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Response of Two Maize Hybrids to Urea Fertilization under Application of Hydroquinone Urease Inhibitor

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TWO FIELD experiments were conducted during 2006 and 2007 summer seasons at Gaziret-Hanout,Kafr Sakr District, Sharkia Governorate, Egypt to study the response of two maize hybrids (SC 122 and TWC 310) to three levels of urea fertilization, *i.e.*75,100 and 125 kgN/fad(1ha=2.381fad) under application of three hydroquinone (HQ) urease inhibitor levels (0, 1.5 and 3.0 kg HQ/100 kg N). The adopted experimental design was split-split plot with three replicates.

The results revealed that TWC 310 maize hybrid was superior in most of studied characters compared to SC122 which superior in ear length and protein percentage. However, both tested hybrids gave almost the same protein yield/fad. Increasing N levels from 75 to 100kg N/fad resulted in a significant increase in plant height, 100-grain weight, protein percentage and protein yield/fad, while the increase in urea-N levels up to 125kgN/fad increased significantly all other studied characters, except oil percentage which significantly decreased by any increase in N levels up to 125kgN/fad. Treating urea fertilizer with HQ urease inhibitor at the rate of 1.5kgHQ/100 kg N increased significantly both plant height and 100-grain weight, while increasing HQ levels up to 3.0kgHQ/100 kg N resulted in a significant increase in the other most studied characters compared with untreated urea. Any further HQ increment caused further reduction in oil percentage.

Regarding the interaction effects, TWC 310 gave the higher number of grains/ ear when urea was treated with 3.0kgHQ/100kgN with a response rate of 25.66 grain yield/ fad was responded to urea-N up to 100 kg N/fad when 1.5 or 3.0kg HQ/100kg N was added. The highest oil yield / fad was attained when 125 kg N/fad was applied and when urea treated with 3.0 kg HQ/100 kg N.

The results revealed positive and significant correlation coefficients between grain yield/ fad, and most of studied characters, while negative and significant correlation was found for grain yield related to oil percentage. The path analysis revealed that the direct effect of number of ears/plant was 17.06% being higher than that of 100-grain weight and number of grains/ear which was 15.18 and 5.11% of maize grain yield variation, respectively. Regression analysis revealed that number of ears/ plant and number of grains/ ear are similar to that of grain yield and each is of quadratic relationship with

urea-N fertilization, while the response of 100-grain weight to urea-N fertilizer had a linear relationship.

Keywords: Maize, Urease inhibitor, Hydroquinone, N-fertilization, Yield analysis .

In Egypt, the local maize production is still not sufficient to meet the increase in consumption. The increase of maize grain yield could be achieved by using high yielding varieties suited to different environmental conditions and adopting optimum agronomic practices. Recently, Research Institutes provided farmers with commercial high yielding maize varieties which respond to high nitrogen fertilization doses (Aly *et al.*,1996).

Maize varieties differ in their yielding abilities depending on their genetic structures and their interaction with the environmental conditions. Many investigators found differences among the tested maize varieties, of them: Khamis *et al*. (2005), Oraby *et al*. (2005) and Abd El-Maksoud & Sarhan (2008).

It is well known that nitrogen is a key element in maize nutrition. Therefore, an adequate supply of nitrogen is essential to maximize maize yield. Khamis *et al*. (2005) reported that ear length, number of ears/plant, number of grains/row, ear grain weight, 100-grain weight and grain yield/fad increased significantly with the increase in urea - N from 30 to 90 kg N/fad with insignificant difference between 90 and 120 kg N/fad, while number of rows /ear did not respond significantly to the increase in urea - N rates. Oraby *et al*. (2005) found that number of grains per both row and ear, 100-grain weight as well as grain yield/fad were continuously and significantly increased by each increment of N-rate up to 150 kg / fad, while number of rows/ear was gradually increased up to the highest N rates in old lands and up to the medium N rate in new reclaimed lands. Also, Hans (2006), Abd El-Maksoud & Sarhan (2008) and Thiraporn *et al*. (2008) came to the same conclusions in this respect.

