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Research paper

Effect of Different Nitrogen Levels on Some Quality Characters of Three Maize (*Zea mays* L.) Cultivars Under Northern State Conditions

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ABSTRACT

This study aimed to compare the use of different nitrogen levels on some quality characters of three maize cultivars namely Hudeiba-1, Hudeiba-2 and Balady. A split plot arrangement in randomized complete block design with four replications was used to compare some quality characters of three maize cultivars receiving four levels of nitrogen. The three maize cultivars (Balady, Hudeiba-1 and Hudeiba-2) were assigned to the main plot, whereas the four levels of nitrogen (0, 43, 86 and 129 Kg/ha) were assigned to the sub plot. The experiment was conducted during two consecutive summer seasons 2013/14 and 2014/15 at the demonstration farm of the Faculty of Agricultural Sciences–University of Dongola–Sudan (Latitude 19˚ 11˝ N and Longitude 30˚ 29˝ E and altitude 227 m ASL). The results revealed that increase in nitrogen level had a highly significant effect on both crude protein and crude fibre content in both seasons. Application of 129 kg N/ha gave 1 and 6% significantly greater crude protein content over control in both seasons, whereas the increase in crude fiber was 1 and 13%. Also, differences among maize cultivars was significant for crude protein and crude fibre contents in both seasons. Interaction between nitrogen levels and maize cultivars gave significant differences in crude protein and crude fibre content in the first season.

Key Words: Crude fibre, crude protein, cultivars, nitrogen levels, maize.

تأثير السماد النيتروجيني علي بعض صفات الجودة لثلاثة أصناف من الذرة الشامية تحت ظروف الولاية الشمالية

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هدفت هذه الدراسة إلي مقارنة استخدام مستويات مختلفة من السماد النيتروجيني علي بعض صفات الجودة لثلاثة أصناف من الذرة الشامية هي: البلدى، حديبة-1 وحديبة-2. تم استخدام تصميم القطع المنشقة بتصميم القطاعات العشوائية الكاملة بأربعة مكررات وذلك لمقارنة بعض صفات الجودة لثلاثة أصناف من الذرة الشامية (البلدي وحديبة -1 وحديبة-2) في أربعة مستويات من السماد النيتروجيني (0، 43، 86 و129 كجم/هكتار). أجريت التجربة خلال المواسم الصيفية 2014/13 و 2015/14 المتتالية بالمزرعة التجريبية- كلية العلوم الزراعية- جامعة دنقلا- السودان. أوضحت النتائج أن زيادة الجرعة من السماد النيتروجيني كان لها تأثير معنوي علي محتوي البروتين ومحتوي الألياف في كلا الموسمين. حيث أعطي إضافة 129 كجم نتروجين زيادة في محتوي البروتين 1% و 6 % مقارنة بالشاهد بينما كانت الزيادة في محتوي الألياف 1% و 13% في كلا الموسمين. ايضا كان هنالك اختلاف معنوي بين أصناف الذرة الشامية في محتوي البروتين ومحتوي الألياف في كلا الموسمين. التداخل بين السماد النيتروجيني وأصناف الذرة الشامية كان معنويا خلال الموسم الأول.

