Nitrogen Rates and Hybrids Influence as Affected on Maize (*Zea mays* L.) Silage Yield and Quality

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ABSTRACT

A field experiment was conducted in 2008 and 2009 summer seasons to evaluate six maize hybrids; namely, SC124, SC155, TWC310, TWC324, TWC327 and TWC352, under three nitrogen rates; viz., 90, 135 and 180 kg N fa^{-1}, for their silage yield and quality. The results showed that nitrogen had a significant effect on mean squares for fresh and dry silage yields, crude protein and digestible crude protein. Also, hybrids had a significant effect on mean squares for all studied traits, except for crude fiber and total digestible nutrient. Hybrids significantly yielded more fresh silage of 2.86 and 4.81 tons fa^{-1} at 135 and 180 kg N fa^{-1}, compared with 90 kg N fa-1. Silage dry matter yield, under 135 and 180 kg N fa^{-1}, gave 0.94 and 1.56 tons fa^{-1} more than that under 90 kg N fa^{-1}. Nitrogen rates of 135 and 180 kg fa^{-1} produced crude protein of 0.49 and 1.4 % more than 90 kg N fa^{-1}. Hybrids significantly differed for all studied traits, except for crude fiber and total digestible nutrients. Fresh silage yield ranged from 23.21 to 28.34 ton fa^{-1}, where, hybrid ranks were TWC324 ≥ TWC327 ≥ TWC310 ≥ TWC352 ≥ SC124 ≥ SC155. Silage dry matter yield ranged from 8.09 to 9.74 ton fa^{-1}. Hybrids significantly varied for their dry matter yield, where TWC324 ≥ TWC310 ≥ TWC327 ≥ SC155 ≥ TWC352 ≥ SC124. For crude protein, TWC327 was the best, followed by TWC324, then, TWC310. Mean of crude fiber ranged from 21.71 to 23.38 %, where TWC310 had the lowest mean. Significant positive correlation was found for FSY with DMY (0.90), CP and DCP (0.83). Significant positive correlation was detected for CP with DCP (0.99). Crude fiber (CF) had a negative correlation with FSY, DM, CP, DCP and TDN. Also, ASH had a negative correlation with FSY, DM, CP, DCP and TDN. Finally, nitrogen affected fresh silage yield, silage dry matter yield, crude protein and digestible crude protein. TWC324, TWC327 and TWC310 hybrids had the highest fresh silage yield, silage dry matter yield, crude protein and digestible crude protein. Accordingly, these hybrids might be used for high silage production.

Key words: maize, corn, silage, dry matter, crude protein, crude fiber, ash.

Abbreviation: SC, Single-cross hybrid; TWC, Three-way cross hybrid; FSY, Fresh silage yield; DMY, Silage dry matter yield; CP, Crude protein; DCP, Digestible crude protein; CF, Crude fiber; TDN, Total digestible nutrient..

INTRODUCTION

Whole-plant maize silage continues to be a major forage in the world dairy industry (Johnson *et al.*, 1999). Until recently, it was, generally, accepted that the characteristics of a good silage hybrid were those of a good grain hybrid, based on the assumption that silage nutritive value was determined by the grain component (Andrews *et al.*, 2000; Bagg, 2001). The favor characters of dual-purpose hybrids were summarized to be leafy, lower ear placement, greater total leaf area and areas above the ear node (Subedi and Ma, 2005), which contributed to a large amount of the silage dry matter with greater total digestability (Dwyer *et al.*, 1998).

Nitrogen fertilization affects maize dry matter (DM) production by influencing leaf area development, leaf area maintenance and photosynthetic efficiency of the leaf area (Muchow and Davis, 1988). O'Leary and Rehm (1990) reported that corn DM yields linearly increased, at three sites, and curvinearly at five sites with inconsistent corn silage quality responses to N rates. Cox *et al.*, (1993) reported that maximum economic DM yields for corn occurred at a rate of about 150 kg N ha^{-1}. Corn silage quality, however, increased as N rates increased from zero to 200 kg ha^{-1} (Cox, 1994). Unfortunately, higher N rates resulted in increased residual soil NO_3-N concentrations. Cox *et al.* (1993) found that corn silage producers might balance potential benefits of high DM yield and improved corn silage quality with the potential risk of increased residual soil NO_3-N concentrations when considering N management.