Urea is one of the most commonly N- fertilizer used for maize production, but here in Egypt, most of farmers conventionally apply urea to soil surface. This practice can result in extreme loss of urea - N through NH_3 voltalization (Khamis *et al*., 2005). One approach to decrease urea N-loss via NH_3 voltalization is the use of urease inhibitors that retard rapid urea hydrolysis and therefore reduce NH_3 voltalization potential and this can result in increasing the response to nitrogen and hence, maize grain yield to increase.

Concerning urease inhibitors and its effects on decreasing urea - N loss via NH_3 voltalization, Zhang *et al*. (1997) reported that adding dicyandiamide as an ammonia - stabilizing agent to ammonium bicarbonate as a nitrogen fertilizer caused a reduction of direct NH_3 voltalizaton by 53%, a fertilizer availability period prolonged from 35-45 to 90-110 days and an increase in the rate of nitrogen fertilizer being utilized by 5.9-10.2% and saving of the amount of fertilizer to be applied by 20 - 30% for the same level of maize grain yield, or an

increase of maize grain yield by over 10% for the same level of nitrogen fertilizer. Hernan *et al*. (1999), found that ammonia losses from urea without adding the urease inhibitor N-(n-butyl) thiophosphoric triamide ranged between 2.6 and 13.3% of applied N, being greater with higher N-rates. Further more, Khamis *et al*. (2005) detected a significant increase in ear length, ear number/ plant , row number/ ear, grain number / row, ear grain weight, 100-grain weight, grain yield / fad, N-concentration in grains and N-use efficiency of maize due to adding 1,4 - phenylenediamine (PDA) and hydroquinone (HQ) to urea fertilizer as urease inhibitors. However, no compound has been found to meet all the requirements for an ideal inhibitor of urease (Vetsch & Randall, 2000).

This study aimed to investigate the response of two maize hybrids to urea fertilizer levels under urease inhibitor application.

Materials and Methods

Two field experiments were carried out at Gaziert -Hanout, Kafr Sakr District, Sharkia Governorate, Egypt during 2006 and 2007 summer seasons. The aim of this investigation was to study the response of two maize hybrids (SC 122 and TWC 310) to three urea fertilizer levels (75, 100 and 125kg N/fad) under three levels of hydroquinone (HQ) as urease inhibitor (0, 1.5 and 3.0 kg HQ/ 100 kg N).

A split-split plot design with three replicates was used, where maize hybrids occupied the main plots. The three urea levels were allotted to the sub plots, whereas the HQ levels were randomly distributed in the sub-sub plots. The soil of the experimental field was loamy sand in texture having a pH 8.0 and 8.1; 1.08 and 1.10% organic matter content and containing 40.15 and 39.25 ppm available N, 9.18 and 8.95 ppm available P and 195 and 223 ppm available K for the upper 30 cm of the soil surface in the two growing seasons, respectively. The plot area was 16.8m^2 included 6 ridges of 4 m long and 70cm apart. The preceding crop in the two seasons was lupin.

Maize (*Zea mays* L.) seeds were sown on 3rd June in both seasons with hill spacing of 25cm. Maize plants were thinned to one plant / hill 20 days after sowing and before the 2nd irrigation. The urea fertilizer (46.5% N) was used in three equal doses, after 20, 40 and 60 days from sowing. Hydroquinone (HQ) urease inhibitor was adhered to urea prills by first dissolving the powdered HQ in methanol then spraying it on the urea prills just before urea application. Calcium superphosphate (15.5% P_2O_5) at the rate of 100kg /fad and potassium sulphate (48% K_2O) at the rate of 50 kg/fad were added as a basical fertilization just before sowing. The prevailing agronomic practices in the region were kept.

At harvest, ten guarded plants were taken from the 2nd and 5th ridges in each plot, then plant height (cm), ear length (cm), number of ears / plant, number of rows / ear, number of grains / row, number of grains / ear and 100-grain weight were measured. Grain yield (ardab/fad), which adjusted to 15.5% moisture content was determined from the central two ridges (5.6m^2) in each plot. To

determine crude protein and oil contents, samples of dried grains were ground to fine powder and N content was determined using the modified micro-Kijeldahel apparatus as described by A.O.A.C. (1988). The obtained N values were multiplied by 6.25 to calculate crude protein percentage. Oil content was extract by diethylether in a soxhlet apparatus according to Comstock & Culberston (1958). Protein and oil yields/ fad were calculated from multiplying grain yield / fad in kg by protein and oil percentages, respectively.