Introduction

Maize also known as Corn (*Zea mays* L.) is a grain crop that belongs to the family *Poaceae*. The origin of this grain remains unknown, however, many historians believe that maize was first domesticated in Mexico's Tehuacan valley, then introduced to Africa by the Portuguese in the sixteenth century and has become Africa's most important staple food crop (FAO, 2005). Maize is the most important cereal crop in the world after wheat and rice. It has great yield potential and attained the leading position among cereal based on production as well as productivity and that is why it is called "queen of cereals" (Turi *et al.*, 2007). Maize is multipurpose crop, provides food for human, feed for animals and poultry, and fodder for livestock. It is rich source of raw materials for industry. Also, maize is an important source of calories and protein in human lives in many countries of the world and is the main staple food in Africa particularly in eastern Africa (Salami *et al*., 2007). The top ten maize producers in 2016/2017 (in million metric tons) were United States of America (385), China (219,5), Brazil (91,5), Argentina (37,5), Ukraine (28), India (26), Russia (15,5), South Africa(14,6), Canada (13,2) and Indonesia (10,2) (FAOSTAT, 2017). In Sudan (117 in the world ranking) maize "*Aish El reef*" is considered a minor crop and is normally grown in Kordofan and Darfur or in small irrigated areas in the Northern States. In Sudan there is strong desire that, in years to come, maize production will be a real revolution in agriculture, therefore any research work on maize production will be of paramount importance (Mukhtar, 2006). In the Northern State of Sudan farmers usually concentrate their efforts on the cultivation of winter crops: wheat and faba bean only, while during summer season few areas are cultivated and a large areas are left without cultivation- these areas can be used in farming maize for the use as grains and or green fodder. Maize is nitro positive and needs ample quantity of nitrogen to attain high yield. Nitrogen deficiency is a key factor for limiting maize yields (Alvarez and Grigera, 2005). Low yield of maize can be attributed to many constraints but nitrogen fertilizer application is one of the major factors (Witt *et al*., 2008). It is, therefore, imperative to use an optimum amount of nitrogen through a suitable and efficient source. Therefore, this study was conducted to investigate the effects of using different nitrogen levels on some quality characters namely crude protein and crude fibre content of three maize cultivars grown under Northern state conditions.

Materials and Methods

Experimental site

Three open pollinated cultivars of maize namely; Local variety (Balady), Hudeiba-1 and Hudeiba-2 (open-pollinated varieties improved by Agricultural Research Corporation (ARC) were grown under four nitrogenous fertilizer levels (0, 43, 86 and 129 kg/ha) at Demonstration Farm of the Faculty of Agricultural Sciences, University of Dongola- El Seleim Northern state of the Sudan for two consecutive summer seasons (2013/14 and 2014/15). The Northern State occupies the distant northern part of the Sudan and is within the desert region of the Sudan which has extremely high

temperature and radiation in summer and low temperature in winter. In general in Dongola rainfall is scarce and wind prevails from the north.

Experimental design and treatment

A Split plot arrangement in randomized complete block design with four replications was used to execute the experiment, where the three cultivars (V1, V2 and V3) assigned to the main plots and the four nitrogen levels to the sub plots. Nitrogen levels used for the treatment were notified as N0, N1, N2 and N3, respectively.

Plant materials and characters

Each Cultivar (Hudeiba-1 =V1, Hudeiba-2= V3 and the local variety=V2) was grown in four ridges 3meters long in both seasons at a seed rate of 37.5kg/ha with spacing 20 and 70 cm for intra and inter row spacing, respectively. Three to four seeds were sown per hole and then thinned to one plant per whole three weeks after sowing in both seasons. The irrigation was applied at an interval of 10 to 12 days. In each season hand weeding was carried out once. Seeds crude protein and crude fibre contents were determined following the standard methods of the Association of Official American Analytical Chemists (AOAC, 1990). The organic nitrogen content was determined using the micro-Kjeldahl method, and an estimate of the crude protein content was estimated by multiplying the organic nitrogen content by a factor of 6.25% (Sosulski and Imafidon, 1990). Two different samples were analyzed in triplicate. The data in each season were subjected to standard procedure of analysis of variance (ANOVA) and then means were separated using Least Significant Difference (LSD) test according to Gomez and Gomez (1984) using MSTATC software.

Results and Discussion

Effect of nitrogen levels on quality characters

Nitrogen caused highly significant differences (Table 1) in crude protein and crude fibre content in both seasons. The data which is presented in table-2 showed that application of 129 kg N-ha gave 1 and 6% significantly greater crude protein content over control, whereas the increase in crude fiber content was 1 and 13% in both seasons. The increase in crude protein due to nitrogen can be attributed to the fact that nitrogen often plays a great role in the synthesis of protein. Similar results were obtained by Ayub *et al*. (2003), Almodares *et al*. (2009), Nadeem *et al*. (2009) and Reddy and Bhanumurty (2010) who all found the same results. Additionally, nitrogen significantly affected crude fibre content in both seasons. Considering crude fibre, similar result was reported by Ayub *et al*. (2003) who indicated that higher nitrogen application significantly increased crude fibre.

