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NITROGEN USE EFFICIENCY OF THREE MAIZE (*ZEA MAYS* L.) CULTIVARS

Galal A. EL Toum[1], Yassin M. I. Dagash[2], Sami A. Mahagoub[1]

[1] Department of Agronomy, College of Agric. Sciences, University of Dongola, Sudan
[2] Department of Agronomy, College of Agricultural Studies, University of Science and Technology, Sudan
****Corresponding author: galaleltoum1234@gmail.com***

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ABSTRACT

Nitrogen use efficiency is one of the key issues in farming and fertilization, it is defined as the amount of product produced per unit of resource used. A split plot arrangement in randomized complete block design with four replications was used to compare the yield, nitrogen use efficiency and some quality characters of three maize (*Zea mays* L.) cultivars. The analysis of variance revealed that both nitrogen and maize cultivars were significantly differences in yield, nitrogen use efficiency, crude protein and crude fibre content in both seasons. This study revealed that improving nitrogen use efficiency can help in optimizing nitrogen use in maize.

KEYWORDS

Maize cultivars, Nitrogen use efficiency, Zea mays, Crude protein, Crude fibre.

1. INTRODUCTION

Maize also known as Corn (*Zea mays* L.) is a grain crop that belongs to the family Poaceae. The origin of this crop 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 [1]. 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 cereals based on production as well as productivity and that is why it is called "queen of cereals" [2]. Nitrogen use efficiency parameters are high under low nitrogen levels and decrease with increasing nitrogen level. Decreased nitrogen use efficiency at high nitrogen is attributed to higher losses because the plant is unable to absorb all of nitrogen applied [3]. Maize is nitro positive and needs ample quantity of nitrogen to attain high yield. Nitrogen deficiency is a key factor for limiting maize yield [4]. Low yield of maize can be attributed to many constraints but NPK fertilizer application is one of the major factors [5].

2. MATERIALS AND METHODS

A pot experiment was carried out during two consecutive summer seasons 2013/2014 and 2014/2015 at the Demonstration Farm of the Faculty of Agricultural Sciences –University of Dongola-Sudan (Latitude 19° 11′ N and Longitude 30° 29′ E). 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. A Split plot arrangement in randomized complete block design with four replications was used to execute the experiment where the three cultivars assigned to the main plots and the four nitrogen levels to the sub plots. Nitrogen levels (0, 43, 86and 129kg/ha) used for the treatment were notified as N0, N1, N2 and N3, respectively. Three to four seeds were sown per hole and then thinned to one plant per hole three weeks after sowing in both seasons. The total grain yield was calculated according to the following formula: Total grain yield (tons/ha) = grain weight(g)/m2 / 100 [6]. Nitrogen use efficiency calculated as follows: NUE = grain yield/ actual amount of nitrogen added [7]. Seeds crude protein and crude fibre contents were determined following the standard methods of the Association of Official American Analytical Chemists [8]. The organic nitrogen content was determined using the micro-Kjeldahal method, and an estimate of the crude protein content was estimated by multiplying the organic nitrogen content by a factor of 6.25% [9]. Two different samples were analyzed in triplicate. The data were submitted to standard procedure of analysis of variance, means were separated using Duncan Multiple Range Test (DMRT) as described by [10].

3. RESULTS AND DISCUSSION

3.1 Effect of Nitrogen on the Yield, Nitrogen Use Efficiency and Quality

Results in table-1 and table-2 showed that nitrogen caused highly significant differences in the yield and yield efficiency in both seasons. Maize yield is high when responsive to nitrogen fertilizer [11]. Also, this result was similar to those reported by a group researcher who all found the same result [12-18]. Similarly, the result of this study indicated a highly significant effect of nitrogen on nitrogen use efficiency (NUE) in both seasons. Nitrogen use efficiency decreased significantly with the increase of nitrogen rate. This could probably be attributed to the inability of plants to assimilate all of nitrogen taken up. Similar result was reported by a researcher who indicated that nitrogen use efficiency decreased with the increase of nitrogen rate because the plants were unable to assimilate all of nitrogen taken up [3]. Furthermore, nitrogen caused highly significant differences in crude protein and crude fiber content in both seasons. Similar results were obtained by some scientist who all found the same result [19-22]. 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.

Table 1: F-values for the yield, nitrogen use efficiency and quality of maize cultivars during the summer season 2013/2014 and 2014/2015

Characters	Nitrogen		Cultivars		Interaction	
	1st Season	2nd season	1st Season	2nd season	1st Season	2nd season
Crude protein	42.78**	27.03**	7.45*	15.56*	0.63 n.s	5.90*
Crude fibre	46.53**	34.67**	3.14 *	9.11*	1.63 n.s	3.14 *
Yield	18.27**	14.23**	39.94**	31.11**	1.26 n.s	1.12 n.s
Nitrogen use efficiency	31.16**	29.76**	24.37**	20.12**	5.94*	5.00*

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

Table 2: Effect of nitrogen on quality, yield and nitrogen use efficiency of maize during summer seasons 2013/2014 and 2014/2015.