The proper statistical analysis of split - split plot design was used. Combined analysis was performed for the characters recorded in both seasons. Differences among treatment means were judjed using Duncan's multiple| range test (Duncan, 1955). Means followed by different letters were statistically significant. In interaction Tables, small and capital letters were used to compare means in columns and rows, respectively. The combined data of yield components and yield were subjected to simple correlation, path coefficient and regression analysis calculated according to Svab (1973).

Results and Discussion

Yield and yield attributes

Data presented in Tables 1, 2, 3 and 4 show the effect of both urea-N and urease inhibitor hydroquinone (HQ) levels on yield and its attributes in both growing seasons as well as the combined analysis of the two tested maize hybrids.

Maize hybrid differences

Combined analysis revealed that TWC 310 surpassed the other maize hybrid SC 122 in plant height, number of ears / plant, number of rows/ ear, number of grains/row, number of grains/ear, 100-grain weight, oil percentage and both grain and oil yields/ fad. The SC 122 produced the longer ears and the higher protein percentage compared to TWC 310. However, both studied hybrids were insignificantly differed in protein yield/ fad. These differences between the two maize hybrids depending on the genetic make up and its interaction with the environmental conditions. Similar differences among maize hybrids were observed by Ahmed & El-Sheikh (2002), Khamis *et al*. (2005), Oraby *et al*. (2005) and Abd El-Maksoud & Sarhan (2008).

Urea - N fertilization effects

According to the combined data, ear length, number of ears /plant, number of rows/ear, number of grains / row, number of grains / ear and grain and oil yields/fad significantly increased by any increment of N fertilizer up to 125 kg N/fad. Whereas, plant height, 100-grain weight, protein percentage and protein yield/ fad significantly increased up to 100kg N/fad. The mean increases of each increment up to 125kg N/fad were 0.885 ardab, 8.925 kg and 13.195kg / fad for grain, protein and oil yields, respectively. However, oil percentage significantly decreased by increasing N-levels up to 125kg N/fad. These findings are in agreement with those obtained by Ahmed & El-Sheikh (2002), Mohamed (2004), Khamis *et al*. (2005), Oraby *et al*. (2005) and Abd El-Maksoud & Sarhan (2008).

TABLE 1. Plant height (cm), ear length (cm) and number of ears/plant as affected by maize hybrids, urea - N and HQ levels .

Main effects and interaction	Plant height (cm)			Ear length (cm)			Number of ears/plant		
	1st season	2nd season	combined	1st season	2nd season	combined	1st season	2nd season	combined
Maize hybrids (M):									
SC 122	303.0	308.9b	305.9b	19.97a	22.37a	21.17a	1.201b	1.318b	1.259b
TWC 310	309.7	313.2a	311.5a	18.66b	19.24b	18.95b	1.247a	1.351a	1.299a
F-test	N.S	*	*	**	**	**	**	*	**
Urea-N fertilizer levels (N):									
75kg N/fad	295.3b	305.0c	300.1b	18.86c	20.25b	19.56c	1.168b	1.217c	1.193c
100kg N/fad	310.4ab	312.3b	311.4a	19.44b	20.60b	20.02b	1.246a	1.343b	1.294b
125 kg N/fad	313.3a	315.9a	314.6a	19.65a	21.57a	20.61a	1.258a	1.444a	1.351a
F-test	**	**	**	**	**	**	**	**	**
Hydroquinone levels (HQ):									
0kg HQ/100 kgN	303.8	305.8c	304.8b	18.92c	20.02c	19.47c	1.178b	1.280c	1.229c
1.5kg HQ/100 kgN	309.6	312.8b	311.2a	19.37b	20.98b	20.18b	1.240a	1.327b	1.284b
3.0 kg HQ/100 kgN	305.6	314.5a	310.0a	19.66a	21.42a	20.54a	1.254a	1.396a	1.325a
F-test	N.S	**	*	**	**	**	**	**	**
Interactions :									
M X N	N.S	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S
M X HQ	N.S	N.S	N.S	N.S	N.S	N.S	*	N.S	N.S
N X HQ	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

1ha=2.381fad

TABLE 2. Number of rows/ear, number of grains/row and number of grains / ear as affected by maize hybrids, urea -N and HQ levels.

