	1.30	0.007	0.007	0.007	0.004	0.80	0.97	0.037	0.002	0.074	n.s	0.006	n.s
Foliar Fertilizer													
Control	274.50	19.102	5.332	20.103	26.107	131.50	229.67	2.895	5.053	7.892	36.78	10.233	80.265
Urea 1%	279.50	19.153	5.367	20.168	26.175	133.50	233.00	2.925	5.125	8.050	36.33	10.270	80.127
Urea 2%	283.67	19.192	5.385	20.218	26.212	135.33	235.00	2.977	5.170	8.147	36.54	10.300	80.183
Potassium 1%	281.67	19.212	5.415	20.240	26.250	136.50	237.17	3.005	5.218	8.233	36.56	10.320	80.222
Potassium 2%	287.50	19,242	5.440	20.267	26.275	138.67	239.50	3.050	5.265	8.315	36.68	10.340	80.245
Urea 1% + Potassium 1%	287.83	19.250	5.442	20.220	26.300	133.83	242.00	2.935	5.325	8.260	35.53	10.355	80.268
Urea 1% + Potassium 2%	291.33	19.275	5.460	20.253	26.335	136.17	243.67	2.988	5.362	8.350	35.79	10.375	80.300
Urea 2% + Potassium 1%	295.67	19.302	5.505	20.275	26.350	138.00	248.00	3.035	5.435	8.470	35.84	10.402	80.325
Urea 2% + Potassium 2%	301.33	19.335	5.520	20.317	26.373	140.17	250.83	3.092	5.522	8.613	35.90	10.427	80.370
L.S.D. at 5%	1.39	0.005	0.005	0.009	0.006	0.49	0.90	0.017	0.008	0.060	0.27	0.008	n.s

Table 5: Effect of interaction between cultivars x foliar fertilizer on yield and its components of maize hybrids.(Average of 2013 and 2014 seasons).

Characters / Treatments		Plant height (cm)	Ear length (cm)	Ear diameter (cm)	Number of rows / ear	Grain index (g)	Grain yield(g) /plant	Straw yield(g) /plant	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index %	Protein %	Carbohydrate %
Cultivars x Foliar Fertilizer														
National 6	Control	280.33	19.203	5.407	20.207	26.213	133.33	235.00	2.937	5.170	8.113	36.34	10.280	80.197
	Urea 1%	285.33	19.230	5.433	20.243	26.260	136.00	237.00	2.970	5.210	8.180	36.31	10.320	80.220
	Urea 2%	290.00	19.250	5.450	20.270	26.280	137.67	239.00	3.023	5.260	8.283	36.50	10.350	80.250
	Potassium 1%	286.67	19.270	5.470	20.280	26.300	138.00	240.33	3.040	5.287	8.327	36.54	10.370	80.270
	Potassium 2%	294.00	19.300	5.490	20.303	26.320	140.00	242.00	3.080	5.320	8.400	36.67	10.390	80.290
	Urea 1% + Potassium 1%	291.67	19.287	5.470	20.270	26.350	135.67	245.00	2.970	5.390	8.360	35.53	10.400	80.317
	Urea 1% + Potassium 2%	294.33	19.300	5.490	20.290	26.380	137.33	246.67	3.007	5.430	8.437	35.64	10.420	80.350
	Urea 2% + Potassium 1%	296.67	19.330	5.520	20.303	26.400	139.00	250.33	3.060	5.500	8.560	35.75	10.453	80.380
	Urea 2% + Potassium 2%	304.33	19.350	5.537	20.350	26.417	141.33	253.67	3.123	5.583	8.710	35.87	10.490	80.420
T.W. 329	Control	268.67	19.000	5.257	20.000	26.000	129.67	224.33	2.853	4.937	7.670	37.22	10.187	80.333
	Urea 1%	273.67	19.077	5.300	20.093	26.090	131.00	229.00	2.880	5.040	7.920	36.36	10.220	80.033
	Urea 2%	277.33	19.133	5.320	20.167	26.143	133.00	231.00	2.930	5.080	8.010	36.58	10.250	80.117
	Potassium 1%	276.67	19.153	5.360	20.200	26.200	135.00	234.00	2.970	5.150	8.120	36.58	10.270	80.173
	Potassium 2%	281.00	19.183	5.390	20.230	26.230	137.33	237.00	3.020	5.210	8.230	36.70	10.290	80.200
	Urea 1% + Potassium 1%	284.00	19.213	5.413	20.170	26.250	132.00	239.00	2.900	5.260	8.160	35.54	10.310	80.220
	Urea 1% + Potassium 2%	288.33	19.250	5.430	20.217	26.290	135.00	240.67	2.970	5.293	8.263	35.94	10.330	80.250
	Urea 2% + Potassium 1%	294.67	19.277	5.490	20.247	26.300	137.00	245.67	3.010	5.370	8.380	35.92	10.350	80.270
	Urea 2% + Potassium 2%	298.33	19.320	5.503	20.283	26.330	139.00	248.00	3.060	5.460	8.520	35.92	10.363	80.320
L.S.D. at 5%		1.96	0.007	0.008	0.012	0.008	0.69	1.28	0.023	0.012	0.085	n.s	0.012	n.s

Conclusion:

Using nitrogen and potassium through foliar feeding is an effective mean to increase the efficiency of these nutrients on maize productivity. However, It is clear from all the previous data that foliar fertilization of S.C. S.C. National 6 maize cultivar with 2% urea + 2% potassium could be most effective treatment under the circumstances of this Kom Oshim District, Fayoum Governorate.

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