Hybrid selection is a key for improving forage quality for optimum animal output. Historically, there has been a significant genetic variability for forage quality among maize hybrids. Most differences in maize silage and digestibility were considered to be related to hybrids maturity differences (Kuehn *et al.*, 1999). Several studies had identified differences among hybrids as whole plant yield and grain yield. Laboratory analyses of whole maize plants showed that maize hybrids differed in crude protein (CP) and crude fiber (CF).

The objectives of the present study were to: *(I)* determine the effect of nitrogen rates on maize silage yield and quality, *(ii)* evaluate six maize hybrids under three nitrogen rates and *(iii)* describe the relationship among different traits.

MATERIALS AND METHODS

A field experiment was conducted in 2008 and 2009 summer seasons on calcareous soil and surface irrigation at Nubaria Agricultural Research Station, FCRI, ARC, Egypt. The experimental design was a randomized complete block in a split-plot arrangement with four replicates. Main plots were three nitrogen levels; i.e., 90, 135 and 180 kg fa^{-1}.While, the sub-plots were six maize hybrids; i.e., SC124, SC155, TWC310, TWC324, TWC327 and TWC352. Nitrogen fertilizer was ammonium nitrate, surface applied at 25 and 40 days after planting. All other cultural practices were carried out as commonly followed in Nubaria region.Soil main physical and chemical characteristics had determined, according to the methods described by Page *et al.*, (1982) and were presented in Table (1).

Sub-plots (four rows) were thinned to final plant densities of 26000 plants fa^{-1} at about 25 days after sowing. The two center row plants were cut at soil surface in both years at the one-third to one-half of milk-ripe stage, which corresponded to about 350 kg^{-1} DM in all sub-plots to determine fresh silage and dry matter yields. Five plants were randomly selected at cut time from each sub-plot to estimate DM concentration and forage quality characteristics. The remaining plants, in the harvest area, were weighed and discarded. Samples were dried at 60°c in a forced-air dryer to a constant moisture. Samples were, then, passed through a splitter, reduced to 50 g in weight. Samples (0.5g) were analyzed by wet chemistry for whole-plant crude fiber (CF), according to procedures, described by Van Soest *et al.* (1991) and Kjeldahl N (x 6.25 = CP). Digestible crude protein (DCP) and total digestible nutrients (TDN) were calculated, according to the equations of Church (1979), as follows:

DCP = CP x 0.929 – 3.48; TDN = 72.1 – (CF x 0.34). Organic matter (OM %) was calculated as: OM = 100 – ash.

Data were analyzed for fresh silage yield (weight of whole green plants, in tons fa^{-1}), dry matter yield (weight of whole dry plants, in tons fa^{-1}), crude protein (%), digestible crude protein (%), crude fiber (%), total digestible nutrients (%), organic matter (%) and total ash (%).

Since, hybrids were considered fixed, whereas, replicates and years were considered random, a mixed model was used to analyze the data with general linear model (GLM) procedures, using the SAS Statistical Software Package (SAS Program, release 9.1, 2003). Homogeneity of error variances was tested for the two years, using Bartlett's test, according to Steel and Torrie (1980). Homogeneity variances were detected. Hence, a combined analysis was run for the studied traits across the two years. Because significant year x treatment interactions were not observed for most measurements, a combined analysis was performed across both years. Mean separation among treatments and interactions, involving hybrids and nitrogen rates, were obtained by using the LSD test when significant F-test ($P \geq 0.05$) were observed. Regression analysis examined the relationship among dependent variables and nitrogen rates, using PROC GLM model of SAS Statistical Software Package. Correlation relationships among variables were calculated, using PROC CORR procedures of SAS Statistical software. Effects were considered significant in al statistical calculations for p-values < 0.05.

RESULTS AND DISCUSSION

Analysis of variance:

Years had insignificant mean squares for crude fiber, total digestible nutrients, organic matter and total ash (Table 2). On the other hand, years had significant mean squares for the other studied traits. Nitrogen rates significantly affected fresh silage yield, silage dry matter yield, crude protein and digestible crude protein (Table 2). Hybrids gave significant values of mean squares for all studied traits, except for crude fiber and total digestible nutrients. Hybrids interaction effects, with both years and nitrogen rates, were not significant for the studied traits. The Y x N x H interaction significantly affected all studied traits, except for organic matter (%) and total ash (%) (Table 2).

Table 1: The main chemical and physical characteristics of the experimental soil at Nubaria Agriculture Research Station in 2008 and 2009 seasons.