Main effects and interaction	Number of rows/ear			Number of grains/row			Number of grains/ear		
	1st season	2nd season	combined	1st season	2nd season	combined	1st season	2nd season	combined
Maize hybrids (M):									
SC 122	12.18b	12.43b	12.31b	37.69b	42.73b	40.21b	459.12b	531.57b	495.35b
TWC 310	12.40a	12.53a	12.46a	38.80a	50.13a	44.47a	480.71a	626.00a	553.36a
F-test	**	**	**	**	**	**	**	*	**
Urea-N fertilizer levels (N):									
75kg N/fad	12.21b	12.40b	12.31c	37.63c	43.64c	40.63c	459.63c	541.24c	500.43c
100kg N/fad	12.31a	12.42b	12.37b	38.37b	46.23b	42.30b	472.31b	571.39b	521.84b
125 kg N/fad	12.35a	12.62a	12.49a	38.74a	49.42a	44.08a	477.91a	623.73a	550.80a
F-test	**	**	**	**	**	**	**	**	**
Hydroquinone levels (HQ):									
0kg HQ/100 kgN	12.22b	12.42	12.32c	37.68c	43.84c	40.76c	460.61c	542.72c	501.64c
1.5kg HQ/100 kgN	12.30ab	12.47	12.38b	38.39b	46.72b	42.55b	471.62b	582.10b	526.84b
3.0 kg HQ/100 kgN	12.35a	12.56	12.45a	38.67a	48.72a	43.70a	477.71a	611.53a	544.59a
F-test	**	N.S	**	**	**	**	**	**	**
Interactions :									
M X N	*	N.S	N.S	N.S	N.S	N.S	*	N.S	N.S
M X HQ	*	N.S	N.S	N.S	N.S	N.S	**	N.S	*
N X HQ	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

1ha=2.381fad

TABLE 3 . 100 - grain weight (gm), grain yield (ardab / fad) and protein percentage as affected by maize hybrids, urea - N and HQ levels.

Main effects of interaction	100-grain weight (gm)			Grain yield (ardab/fad)			Protein percentae		
	1st season	2nd season	combined	1st season	2nd season	combined	1st season	2nd season	combined
Maize hybrids (M):									
SC 122	25.93b	33.06b	29.50b	19.98b	20.79b	20.38b	10.41a	11.46a	10.93a
TWC 310	26.87a	34.44a	30.66a	21.01a	21.69a	21.35a	9.71b	11.30b	10.50b
F-test	**	**	**	**	*	**	**	*	**
Urea-N fertilizer levels (N):									
75kg N/fad	25.44c	32.52c	28.98b	19.44c	20.44c	19.94c	9.76c	11.27b	10.52b
100kg N/fad	26.74b	33.90b	30.32a	20.79b	21.11b	20.95b	10.08b	11.64a	10.86a
125 kg N/fad	27.03a	34.83a	30.93a	21.26a	22.15a	21.71a	10.32a	11.23b	10.78a
F-test	**	**	**	**	**	**	**	**	**
Hydroquinone levels (HQ):									
0kg HQ/100 kgN	25.81b	32.17b	28.99b	19.61c	20.43b	20.02c	9.79c	11.11c	10.45c
1.5kg HQ/100 kgN	26.56a	34.26a	30.41a	20.63b	21.44a	21.04b	10.06b	11.42b	10.74b
3.0 kg HQ/100 kgN	26.83a	34.83a	30.83a	21.23a	21.85a	21.54a	10.32a	11.62a	10.97a
F-test	**	N.S	**	**	**	**	**	**	**
Interactions :									
M X N	N.S	*	N.S	N.S	N.S	N.S	*	N.S	N.S
M X HQ	M.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
N X HQ	N.S	N.S	N.S	**	N.S	*	N.S	N.S	N.S

1ha=2.381fad

TABLE 4. Oil percentage, protein yield (kg/fad) and oil yield (kg/fad) as affected by maize hybrids, urea-N and HQ levels.