Treatment	Characters							
	Crude protein		Crude fibre		yield		Nitrogen use efficiency	
	1st Season	2nd season	1st Season	2nd season	1st Season	2nd season	1st Season	2nd season
N0	10.23d	10.88d	4.08 d	3.60c	3.97c	2.93b	-	-
N1	10.31 c	11.20c	4.10 c	3.94b	6.24a	4.94a	114.88a	145.20a
N2	10.23 b	11.47b	4.12 b	4.05a	5.49b	4.85a	56.40b	63.81b
N3	10.35 a	11.61a	4.14 a	4.14a	5.85ab	4.99a	38.68c	45.35c
mean	10.31	11.29	4.11	4.48	5.39	4.43	69.99	84.79
LSD	00.02	00.14	0.10	0.09	0.23	0.11	05.22	08.46
SE	00.04	00.04	0.06	0.03	0.66	0.30	02.14	02.98
C.V	01.93	02.15	3.57	4.32	21.16	26.97	31.23	26.53

Means followed by the same letters within each column for each treatment are not significantly different at 5% level of probability.

3.2 Performance of Cultivars in Yield, Nitrogen Use Efficiency and Quality

Table (3) shows that cultivars differ significantly in grains yield in both seasons. Differences among maize cultivars with respect to yield have been reported by some researcher which they found the same result [23,24]. The variation in grain yield among cultivars could be attributed to differences in genetic makeup, environment and interaction between these aspects. Also, the same cultivars show different nitrogen use efficiency when subjected to different levels of nitrogen in both seasons. The differences in nitrogen use efficiency between the three cultivars of maize may be due to the fact that improved cultivars usually have higher nutrient use efficiency than traditional cultivars. Similarly, the result of this study indicated significant differences among cultivars of maize in crude protein and crude fibre content in both seasons. This result was in line with that reported found significant differences in crude protein and crude fibre content between maize cultivars [19,25].

Table 3: Performance of cultivars in quality, yield and nitrogen use efficiency of maize in summer season of 2013/2014 and 2014/2015.

Treatment	Characters							
	Crude protein		Crude fibre		yield		Nitrogen use efficiency	
	1st Season	2nd season	1st Season	2nd season	1st Season	2nd season	1st Season	2nd season
V1	10.33 a	10.73c	3.99 a	3.56b	6.07a	5.44a	63.26a	69.50a
V2	10.19 b	11.42b	3.77 b	4.10a	3.79b	2.49c	28.95b	46.92b
V3	10.38 a	11.70a	4.07 a	4.13a	6.31a	4.86b	56.51a	74.36a
mean	10.30	11.28	3.94	3.93	5.39	4.26	49.57	63.59
LSD	00.15	00.18	00.10	0.24	0.22	0.05	06.70	10.26
SE	00.14	00.46	0.72	0.06	0.76	0.18	03.64	02.97
C.V	01.93	02.15	3.57	4.32	21.16	26.97	31.23	26.53

Means followed by the same letters within each column for each treatment are not significantly different at 5% level of probability.

LSD= least significant difference. SE± = standard error. C.V% = coefficient of variation

4. CONCLUSIONS

In summary, the results of our study revealed that maize requires low nitrogen fertilization to optimize yield and improved cultivars have higher nutrient use efficiency than traditional cultivars.

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REFERENCES

[1] FAO, 2005. Current world fertilizer trends and outlook. Rome. Special Report.

[2] Turi, N.A, Shah, S.S, Ali, S, Rahman, H. Ali T, Sajjad, M. 2007. Genetic variability for yield parameters in maize (*Zea mays*) Genotypes. Journal of Agriculture and Biological Sciences, 2 (4), 1-3.

[3] Giambalvo, D., Ruisi, P., Miceli, G.D., Frenda, A.S., Amato, G. 2009. Nitrogen use efficiency and nitrogen fertilizer recovery of durum wheat genotypes as affected by inter specific competition. Agronomy Journal, 102, 707-715.

[4] Alvarez, R., Grigera, S. 2005. Analysis of soil fertility and management effects on yields of wheat and corn in the rolling pampa of Argentina. Journal of Agronomy and Crop Sciences, 191, 321–329.