Characters	Value
Soil pH*	8.2
E.C. $dS\ m^{-1}$**	2.44
Water soluble anions (meg/l):	
CO_3^{2-}	0.0
HCO_3^-	5.0
$CaCO_3$ (%)	27.4
Organic matter (%)	0.4
Mechanical analysis:	
Sand (%)	64.6
Silt (%)	12.5
Clay (%)	22.9
Soil texture	Sandy clay loam

* Measured in 1:2.5 soil suspension.
** Measured in water extracted from saturated soil past

Table 2: Mean squares from the combined analysis of the studied characters for three nitrogen rates and six maize hybrids evaluated at Nubaria during 2008 and 2009 seasons.

Source of variance	DF	Fresh silage yield	Silage dry matter yield	Crude protein	Digestible crude protein
		(Ton fa^{-1})		(%)	
Years (Y)	1	434.30**	100.17**	1.19**	1.02**
Reps / Years	6	10.73	1.23	0.05	0.04
Nitrogen rates (N)	2	280.60*	29.72*	24.12**	20.81**
Y x N	2	7.94	0.48	0.24	0.21
Error (a)	12	2.79	0.66	0.17	0.14
Hybrids (H)	5	99.67**	12.79**	7.27*	6.27*
Y x H	5	2.77	1.01	1.01	0.87
N x H	10	3.79	1.62	0.52	0.45
Y x N x H	10	7.70**	1.36*	1.53**	1.32**
Error (b)	90	2.75	0.58	0.17	0.15
C.V.		6.44	8.63	5.35	10.27
Source of variance	**DF**	**Crud fiber**	**Total digestible nutrients**	**Organic matter**	**Total ash**
			(%)		
Years (Y)	1	7.56	0.87	1.33	1.34
Reps / Years	6	9.96	1.15	0.44	0.44
Nitrogen rates (N)	2	1.66	0.19	1.07	1.07
Y x N	2	22.48*	2.59*	0.56	0.56
Error (a)	12	4.76	0.55	0.32	0.32
Hybrids (H)	5	7.69	0.89	12.11**	12.11**
Y x H	5	16.90	1.95	0.43	0.43
N x H	10	14.13	1.63	0.11	0.11
Y x N x H	10	12.05**	1.39**	0.53	0.53
Error (b)	90	3.70	0.42	0.29	0.29
C.V.		8.45	1.01	1.00	9.19

*, ** Significant at 0.05 and 0.01levels of probability respectively.

1. Effect of nitrogen rates:

When averaged across years and hybrids, nitrogen applied at 90 kg fa^{-1} gave a significant lower fresh silage yield (23.23 tons fa^{-1}), while, nitrogen rates of 135 or 180 kg fa^{-1} gave a significantly higher value of 26.9 or 28.04 tons fa^{-1}. Generally, hybrids significantly yielded more 2.86 or 4.81 tons fa^{-1} at 135 and 180 kg N fa^{-1}, compared to 90 kg N fa^{-1} (Table 3).

As for dry matter yield, nitrogen rates at 135 and 180 kg fa^{-1} gave 8.95 and 9.57 tons fa^{-1}, compared with 8.01ton fa^{-1} at 90 kg N fa^{-1}. Dry matter yield under 135 and 180 kg N fa^{-1}, had a significant value of 0.94 and 1.56 tons fa^{-1} more than that at 90 kg fa^{-1}. These results are in a good agreement with findings reported by Fransen (2004). Some studies reported that dry matter yield would level off after 650 g kg^{-1} moisture (Wiersma *et al.,* 1993).

Crude protein had previously been shown to decline with increasing maturities (Sheperd and Kung, Jr. 1996). Crude protein percentage was significantly affected by nitrogen and Y x H x H interaction (Table 2). Mean of crude protein, at 90 kg N fa^{-1}, was 7.18 and 7.67 %, for 135 kg N fa^{-1}, while, 180 kg N fa^{-1} gave 8.58 % crude protein (Table 3). Nitrogen rates of 135 and 180 kg fa^{-1} had 0.49 and 1.4 % more crude protein than 90 kg N fa^{-1}. Also, 180 kg N fa^{-1} had 0.91 % more than 135 kg N fa^{-1} (Table 3).

Nitrogen rates significantly affected digestible crude protein, as shown by Y x N x H interactions (Table 2). The same trend of nitrogen rates on crude protein was observed on digestible crude protein, where the 180 kg N fa-1 ha gave the highest mean of DCP (4.49), followed by 3.65 of 135 kg N fa^{-1}, then, 3.19 for 90 kg N fa^{-1} (Table 3).