Main effects of interaction	Oil percentage			Protein yield (kg/fad)			Oil yield (kg/fad)		
	1st season	2nd season	combined	1st season	2nd season	combined	1st season	2nd season	combined
Maize hybrids (M):									
SC 122	4.41b	3.91b	4.16b	290.73a	334.55b	312.64	123.93b	113.90b	118.92b
TWC 310	4.83a	4.34a	4.58a	284.98b	343.17a	314.08	141.55a	131.83a	136.69a
F-test	**	**	**	*	*	N.S	**	**	**
Urea-N fertilizer levels (N):									
75kg N/fad	4.87a	4.36a	4.61a	280.74c	322.43b	301.59b	118.08c	110.57c	114.32c
100kg N/fad	4.65b	4.15b	4.40b	293.01a	345.09a	319.05a	134.37b	122.39b	128.38b
125 kg N/fad	4.33c	3.87c	4.10c	289.82b	349.05a	319.44a	145.77a	135.64a	140.71a
F-test	**	**	**	**	**	**	**	**	**
Hydroquinone levels (HQ):									
0kg HQ/100 kgN	4.92a	4.42a	4.67a	283.06b	317.71c	300.33c	177.77c	108.35c	113.06c
1.5kg HQ/100 kgN	4.66b	4.17b	4.42b	290.03a	342.63b	316.33b	134.14b	125.56b	129.85b
3.0 kg HQ/100 kgN	4.92c	3.78c	4.03c	290.48a	356.35a	323.41a	146.31a	134.69a	140.50a
F-test	**	**	**	**	**	**	**	**	**
Interactions :									
M X N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
M X HQ	M.S	N.S	N.S	N.S	*	N.S	N.S	*	N.S
N X HQ	*	N.S	N.S	N.S	N.S	N.S	**	**	**

1ha=2.381fad

Urease inhibitor (HQ) effects

The amendment of urea fertilizer with HQ as a urease inhibitor caused significant increases in yield and all yield attributes characters of maize, except oil percentage and this was more pronounced in the combined analysis of the two growing seasons. Ear length, number of ears/plant, number of rows/ear, number of grains/row, number of grains /ear, protein percentage, grain, protein and oil yields/fad were continuously and significantly increased by treating urea with HQ urease inhibitor up to 3.0 kg/fad, whereas both plant height and 100-grain weight were significantly responded to 1.5 kg HQ/fad.

Compared to check plots (without HQ application), each increment of HQ urease inhibitor resulted in a mean increase of 0.760 ardab, 11.540 kg and 13.720 kg for grain, protein and oil yields/fad, respectively. The beneficial effects of treating urea with HQ urease inhibitor may be attributed to reducing urea-N losses and hence increasing fertilizer use efficiency as well as the important role of HQ to retard urea hydrolysis and reduced gaseous and leaching losses and thereby maintained an optimal level of available N in the soil for a long period (Khamis *et al*., 2005). Shlegel *et al*. (1986) reported that urease inhibitors increased grain yield of maize when added to urea that was surface-applied. Similar results were reported by Zhang *et al*. (1997) and Hernan *et al*. (1999 and 2001).

Interaction effects

Data in Table 5 revealed that TWC 310 always gave the higher number of grains/ ear compared to SC 122 and this was true under the three levels of HQ urease inhibitor. The number of grains/ ear was responded to HQ levels up to 1.5 kg/fad and up to 3.0 kg/fad regarding to SC 122 and TWC 310, respectively. Again, the higher increase due to HQ increment was obtained from TWC 310 where each increment of HQ produced an increase of 25.662 grains/ear compared to SC 122 which gave an increase in grains number / ear of 17.294 due to each HQ increment.

TABLE 5. The interaction effect between maize hybrids and HQ levels on number of grains/ear (combined).

Maize hybrids	HQ levels (kg/100kg N)			Response rate
	0	1.5	3.0	
SC 122	B 476.828b	A 497.794b	A 511.417b	17.294
TWC 310	C 526.444a	B 555.878a	A 577.767a	25.662

The interaction effect between urea-N and HQ levels on grain and oil yields/ fad was significant as shown in Table 6. At the three studied levels of nitrogen, grain yield was responded to HQ urease inhibitor up to 1.5 kg/fad. When urea untreated with HQ, grain yield / fad significantly increased up to 125 kg N/fad,

but when applying HQ at the rate of 1.5 or 3.0 kg/fad ,the grain yield / fad responded to 100 kg N /fad.

