Evaluation of maize plant fractions submitted to different levels of nitrogen fertilization

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ABSTRACT

The use of nitrogen fertilizers in the appropriate dosage can modify the bromatological compositions of the plant. The objective of this study was to evaluate the chemical composition of the fractions of the corn plant submitted to different levels of fertilization. The experiment was carried out in the municipality of Bocaiúva, located in the interior of Minas Gerais. In the execution of the experiment, the transgenic corn VT PRO 3 from Agroceres was used. The experiment was arranged in a randomized block design with five replications. The treatments consisted of four N doses: 100, 200, 300 and 400 kg N/ha/cut). A single source of N, urea, was used. The data obtained were submitted to analysis of variance and regression analysis. The increase in nitrogen doses influenced the crude protein content of the corn plant. The maximum point for CP content was observed at a dose of 173 N (Kg/ha), and 20.01% of CP was observed. The neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents of the stem were influenced by the increase of N rates ($p < 0.05$). It is concluded that in the results obtained there was an influence of nitrogen fertilization on the chemical composition of corn.

Keywords: Bromatology, Nitrogen, *Zea mays*.

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INTRODUCTION

The proper use of nitrogen fertilizer in irrigated corn increases productivity and profit per hectare (ARAÚJO, 2004). The production of corn grain is of great influence on the Brazilian economy, followed by soybeans, which also contributes to it. Brazil is one of the main producers of grains in the world, and although it has been breaking productivity records every year, many crops still have considerable average performance below the point of maximum economic yield. However, the supply of mineral and organic fertilization is essential to achieve satisfactory crop productivity.

Nitrogen fertilization is extremely important for corn, since it is the nutrient absorbed in greater quantities by the crop, and nitrogen (N) is responsible for the main biochemical reactions in plants (CAIRES; MILLA, 2016). Its availability directly affects leaf area, photosynthesis rate, root system growth, ear size, number and mass of grains, and grain health (FERNANDES, 2005; PIONNER, 1995). The sources of N sought in the market are those capable of increasing crop productivity and that are economically viable, where application losses are minimal, therefore, urea meets these prerequisites, being the most used source, but the most common nitrogen fertilizers that contain ammonia and urea are capable of acidifying the soil, when used in high doses (CAIRES et al., 2015).

Aiming at the increase in the use and also in the cost of nitrogen fertilizers, there is growing concern about the probable negative effects resulting from the excessive use of this fertilizer. Therefore, it becomes a challenge to make a correct nitrogen fertilization, without a lack or excess of N applied to the crop, since the high levels of the nutrient in the soil can cause losses and environmental contamination. Inside the plant cell, nitrogen is transported to carbonate compounds, where it will be part of amino acids, nucleotides, chlorophylls, coenzymes and protein, which justifies the increase in CP levels found in this work, since the N applied via chemical fertilization was converted into protein for the plant. A small reduction in CP content was observed with the increase of the N dose to 400kg/ha. This reduction in the efficiency of N utilization with increasing dose is due, in addition to the lower use by plants, to physiological limitations, possible losses due to N leaching and volatilization, and possible nutritional imbalance at high doses (MELLO, 1987).

With the increase in productivity and demand for these nutrients in corn cultivation, research aimed at maximizing productivity and reducing production costs, determining the ideal application dosage and methods for using nutrients become increasingly important (ROLIM et al., 2018). The objective of this study was to evaluate the chemical composition of maize plant fractions submitted to different levels of nitrogen fertilization.

MATERIAL AND METHODS

For the execution of the experiment, Agrocere's VT PRO3 transgenic corn was used, a transgenic hybrid with emphasis on grain yield potential and tolerance to Polysora rust. It is a cultivar responsive to fungicide management, has an early cycle, relative maturity of 137 days. The plant height varies between 220 and 247cm, while the ear insertion varies between 120 and 133cm, it has good stuffing, erect leaf architecture, orange grain color, semi-dentate type and the weight of a thousand grains is 446g. VT PRO 3 ® is a biotechnology that, in addition to offering protection against shoot pests that attack leaves, stems and ears (*Spodoptera fugiperda, Helicoverpa zea, Diatraea saccharalis, Elasmopalpus lignosellus*), with tolerance to the herbicide glyphosate, which facilitates weed management and has the exclusive protection of corn roots against pinworm attack (*Diabrotica speciosa)*). It is also tolerant to the fungi Turcicum, Cercospora and Diplodia.