Nitrogen rates affected crude fibers and total digestible nutrients, as given by YxNxH interactions (Table 2). Nitrogen rates did not significantly affect organic matter and total ash (Table 2). Also, the interaction of nitrogen did not exist.

II. Effect of hybrids:

Hybrids were significantly different for all studied traits, except for crude fibers, total digestible nutrients and plant height (Table 2). Hybrid interactions with years and nitrogen rates varied for the studied traits, where, H x N and H x Y were insignificant, except for N x H, for plant height. Many studies had reported differences among hybrids for whole-plant silage yield and quality (Denium, 1988; Cox, 1994).

Mean of fresh silage yield ranged from 23.21 (SC.155) to 28.34 (TWC.324) tons fa^{-1}. Generally, three-way cross hybrids had fresh silage yield that was significantly more than single-cross hybrids. The rank of the tested hybrids, for fresh silage yield, was TWC324 ≥ TWC327 ≥ TWC310 ≥TWC352 ≥ SC124 ≥ SC155 (Table 3).

Silage dry matter yield, across two years, ranged from 8.09 (SC124) to 9.74 (TWC324) tons fa^{-1} (Table 3). Hybrids significantly varied for their dry matter yield and were arranged as follows: TWC324 ≥ TWC310 ≥ TWC327 ≥ SC155 ≥ TWC352 ≥ SC124 (Table 3). Differences in fresh silage and silage dry matter yield, among hybrids, might be attributed to genetic variability. These results agreed with those obtained by Joanning *et al.* (1981). Bendary *et al.*, (2001) and Kravchenko *et al.* (2005) who mentioned that crop yield was highly variable across field as a result of complex interactions among different, factors such as topography, soil properties and the prevailing weather conditions during the growing season and management practices.

Table 3: Means of the studied characters for three nitrogen rates and six maize hybrids across 2008 and 2009 years.

		Fresh silage yield	Silage dry matter yield	Crude protein	Digestible crude protein
		(Ton fa^{-1})		(%)	
Nitrogen rates:	90	23.23 b[(1)]	8.01 c	7.18 c	3.19 c
	135	26.09 a	8.95 b	7.67 b	3.65 b
	180	28.04 a	9.57 a	8.58 a	4.49 a
$LSD_{(0.05)}$		2.40	0.60	0.43	0.40
Hybrids:					
SC.124		23.83 d	8.09 b	7.29 c	3.29 c
SC.155		23.21 d	8.32 b	7.33 c	3.33 c
TWC.310		26.83 b	9.53 a	7.94 abc	3.89 abc
TWC.324		28.34 a	9.74 a	8.19 ab	4.13 ab
TWC.327		26.97 b	9.20 a	8.67 a	4.57 a
TWC.352		25.31 c	8.19 b	7.47 bc	3.46 bc
$LSD_{(0.05)}$		1.23	0.74	0.75	0.69
		Crude fiber	**Total digestible nutrients**	**Organic matter**	**Total ash**
			(%)		
Nitrogen rates:	90	22.99	64.28	93.90	6.09
	135	22.64	64.39	94.05	5.94
	180	22.69	64.38	94.20	5.79
$LSD_{(0.05)}$		ns	ns	ns	ns
Hybrids:					
SC.124		22.72	64.37	94.39 a	5.60 b
SC.155		23.38	64.15	93.07 b	6.92 a
TWC.310		21.71	64.32	94.47 a	5.52 b
TWC.324		22.86	64.72	94.59 a	5.40 b
TWC.327		22.95	64.29	94.57 a	5.42 b
TWC.352		23.03	64.27	93.21 b	6.78 a
$LSD_{(0.05)}$		ns	ns	0.48	0.48

(1) Means had the same letter (s) did not significantly differ.
ns: Not significant.

Year x nitrogen x hybrid interaction was significantly different for all studied traits, except for organic matter and total ash. These results reflected that performance of hybrids was different from year to year and from nitrogen rate to another. Fresh silage yield of hybrids ranged from 23.21 to 28.34 ton fa^{-1} over years. In 2008, TWC324 had the highest fresh silage yield, followed by TWC310 and TWC327 at 135 kg N ha^{-1}, while, at 180 kg N ha^{-1}, TWC324 was the best, followed by TWC327 and TWC310 (Fig 1A). In addition, TWC310 was the highest hybrid, followed by TWC324 and TWC327 at 135 kg N ha^{-1} in 2009, although TWC324 was the best at 180 kg N ha^{-1}, then, TWC310 and TWC327 (Fig 1B).