[5] Witt, C., Pasuquin, J.M.C.A., Doberman, A. 2008. Site –specific nutrients managements for maize in favorable tropical environments of Saia. Proc. 5th Inter. Crop Sci. Cong., April 13-18, Jeju, Korea, pp:1-4.

[6] Baada, A. A. A. 1995. Evaluation of some exotic and local maize (*Zea mays* L.) Genotypes.M.Sc. Thesis. University of Khartoum, Sudan.

[7] Greenwood, D.J., Lemaire, G., Goose, G., Cruz, P., Draycott, A. 1989. Apparent recovery of fertilizer nitrogen by vegetable crops. Soil Science. Plant Nutrition, 35, 367-381.

[8] AOAC. 1990. Association of Official Analytical Chemist. Official Methods of Analysis, 15thcdn. Washington, DC: AOAC.

[9] Sosulski, F.W., Imafidon, G. I. 1990. Amino acid composition and nitrogen to protein conversion factors for animal plant foods. Journal of Agricultural and Food Chemistry, 38, 1351 –1356.

[10] Gomez, K.A., Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. 3rd Edition. John Wiley. New York.

[11] Moose, S., Below, F.E. 2008. Biotechnology approaches to improving maize nitrogen use efficiency. In: Molecular genetics approaches to maize improvement. Kriz, A.L. and B.A. Larkins (ends). Springer Berlin Heidelberg (Publisher).Volume 63. Part II.

[12] Doberman, A.R. 2005. Nitrogen use efficiency – state of the art. Agronomy – Faculty Publications. Agronomy and Horticulture Department of Nebraska – Lincoln.

[13] Badr, M.M., Authman, A.S. 2006. Effect of plant density, organic manure, bio and mineral nitrogen fertilizers on maize growth and yield and soil fertility. Journal of Agricultural Sciences, Moshtohor, 44 (1), 75–88.

[14] Bakhet, J.S., Ahmad, I.M., Tariq, H.A., Shafai, M. 2006. Response of maize to planting methods and fertilizer. Journal of Agricultural and Biological Science, 1(3), 1–14.

[15] Delibaltova, V., Kirchev, H., Sevov, A., Matev, A., Yordanova, N. 2010. Genotypic response of maize hybrids to different nitrogen applications under climatic conditions of Plovdiv region. Balwois-Ohrid, Rep. of Macedonia. May 25: 29.

[16] Hammad, H.M., Ahmad, A., Khaliq, T., Farhad, W., Mubeen, M. 2011. Optimizing rate of nitrogen application for higher yield and quality in maize under semiarid environment. Crop and Environment, 2 (1), 38–41.

[17] Wasaya, A. 2011. Growth and yield response of maize (Zea mays L.) to nitrogen management and tillage practices. Ph.D. Department of Agronomy Faculty of Agriculture. Faisalabad. 203.

[18] Khan, N.W., Ijaz, N.K., Khan, A. 2012. Integration of Nitrogen Fertilizer and Herbicides for Efficient Weed Management In Maize Crop. Sarhad Journal of Agriculture, 28 (3), 458-463.

[19] Ayub, M., Ahmed, R., Nadeem, M.A., Ahmed, B., Khan, R.M.A. 2003. Effect of different levels of nitrogen and seed rate on growth, yield and quality of maize fodder. Pakistan Journal of Agricultural Sciences, 40, 140–143.

[20] Almodares, A., Jafarinia, M., Hadi, M.R. 2009. The effect of nitrogen fertilizer on chemical composition in Corn and Sweet Sorghum. American –Eurasian Journal of Agriculture and Environment Science, 6 (4), 441–446.

[21] Nadeem, M.A. Z., Igbal, M. A., Mubeen, K., Ibrahim, M. 2009. Effect of nitrogen application on forage yield and quality of maize sown alone and in mixture with legumes. Pakistan Journal of Life Sociology Science, 7 (2), 161-167.

[22] Reddy, D.M., Bahnumurthy, V.B. 2010. Fodder grain, grain yield, nitrogen uptake and crude protein of forage maize as influenced by different nitrogen management practices. International journal of Biological Research, 1, 69-71.

[23] Ayub, M., Awan, T.H., Tanveer, A., Nadeem, M. A. 2001. Studies on fodder yield and quality of maize cultivars. Pakistan Journal of Agricultural Engineering and Veterinary sciences, 17 (1-2), 28-32.

[24] Bertoia, L., Lopez, C., Burak, R. 2006. Biplot analysis of forage combining ability in maize landraces. Crop Science, 46 (3), 1346-1353.

[25] Altin, G.W., Hunter, R.B. 1994. Comparison of growth, forage yield and nutritional quality of diploid and autotetraploid maize synthesis. Canadian Journal of Plant Science, 64 (3), 593–598.