The experiment was arranged in a randomized block design with five replications. The treatments consisted of four N doses: 100, 200, 300 and 400 kg N/ha/cut). A single source of N, urea, was used. To cut the grass, a square measuring 1 m² was used and placed in the useful area of each experimental plot. The plants that were found inside the square were cut at a height of 0.25m above ground level, to determine their green mass production through weighing. The experiment area was subdivided into four plots of 3x3m, where each plot received different levels of fertilization.

The research began with the mechanized planting of the crop using row spacing of 80 cm, with an average of six plants per linear meter and with a perspective of 60 thousand plants per ha. The crop was treated with irrigation in a mesh of fixed sprinklers. At the time of planting, the crop received a fertilization of 200 kg of MAP and 100 kg of KCL, then the crop was divided into four standard modules of 3x3 meters where all received standardized manual fertilization of 100 kg of N every 14 days, accounting for the following values at the end of fertilization: 100 kg of N in module A, 200 kg of N in module B, 300 kg in module C and 400 kg of N in module D. The harvest of the plant had the parameter of grain maturation, that is, when the grain reached 2/3 (two thirds) of the milk grain row, the harvest was carried out through the whole plant with a cut close to the ground.

The evaluation of the chemical composition of the corn plant was carried out at the Food Analysis Laboratory of the State University of Montes Claros (UNIMONTES) – Campus Janaúba, MG. Soon after the measurement of the productivity parameters that occurred of the complete plant, in a forced ventilation oven at a temperature of 56°C for 72 consecutive hours or until it reached constant weight. Based on the data obtained, the productivity of the used area was converted by the productivity per ha. The pre-dried samples were ground in a stationary mill with a 1mm mesh sieve and then packed in glass with lids identified for the analysis of the chemical composition of the food: dry matter (DM), ash (CNZ), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF). The analyses of DM, CP and ash were performed according to the standard procedures of the Association of Official Analytical Chemists (AOAC, 1990), and the analyses of NDF, FDA and LIG, according to Van Soest et al. (1991).

The data were analyzed in SISVAR® (FERREIRA, 2014) with a model containing the fixed effects of N doses (Treatments). The variation in soil fertility was the blocking factor of the experiment, considering it as a random effect in the analysis of variance. The UNIVARIATE procedure was used to detect outliers or influent values and to examine the normality of the residuals. The variables referring to the chemical-bromatological composition of the whole maize plant were analyzed according to the model: $Y\ ij = \mu + Ti + Bj + eij$,

Where:

Yij = observed value for variable i in relation to the treatment in block j; u = mean of all experimental units for the variable under study;

Ti = effect of nitrogen fertilization levels i on the value of the Yij observation with i = 1,2,3, and 4;

Bj = random effect of blocks j, with j = 1,2,3, ... and 5;

EIJ = error associated with the observation

Independent Yij, which hypothetically has a normal distribution with a mean of zero and a variance of δ2.

Comparisons between nitrogen rates in the maize plant were performed by decomposing the sum of squares into orthogonal linear contrasts and quadratic effects, at 5% probability, with subsequent adjustments of the regression equations. Mean values were considered different when $\alpha<0.05$

RESULTS AND DISCUSSION

Table 1 shows that the contents of Dry Matter (DM), Ash (CZ), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) did not show statistical difference between the different N rates<. A quadratic regression behavior was observed, and the maximum CP content estimated by the equation would be at the dose of 173.75 N (Kg/ha), and 20.01% of CP was verified.