TWC324 was the highest for dry matter yield at 135 kg N ha^{-1}, followed by TWC310 and TWC327, in 2008 (Fig 1A), while, at 180 kg N ha^{-1}, TWC324 ranked first, then, TWC327 and TWC310. In 2009, the same trend was detected at 135 and 180 kg N ha^{-1}, where, TWC310 had the highest mean dry matter yield, followed by TWC324 and TWC327, respectively (Fig 1B).

For crude protein, TWC327 ranked first and had the highest mean (8.67 g kg^{-1}), followed by TWC324, then TWC310. TWC352, SC155 and SC124 Hybrids had the lowest values of crude protein (7.47, 7.33 and 7.29 g kg^{-1}), respectively (Table 3).

The same trend of hybrid crude protein was observed for digestible crude protein (DCP), where, TWC327 ranked first (4.57 g kg^{-1}), followed by TWC324 (4.13 g kg^{-1}), TWC310 (3.89 g kg^{1}), then, TWC352, SC155 and SC124 (Table 3). The differences in DCP might be due to differences in quantity and quality of crude protein in the tested hybrids. Although maize is mainly considered a source of carbohydrate, it is, also, an important protein source because of its considerable total protein yield per faddan, which may produce higher yield potential due to the continued high crop growth rate around flowering (Uribelarrea *et al.*, 2004).