Table 1: F-values for crude protein and crude fibre contents of three maize cultivars during the summer season 2013/2014 and 2014/2015

Characters	Nitrogen levels		Maize cultivars		Nitrogen and maize cultivars interaction	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Crude protein (%)	27.03**	42.78**	15.56*	7.45*	5.90*	0.63 n.s
Crude fibre (%)	34.67**	46.53**	9.11*	3.14 *	3.14 *	1.63 n.s

*significant at 5% level, ** significant at 1% level, ns: non- significant at 5% level

Table 2: Effect of nitrogen levels on some quality of three maize cultivars during the summer seasons of 2013/2014 and 2014/2015

Treatment	Crude protein (%)		Crude fibre (%)	
	2nd season	1st season	2nd season	1st season
N0	10.23d	10.88d	4.08 d	3.60c
N1	10.31 c	11.20c	4.10 c	3.94b
N2	10.23 b	11.47b	4.12 b	4.05a
N3	10.35 a	11.61a	4.14 a	4.14a
Overall mean	**10.31**	**11.29**	**4.11**	**4.48**
LSD	00.02	00.14	0.10	0.09
SE±	00.04	00.04	0.06	0.03
C.V%	01.93	02.15	3.57	4.32

Means within column followed by the same letter (s) were not significantly different according to LSD test at 5% level.

Performance of cultivars in quality characters

Table-3 shows that cultivars differ significantly in crude protein and crude fibre content in both seasons. This result was in line with that reported by Ayub *et al*. (2003), Altin and Hunter (1984) they found significant differences in crude protein and crude fibre content between maize cultivars. In contrast, Ayub *et al*. (2001) reported that maize cultivars did not differ significantly in crude protein and crude fibre content. This could probably be attributed to narrow genetic base of the material used in this experiment. The interaction of nitrogen levels and maize cultivars which is presented in Table (4) showed significant differences in crude protein and crude fibre content in the first season. This reflected differential response of maize cultivars to nitrogen fertilization.

Table 3: Performance of maize cultivars in some quality characters of during the summer seasons of 2013/2014 and 2014/2015

Treatment	Crude protein (%)		Crude fibre (%)	
	2nd season	1st season	2nd season	1st season
V1	10.33 a	10.73c	3.99 a	3.56b
V2	10.19 b	11.42b	3.77 b	4.10a
V3	10.38 a	11.70a	4.07 a	4.13a
Overall mean	**10.30**	**11.28**	**3.94**	**3.93**
LSD	00.15	00.18	00.10	0.24
SE±	00.14	00.46	0.72	0.06
C.V%	01.93	02.15	3.57	4.32

Means within column followed by the same letter (s) were not significant different according LSD test at 5%level.

Table 4: Interaction between nitrogen levels and cultivars on some quality characters of maize during the summer seasons 2013/2014 and 2014/2015

Treatment	Crude protein (%)		Crude fibre (%)	
	2nd season	1st season	2nd season	1st season
V1× N0	10.38ab	10.29a	3.98d	3.19a
V1× N1	10.36ab	10.74a	3.99cd	3.67a
V1× N2	10.31abc	10.93a	4.01cd	3.68a
V1× N3	10.27abc	10.98a	3.99cd	3.70a
V2× N0	10.17bc	11.04a	4.33a	3.73a
V2× N1	10.29abc	11.26a	4.30ab	4.06a
V2× N2	10.09c	11.63a	4.28ab	4.25ba
V2× N3	10.23abc	11.78a	4.16bc	4.38a
V3× N0	10.45a	11.31a	4.00cd	4.88a
V3× N1	10.40ab	11.59a	4.12cd	4.09a
V3× N2	10.28abc	11.85a	4.06cd	4.23a
V3× N3	10.42a	12.07a	4.10cd	4.33a
Overall mean	**10.30**	**11.29**	**4.11**	**4.02**
LSD	00.20	01.44	0.29	0.98
SE±	00.07	00.05	0.10	0.06
C.V%	01.93	02.15	3.57	4.32

Means within column followed by the same letter(s) were not significant different according to LSD test at 5% level.

Conclusion

The result of this study indicated that increase in nitrogen levels led to increase in crude protein and crude fibre content of maize cultivars. Improved cultivar Hudeiba-2 performed better in crude protein and crude fibre content in both seasons. Since there are major winter crops which can be grown in the area (wheat, faba bean, funnel….etc) that compete with maize, the suggestion of growing the maize crop as a summer crop will help in intensification and diversification of the rotations of the agricultural schemes in the area.

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