Table 1. Dry Matter (DM), Ash (CZ), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Crude Protein (CP) contents of corn plant leaves submitted to different levels of fertilization

Item	Doses of N (kg/ha)				CV	P-value
	100	200	300	400		
MS_105	92,418	91,332	92,232	89,648	2,71	0,3185
CZ	13,792	13,572	14,074	10,850	18,61	0,1847
FDN	58,948	59,156	57,354	60,956	9.06	0,7701
FDA	33,340	30,484	29,554	31,758	9,85	0,2851
PB[1]	13,112	16,146	14,366	11,256	11,10	0,0020

[1] $y = -0.0002x2 + 0.0695x + 7.877R^2 = 0.9524$

Moraes et al. (2013), working with AS32 corn, found a value below that found in the present study, with values of 12.16% CP, a value that was already expected, since a lower amount of N per hectare was used, 62.90% of NDF, a value above that found, while the FDA presented similar results, using 80Kg of N per hectare, a value below the treatments used in the experiment.

There was no difference in the levels of DM, CZ and CP ($p > 0.05$) in the stem of the plants with increasing dose (Table 2). On the other hand, NDF and ADF levels were influenced by the increase in N doses ($p < 0.05$). The minimum point for NDF content was found at a dose of 294.63 N (Kg/ha), and 63.60% of NDF was observed. On the other hand, for the ADF contents, the minimum point was found at the dose of 319.25 N (Kg/ha), where the lowest ADF content was verified, being 33.59%. The NDF content represents the chemical fraction of roughage that has the closest correlation with consumption, and values of cell wall constituents above 60% are negatively correlated with forage intake (MERTENS, 1987; VAN SOEST, 1965). Regarding ADF contents, forages with values around 30% (ideal level for good animal consumption) or less will be consumed at high levels, while those with levels above 40% will be consumed at low levels (NUSSIO et al., 1998).

Table 2. Dry Matter (DM), Ash (CZ), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Crude Protein (CP) contents of the corn plant stem submitted to different levels of fertilization

Item	Doses of N (kg/ha)				CV	P-value
	100	200	300	400		
MS_105	92,792	88,216	92,548	89,558	2,59	0.0630
CZ	4,724	4,988	6,456	5,560	20,27	0.1164
FDN[1]	78,360	68,256	62,278	68,086	10,75	0.0338
FDA[2]	43,136	35,808	32,732	32,920	15,89	0.0464
PB	6,948	4,948	6,154	6,134	18,16	0.0841

[1]Y = 0,0004c2 - 0,2357 l + 98,335R^2 = 0,9781
[2]Y = 0,0002l2 - 0,1277 L + 53,975 R^2 = 0,9993

NDF content directly influences the inclusion of concentrated foods in the diet. Thus, materials with a lower percentage of NDF can participate in a greater proportion, reducing feed costs (ALLEN, 1997). In addition, the NDF content can affect the degradability and rate of passage of the diet through the rumen.

Table 3 shows that the dry matter (DM) content of the corn ears at different N rates showed a difference ($p < 0.05$). The maximum point for DM content found occurred at the dose of 323.75 N (Kg/ha), and 87.72% of DM was observed<. The maximum point found for the ash content was verified at the dose of 282.85 of N (Kg/ha), and 17.64% of ash was verified. The determination of ash contents provides us with an indication of the mineral matter of the food, high mineral matter contents can indicate lower energy levels. The NDF, ADF and CP variables did not show statistical differences in the different doses of N in the ear ($p>0.005$).

Table 3. Dry Matter (DM), Ash (CZ), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Crude Protein (CP) contents of corn plant cob submitted to different levels of fertilization

Item	Doses of N (kg/ha)				CV	P-value
	100	200	300	400		
MS_105[1]	93,290	88,252	90,458	88,622	2,18	0.0061
CZ[2]	4,362	5,130	7,126	5,050	22,92	0.0231
FDN	54,474	53,580	51,592	55,164	9.09	0.6871
FDA	20,130	20,792	20,114	21,332	22,71	0.9706
PB	10,044	9,644	9,564	9,456	7,93	0.6526

[1]y = 8E-05x2 - 0,0518x + 97,108R² = 0,5992
[2]y = -7E-05x2 + 0,0396x + 0,847R² = 0,6696

The high values of NDF and ADF obtained in the ear can be explained as a result of the occurrence of Maillard reactions, which produced components insoluble in acid detergent, determined by the reactions of sugars and carbohydrates to the amino acids present in the corn plant, leading to increases in NDF contents.

CONCLUSION

The application of nitrogen fertilizer at a dose of 200 (kg/ha) of N from urea showed better use by the corn plant.

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