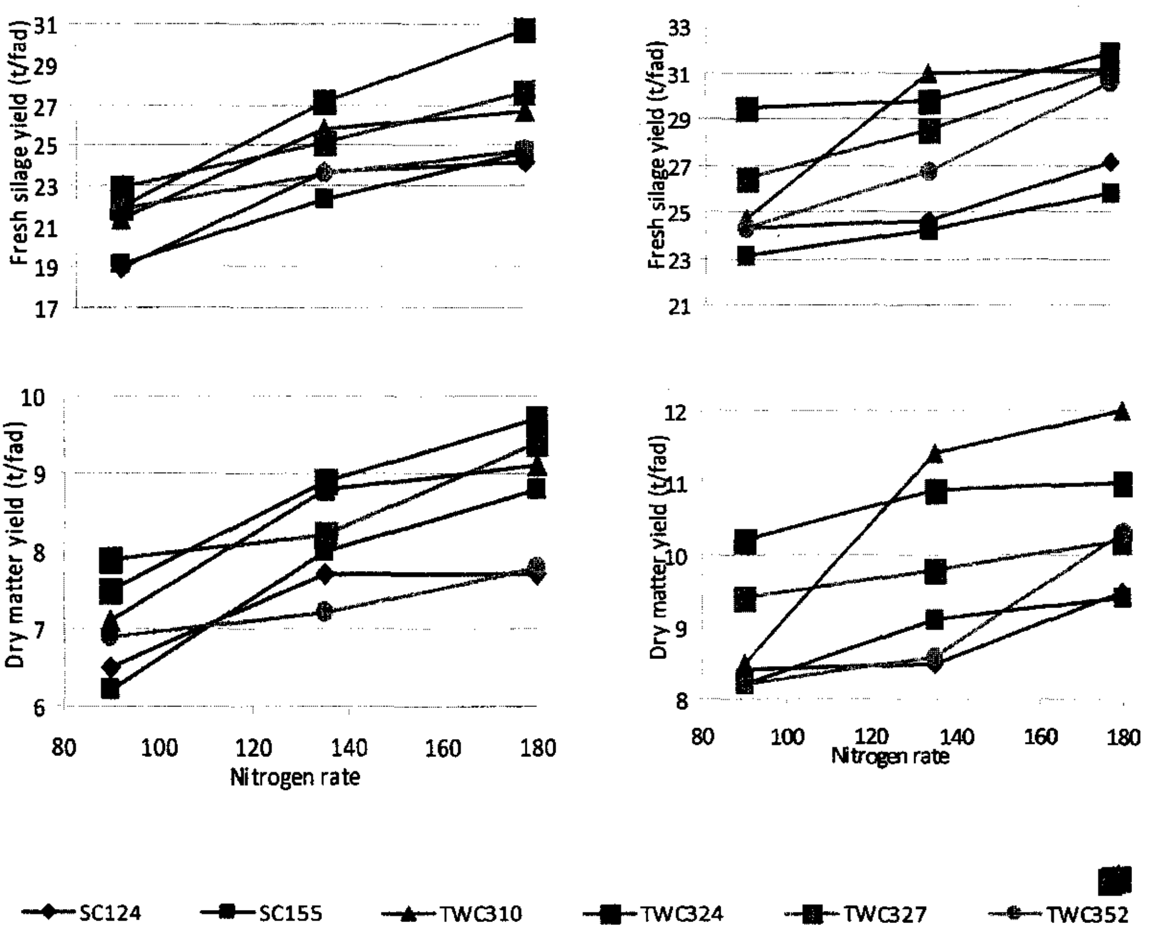

Fig. 1: Effect of nitrogen rates on fresh silage and dry matter yields of six maize hybrids evaluated at 2008 (A) and 2009 (B) seasons.

Table 4: Phenotypic correlation coefficients for the studied traits (n=18) of three nitrogen rates and six maize hybrids over 2008 and 2009.

	FSY	DMY	CP	DCP	CF	TDN	ASH	OM
DMY	0.90**	1.00						
CP	0.83**	0.79**	1.00					
DCP	0.83**	0.79**	0.99**	1.00				
CF	-0.40	-0.50	-0.19	-0.19	1.00			
TDN	0.70**	0.61**	0.37	0.37	-0.16	1.00		
ASH	-0.66**	-0.68**	-0.65**	-0.65**	0.56*	-0.62**	1.00	
OM	0.66**	0.68**	0.65**	0.65**	-0.56*	0.62**	-1.00	1.00

*,** Significant at 0.05 and 0.01 level of probability, respectively

Mean of crude fiber, for the evaluated hybrids, ranged from 21.71 to 23.38 % (Table 3). All the tested hybrids were located in one group (high value), except for TWC310, which was in another group and had the lowest crude fiber (21.71%). Hybrids with inherently different concentrations of fiber may not always perform the same in different environments. Cox *et al.* (1994) and Denium (1988) reported that the relative performance of individual hybrids could change with environmental conditions, whereas other experiments reported that hybrids consistently acted across years (Allen *et al.*, 1990).

For total digestible nutrients, differences among hybrids were small, although TWC324 had the highest value and SC155 had the lowest mean (Table 3).

Small differences were observed among hybrids for organic matter, where all hybrids were located at one group, except for SC155 and TWC352 (Table 3). This result agreed with those obtained by Abdel-Gawad *et al* (2009) who found that no significant differences were observed among maize hybrids for organic matter. The same trend of hybrids was detected for total ash, where, SC155 and TWC352 hybrids had the highest values of ash and significantly differed from the other hybrids (Table 3).

Phenotypic correlation among traits:

Highly significant positive correlations were found for FSY with the other studied traits, except for ASH and CF (negative response, Table 4). The same relationship was observed for DMY. Significant positive correlations were detected for CP with DCP and OM. Significant negative values were found for ASH with FSY, DMY, CP, DCP and TDN. The relationships of OM with the other traits were detected for ASH, but in the opposite direction.

CONCLUSIONS

Nitrogen affected fresh silage yield, silage dry matter yield, crude protein and digestible crude protein. TWC324, TWC327 and TWC310 hybrids had the highest fresh silage yield, silage dry matter yield, crude protein and digestible crude protein. Hence, these hybrids might be used for silage production.

REFERENCES

Abdel-Gawad, M.A.S, Hoda Kh.A. El-Makser and M.M.M. Hassan. **2009**. Evaluation of ten maize hybrids for silage yield and quality. J. Agric. Sci. **34**: 3295-3304. Mansoura Univ., Egypt.

Allen, M.S., K.A.A.O' Niel, D.G. Main and J. Beck. **1990.** Variation in fiber fractions and *in vitro* and cell wall digestibility of corn silage hybrids. J. Dairy Sci. 73 (Suppl. 1):129.

Andrews, C.J., L.M. Dwyer, D.W. Stewart, J.A. Dugas and P Bonn. **2000.** Distribution of carbohydrate during grain fill in leafy and normal maize hybrids. Can. J. Plant Sci. **80**:87-95.

Bagg, J. **2001**. Harvesting corn silage at the right moisture. Available at www.omafra.gov.on.ca/english/crops/facts/harvesting_corn.htm (verified 4 Apr. 2006). Ontario Ministry of Agriculture, Food and Rural Affairs, Queen's Park, Ontario, Canda.