TABLE 6. The interaction effect between N fertilizer and HQ levels on grain and oil yields / fad of maize (combined).

N-fertilizer levels (kg N/fad)	HQ levels (kg/100kg N)			Response rate
	0	1.5	3.0	
	Grain yield (ardab/fad)			
75	B 19.221c	A 20.091b	A 20.508c	0.644
100	B 20.062b	A 21.156a	A 21.637a	0.788
125	B 20.780a	AB 21.858a	A 22.476a	0.848
Response rate	0.780	0.884	0.984	
Oil yield (kg/fad)				
75	C 103.599b	B 115.726c	A 123.647c	10.024
100	C 118.879a	B 128.022b	A 138.247b	9.684
125	C 116.694a	B 145.804a	A 159.617a	21.462
Response rate	6.548	15.039	17.985	

Without HQ application, urea-N applied at 100 kg N/fad produced the highest oil yield/ fad, while when urea fertilizer treated with 1.5 or 3.0kg HQ/fad , the oil yield/ fad was increased up to 125 kg N/fad. At the three levels of urea-N, oil yield/fad was remarkably increased with increasing HQ urease inhibitor level up to 3.0 kg/fad but with different magnitudes. The highest increase due to HQ increment was obtained from 125kg N/fad where each increment of HQ produced an increase of 21.462kg of oil yield. Only about 10.024 and 9.684 kg of oil yield was produced from adding 75 and 100 kg N/fad, respectively.

Yield analysis

Correlation study

Table 7 clearing simple correlation coefficients between maize grain yield/fad and other studied characters (pooled data of both seasons). Positive and significant correlation coefficients were found between grain yield/ fad and each of plant height, ear length , number of ears/ plant, number of rows/ear, number of grains/ear, 100-grain weight and protein and oil yields/fad, while grain yield/ fad was negatively and significantly correlated with oil percentage. However, grain yield was positively and insignificantly correlated with protein percentage. Data clearly indicate that the correlation coefficients between any pair of studied characters were positive and significant, except the correlation between protein percentage and most of other studied characters which was positive and insignificant as well as between protein yield/fad and each of ear length, number of rows/ ear, number of grains/ row and number of grains/ ear which was positive and insignificant. Oil percentage was negatively and significantly correlated with most of studied traits.

TABLE 7. Simple correlation coefficients between grain yield (ardab/fad), yield attributes and other characters of maize (combined data).

Character	1	2	3	4	5	6	7	8	9	10	11
Y-Grain yield (ardab/fad)	0.880**	0.783**	0.947**	0.841**	0.905**	0.908**	0.966**	0.289	-0.893**	0.624**	0.948**
1- Plant height (cm)		0.644**	0.890**	0.709**	0.762**	0.762**	0.825**	0.224	-0.725**	0.568*	0.797**
2- Ear length (cm)			0.625**	0.865**	0.962**	0.953**	0.800**	0.295	-0.762**	0.190	0.787**
3- No. of ears/plant				0.791**	0.794**	0.806**	0.904**	0.181	-0.777**	0.662**	0.855**
4- No. of rows/ear					0.923**	0.941**	0.839**	0.395	-0.679**	0.404	0.754**
5- No. of grains / row						0.998**	0.899**	0.456	-0.826**	0.406	0.871**
6- No. of grains / ear							0.898**	0.455	-0.815**	0.410	0.866**
7- 100-grains weight (gm)								0.359	-0.892**	0.538*	0.932**
8- Protein %									-0.421	0.566*	0.404
9- Oil (%)										-0.468*	0.987**
10- Protein yield (kg/fad).											0.488*
11- Oil yield (kg/fad)											------

Path analysis

The partitioning of simple correlation coefficient between maize grain yield and its components mentioned herein is presented in Table 8.

TABLE 8. Partioning of simple correlation coefficients between maize grain yield (ardab/fad) and its attributes.