Bendary, M.M., C.H.A. Chanem, E.S. Soliman, E.A. Amer and F.A. El-Zeer. **2001.** Nutritional evaluation of ensiling fresh maize stover. Egyptian J. Nutrition and Feeds. 4 (special issue) 105-116.

Cox, W.J. **1994.** Kernel milk ripe stage and corn harvest. Agfocus, Cornel Coop. Ext. Cornell, Ithaca, NY, USA.

Cox, W.J., S. Kalonge, D.J.R. Cherney and

W.S.Reid. **1993**. Growth, yield and quality of forage maize under different nitrogen management practices. Agron. J. **85**:341-347.

Church, D.C. **1979**. Livestock Feeds and Feeding. 4th ed, D & B Books. Ine. Corvailis, Oregon, 97330, USA.

Denium, B. **1988.** Genetics and environmental variation in quality of forage maize in Europe. Neth. J. Agric. Sci. **29**:93-98.

Dwyer, L.M, D.W. Stewart and F. Glenn. **1998.** Silage yields of leafy and normal hybrids. PP.193-216. In: Proc. 53rd Annu. Corn and Sorghum Res. Conf. 1998. Amer. Seed Trade Assoc., Washington, DC, USA.

Fransen, S.C. **2004.** Yield components and quality of silage corn in the Pacific Northwest. PP. 123. *In* S. Bittman and C.G. Kowalenko (ed.) Advanced silage corn management. Pacific Field Corn Assoc., Agassiz, BC, Canada.

Joanning, S.W., D.E. Johnson and B.P. Barry. **1981.** Nutrient digestibility depression in corn silage, and corn grain mixtures feed to stress. J. Anim. Sci. **53**:1095-

Johnson, L., J.H. Harrison, C. Hunt, K. Shinners, C.G. Doggett and D. Sapienza. **1999.** Nutritive value of corn silage as affected by maturity and mechanical processing: A contemporary review. J. Dairy Sci. **82**:2813-2825.

Kravchenko, A.N., G.P. Robertson, K.D. Thelen and R.R. Harwood. **2005.** Management topographical and water effects on spatial variability of corn grain yields. Agron. J. **97**:514-523.

Kuehn, C.S., J.G .Linn, D.G. Johnson, H.G .Jung and M.I. Endres. **1999.** Effects of feeding silage from corn hybrids selected for leafiness or grain to lactating dairy cattle. J. Dairy Sci. **82**:2746-2755.

Muchow, R.C. and R. Davis. **1988.** Effect of nitrogen supply on the comparative productivity of maize and sorghum in a semi-arid tropical environment: II. Radiation interception and biomass accumulation. Field Crops Res. **18**:17-30.

O'Leary, M.J. and G.W. Rehm. **1990.** Nitrogen and sulfur effects on the yield and quality of corn grown for grain and silage. J. Prod. Agric. **3**:135-140.

Page, A.L., R.H. Miller and D.R. Keeney. **1982.** Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties. Amer. Soc. Agron., Madison, Wisconsin, USA.

SAS Software. **2003.** SAS Program, Version 9.1. SAS Inst., Cary, NC.

Sheperd, A.C. and L. Kung, Jr. **1996.** Effects of an enzyme additive on composition of corn silage ensiled at various stages of maturity. J. Dairy Sci. **79**:1767-1773.

Steel, R.G.D. and J.H. Torrie. **1980.** Principles and Procedures of Statistical and Biometrical Approach. Mc. Graw Hill Book Co. Inc., New York, USA.

Subedi, K.D. and B.L. Ma. **2005.** Ear position, leaf area and contribution of individual leaves to grain yield in conventional and leafy maize hybrids. Crop Sci. **45**:2246-2257.

Uribelarrea, M, F.E. Below and S.P. Moose. **2004.** Grain composition and productivity of maize hybrids derived from the Illinois protein strains in response to variable nitrogen supply. Crop Sci. **44**:1593-1600.

Van Soest, P.J., J.B. Robertson and B.A. Lewis. **1991.** Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci. **74**:3583-3597.

Wiersma, D.W., P.R. Csrter, K.A. Albrecht and J.G. Coors. **1993.** Kernel milk ripe stage and corn forage yield, quality and dry matter content. J. Prod. Agric.**6**: 94-99

الملخص العربى

معدلات النيتروجين وكفاءة الهجن وتأثيرها على محصول سيلاج الذرة الشامية وجودته

أحمد عبدالمنعم حبليزة ، مها جلال بلبع

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أجريت تجربة حقلية فى موسمى صيف ٢٠٠٨ و٢٠٠٩ فى تربة جيرية وتحت نظام الرى السطحى بمحطة بحوث النوبارية لتقييم ستة هجن من الذرة الشامية وهى: - (SC124, SC155, TWC310, TWC324, TWC327 and TWC352) تحت ثلاثة معدلات من التسميد النيتروجينى وهى: ٩٠ و١٣٥و١٨٠ كجم نيتروجين / فدان لتحديد محصول سيلاج هذه الهجن وجودته.

تتلخص النتائج المتحصل عليها فيما يلى:

- كان تأثير التسميد النيتروجينى معنويا للوزن الطازج لمحصول السيلاج والوزن الجاف لمحصول السيلاج ومحتوى البروتين وكذلك البروتين المهضوم . كما أن تأثير الهجن كان معنويا لكل الصفات تحت الدراسة عدا الألياف الخام والمواد الكلية المهضومة .
- زاد محصول السيلاج الطازج بمقدار ٢,٨٦ و٤,٨١ طن / فدان تحت معدلى التسميد "١٣٥ و١٨٠" كجم N / فدان مقارنة بمعدل ٩٠ كجم N / فدان. وزاد محصول السيلاج الجاف بمقدار ٠,٩٤و١,٥٦ طن / فدان تحت معدلى التسميد " ١٣٥ و١٨٠ كجم N / فدان" مقارنة بمعدل "٩٠ كجم N / فدان".
- أعطى معدلى التسميد النيتروجينى "١٣٥ و١٨٠ كجم / فدان" زيـــادة فى البروتين الخام بحوالى ١,٤٠ و٠,٤٩% مقارنة بالتسميد بمعدل "٩٠ كجم N / فدان".
- كانت هناك اختلافات معنوية بين الهجن تحت الدراسة لصفة محصول السيلاج الطازج وتراوح متوسط محصولها من ٢٣,٢١ إلى ٢٨,٣٤ طن / فدان ، وكان ترتيب الهجن تبعا لمحصول السيلاج الطازج كما يلى:
- TWC324 > TWC327 ≥ TWC310 > TWC352 > SC124 ≥ SC155
- تراوح محصول السيلاج الجاف من ٨,٠٩ إلى ٩,٧٤ طن / فدان ، وكان ترتيب الهجن تبعا لمحصول السيلاج الجاف كما يلى: TWC324 ≥ TWC310 ≥ TWC327 □ SC155 ≥ TWC352 ≥ SC124 .
- أعطى الهجين "TWC327" أعلى نسبة فى البروتين الخام (٨,٦٧ %) يلية الهجين " TWC324" ثم الهجين "TWC.310". كما أعطى الهجين "TWC.310" أقل القيم فى محتوى الألياف الخام (٢١,٧١ %) ، بينما أعطى الهجينين " TWC352 & SC155" أعلى القيم فى محتواهما من الرماد.
- أظهرت النتائج وجود علاقة ارتباط معنوية موجبة بين محصول السيلاج الطازج وكل من محصول السيلاج الجاف والبروتين الخام والبروتين المهضوم. كما ظهرت علاقة ارتباط موجبة معنوية بين البروتين الخام والبروتين المهضوم. كما أعطت نسبة الألياف الخام علاقة ارتباط سالبة مع كل من محصول السيلاج الطازج والجاف والبروتين الخام والبروتين المهضوم والمواد الكلية المهضومة. كذلك أعطت قيم الرماد علاقة تلازم سالبة مع كل من محصول السيلاج الطازج والجاف والبروتين الخام والبروتين المهضوم والمواد الكلية المهضومة.

أظهرت هذه الدراسة أن زيادة التسميد النيتروجينى حتى ١٨٠ كجم N / فدان أدت إلى زيادة فـــى محـــصول الـــسيلاج الطازج ومحصول السيلاج الجاف وكمية البروتين الخـــام والبـــروتين المهـــضوم. كانـــت الهجـــن TWC324", TWC327, TWC310" هى أفضل الهجن فى محصول السيلاج الطازج والسيلاج الجاف وكمية البروتين الخام والبروتين المهضوم ممـــا يؤكد أنه يمكن زراعة هذه الهجن لإنتاج سيلاج عالى المحصول.