Sources	**Values**
Number of ears/plant:	
Direct effect	0.4130
Indirect effect via number of grains /ear	0.1817
Indirect effect via 100-grain weight	0.3523
Total (ry_1)	0.9470
Number of grains / ear:	
Direct effect	0.2260
Indirect effect via number of ears / plant	0.3321
Indirect effect via 100-grain weight	0.3499
Total (ry_2)	0.9080
100-grain weight:	
Direct effect	0.3897
Indirect effect via number of ears / plant	0.3734
Indirect effect via number of grains / ear	0.2029
Total (ry_3)	0.9660

Data clearly show that the number of ears / plant had the highest direct effect on grain yield (0.4130) followed by 100-grain weight (0.3897) and number of grains / ear (0.2260) in a descending order. Also, the indirect interaction effects between each pair of mentioned components on grain yield gave a considerable values in this respect.The relative importance in contributing grain yield / fad of maize as a percentage of the variation of number of ears / plant, number of grains/ ear and 100-grain weight with their interactions is listed in Table 9 . The results indicate that the number of ears/plant gave a relative contribution of 17.06% of the grain yield variation and being higher than that of 100-grain weight and number of grains /ear which was 15.18 and 5.11% of the grain yield variation, respectively. It is worthy to observe that the joint effect of number of ears/plant with number of grains/ear and with 100-grain weight; number of grains/ear with 100-grain weight as 15.01, 29.10 and 15.82% of the variation, respectively. Here , it is worthy to note that those mentioned characters as well as their interactions could contributed much in maize grain yield since R^2 was 97.28% of the total variation in yield. Also, it is interesting to observe that the residual effects contributing to grain yield in this study was low in magnitude being 2.72%.

TABLE 9. Direct and joint effects of grain yield attributes presented as a percentage of grain yield variation of maize.

Sources	C.D.	%
Number of ears/plant	0.1706	17.06
Number of grains /ear	0.0511	5.11
100-grain weight	0.1518	15.18
Number of ears/plant X Number of grains/ear	0.1501	15.01
Number of ears/plant X 100-grain weight	0.2910	29.10
Number of grains/ears X 100-grain weight	0.1582	15.82
R^2	0.9728	97.28
Residual	0.0272	2.72
Total	**1.0000**	**100.00**

C.D. = Coefficient of determination
% = Percentage contributed

Regression study

Parameters of regression analysis between urea-N rates and maize grain yield as well as yield components are presented in Table 10.

Data clearly indicate that the response of number of ears/ plant and number of grains / ear are similar to that of grain yield /fad and each is of quadratic relationship with urea-N application rates. While, the response of 100-grain weight had a linear relationship with urea-N application rates. Here, it is worthy to note that maize grain yield could be increased by means of increasing 100-grain weight if urea-N is applied at suitable dose and at the proper age of plant.

TABLE 10. Parameters of regression analysis between urea-N fertilization and grain yield as well as yield attributes of maize.

Parameters	Number of ears/plant	Number of grains/ear	100-grain weight (gm)	Grain yield (ardab/fad)
a	1.13	453.40	27.34	18.95
b	8.515	1.610	4.169	1.083
c	-1.034	-0.535	2.500	- 0.413
R^2	0.9471	0.9041	0.9080	0.9483
Max. X	3.61	3.25	-	3.45
Max. Y	1.41	604.50	-	22.81

Conclusion

It could be concluded that the highest grain yield/fad of TWC 310 maize hybrid could be attained by adding 100kg N/fad with 1.5 or 3.0 kg HQ urease inhibitor / 100 kg N to decrease about 25kgN of applied nitrogen amount under loamy sand soil conditions at Sharkia Governorate.

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إستجابة صنفين من الذرة الشامية للتسميد باليوريا تحت تأثير إضافة مثبط إنزيم اليوريز الهيدروكينون

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أقيمت تجربتان حقليتان خلال عامى ٢٠٠٤ و ٢٠٠٥ بجزيرة حانوت - مركز كفر صقر-محافظة الشرقية- جمهورية مصر العربية. لدراسة استجابة صنفى الذرة (هجين فردى ١٢٢، هجين ثلاثى ٣١٠) لثلاث مستويات من التسميد باليوريا (٧٥، ١٠٠، ١٢٥كجم ن /فدان) تحت ثلاث مستويات من الهيدروكينون كمثبط لإنزيم اليوريز (٠ ، ٥ر١ و ٠ ر ٣ كجم/١٠٠ كجم ن). استخدم تصميم القطع المنشقة مرتين فى ثلاث مكررات.تشير النتائج إلى أن الهجين الثلاثى ٣١٠ تفوق فى صفات ارتفاع النبات، عدد الكيزان / النبات، عدد السطور / الكوز، عدد الحبوب/ السطر، عدد الحبوب/ الكوز، وزن ١٠٠ حبة، نسبة الزيت ومحصول كلاً من الحبوب والزيت / فدان، بينما تفوق الهجين الفردى ١٢٢ فى طول الكوز ونسبة البروتين. لم يختلف كلا الهجينين تحت الدراسة فى محصول البروتين/ فدان.

أدت زيادة مستوى التسميد باليوريا من ٧٥ إلى ١٠٠ كجم ن / فدان إلى زيادة معنوية فى إرتفاع النبات، وزن ١٠٠ حبة ونسبة ومحصول البروتين / فدان، بينما نتج عن زيادة مستوى اليوريا حتى ١٢٥كجم ن/ فدان زيادة معنوية فى باقى الصفات المدروسة ما عدا نسبة الزيت التى انخفضت مع زيادة مستوى اليوريا.

أوضحت معاملة اليوريا بالهيدروكينون بمعدل ٥ ,١كجم/١٠٠كجم ن زيادة معنوية فى كل من ارتفاع النبات ووزن ١٠٠ حبة، بينما نتج عن زيادة مستوى الهيدروكينون حتى ٠ ,٣ كجم/ ١٠٠ كجم ن زيادة معنوية فى الصفات المدروسة الأخرى بالمقارنة باليوريا غير المعاملة. أدت زيادة مستوى الهيدروكينون إلى نقص معنوى فى نسبة الزيت.

بالنسبة لتأثير تداخل الفعل بين الأصناف ومستوى الهيدروكينون وكذلك بين مستوى الهيدروكينون ومستوى اليوريا، أعطى الهجين الثلاثى ٣١٠ أعلى عدد حبوب / الكوز حينما عوملت اليوريا بمعدل ٠ ,٣ كجم هيدروكينون حيث كان معدل الإستجابة لهذا الصنف ٦٦ ,٢٥حبة/ الكوز. كانت إستجابة محصول الحبوب / فدان للتسميد باليوريا حتى ١٠٠ كجم ن / فدان حينما عوملت اليوريا بمعدل ٥ ,١ أو ٠ ,٣ كجم

هيدروكينون/ ١٠٠ كجم ن. وبذلك أمكن تحقيق وفر فى كمية النيتروجين المضاف بلغ حوالى ٢٥كجم ن/فدان. وكان أعلى محصول زيت / فدان تم تسجيله عند إضافة ١٢٥كجم ن/فدان والمعاملة بمعدل ٠ , ٣كجم هيدروكينون / ١٠٠ كجم ن. تشير النتائج إلى وجود إرتباط موجب ومعنوى بين محصول الحبوب / فدان ومعظم الصفات المدروسة، بينما كان الإرتباط بين محصول الحبوب/فدان ونسبة الزيت سالب ومعنوى. أظهرت نتائج دراسة معامل المرور أن التأثير المباشر لعدد الكيزان/ النبات كان ٠٦ , ١٧% من تباين محصول الحبوب فى حين كان التأثير المباشر لوزن ١٠٠ حبة ١٨ ,١٥% ولعدد الحبوب / الكوز ١١ , ٥% من تباين المحصول. وقد ساهمت التأثيرات المباشرة وغير المباشرة بمقدار ٢٨ , ٩٧% من تباين المحصول. باستخدام تحليل الانحدار لبيان مدى إستجابة محصول الحبوب ومكوناته للتسميد باليوريا وجد أن هناك إمكانية لزيادة محصول الحبوب عن طريق تقسيم كمية السماد النيتروجينى المناسبة لكى تكون أكثر فعالية فى زيادة وزن ١٠٠ حبة.

توصى الدراسة من خلال النتائج المتحصل عليها بزراعة هجين الذرة الثلاثى ٣١٠ وإضافة ١٠٠ كجم ن / فدان مع معاملة اليوريا قبل إضافتها بالهيدروكينون بمعدل ٥ ,١كجم وذلك حتى يمكن تحقيق ٢٥كجم / فدان انخفاض فى النيتروجين المضاف تحت ظروف الأراضى الرملية الطميية بمحافظة الشرقية.