

Blood meal as nitrogen source and its effect on disease severity on sweet corn

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Abstract

A blood meal is a by-product of the meat processing industry and can be used as nitrogen fertilizer due to its minimum content of 10 % Nitrogen. The objective of this work was to evaluate the effect of doses of blood meal, such as nitrogen fertilizer in topdressing, on the production components and the severity of diseases in sweet corn. The experiment was developed at the Federal Institute of Education, Science and Technology of Mato Grosso do Sul (IFMS), Ponta Porã campus, in a Quartzarenic Neosol. The experimental design used was randomized blocks with five treatments of blood meal doses of (0 kg ha⁻¹; 48 kg ha⁻¹; 96 kg ha⁻¹; 120 kg ha⁻¹ and 144 kg ha⁻¹) and one treatment using urea for topdressing fertilization with 120 kg ha⁻¹ of N. The experiment analyzed the severity of white spot on the tasseling and milk grain stages and also the production components: plant height, insertion height of the first ear, stalk diameter, length of the unhusked commercial ears, diameter of unhusked commercial ears, number of grain row, weight of husked commercial ears, weight of unhusked commercial ears and productivity in kg ha⁻¹. The use of blood meal was as efficient as the use of urea as a nitrogen fertilizer for doses starting from 48 kg ha⁻¹, the maximum productivity was obtained when the dose of 112 kg ha⁻¹ of N blood meal was used. The severity of the white spot did not progress in treatments containing nitrogen fertilization in topdressing.

Keywords: Nitrogen fertilizer. Production components. White spot. *Zea mays*.

Introduction

In Brazil, approximately 36,000 hectares are cropped with sweet corn (*Zea mays* L.). Most of the production is destined for human consumption. This production is more adopted by small and medium farms, therefore it contributes in generating regional employment, improving logistics and food distribution (SANTOS *et al.*, 2011).

To obtain high productivity in the corn crop, the adequate management of fertilization is necessary, especially the supply of nitrogen, which is the most absorbed and exported nutrient by the

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crop (SORATO *et al.*, 2010). Nitrogen contributes to the production of corn since this element takes part in the structural function and activator of several enzymes. These contributions provide green and abundant vegetation, high foliage, and protein levels (MALAVOLTA, 2006).

A blood meal is a source of nitrogen fertilizer, which is a by-product generated in meat processing plants. It has a high nitrogen content (N) when compared to other organic fertilizers, with a minimum content of 10 % N (RIBEIRO; GUIMARÃES; ALVAREZ, 1999). Information on the use of this product as nitrogen fertilizer is scarce, despite the blood meal great importance in the production of animal diets, mainly for fish farming, due to its high added value residue, especially the number of proteins, with essential amino acids, vitamins, and minerals, and its high digestibility coefficient (RENUNCIO, 1997).

How the cultural management of a crop is conducted can influence its productivity, especially the nitrogen fertilization, which can also determine a greater or lesser predisposition to diseases (CARVALHO *et al.*, 2013). Balanced fertilization, in addition to favoring production, can make the plant less susceptible to diseases and may even reduce its severity (HUBER; THOMPSON, 2007). According to Miguel *et al.* (2015), besides providing an increase in productivity, nitrogen fertilization is one of the cultural treatments that can minimize the effects of the main leaf diseases on plants. The white spot, caused by the fungus *Phaeosphaeria maydis* is one of the most important pathogens in the country due to the great geographic range in which it is found (MANFROI *et al.*, 2016). In favorable conditions, the disease can cause a reduction in the photosynthetic rate of the plant causing its early dryness, and also a decrease in the period of grain filling, in the ear size, grain weight, and consequently corn productivity (MENDES; TEBALDI, 2011).

Lastly, the objective of this work was to evaluate the effect of doses of blood meal, as nitrogen fertilizer, on the production components and the severity of the white spot in sweet corn.

Material and methods

The experiment was carried out at the Federal Institute of Education, Science and Technology of Mato Grosso do Sul (IFMS), Ponta Porã, Mato Grosso do Sul campus, located on the BR 463 highway, km 14, 755m above sea level. The soil in the area was classified as Quartzarenic Neosol (EMBRAPA, 2006) with a loam-sand texture containing 11.7 % clay, 3.7 % silt, and 84.6 % sand. The climate is Aw-type, according to the Köppen-Geiger classification, with a rainy season in summer and a dry one in winter (PEEL; FINLAYSON; MCMAHON, 2007). The monthly average rainfall during the sweet corn cycle was 187.03 mm.

The fertilization was carried out following the interpretation of the soil analysis (TABLE 1) according to Ribeiro, Guimarães, and Alvarez (1999), using 555 kg ha⁻¹ of Super Simple Phosphate, 100 kg ha⁻¹ potassium chloride, and 66 kg ha⁻¹ urea. The planting system used was the conventional one, with a heavy harrowing followed by a leveling. The corn cultivar used was the double hybrid AG 1051 from Agroceres, developed for the production of sweet corn and silage, which is recommended for the planting season and the producing regions of Mato Grosso do Sul.

The experimental design used in this work was the randomized block with four replicates. The treatments were set after the chemical analysis of the blood meal (TABLE 2).

Table 1 – Chemical analysis of the soil in the experimental area in the 0-20 cm layer before treatment setting up and corn planting, Ponta Porã, MS, 2021.

pH	O.M.	P	K	Al ³⁺	Ca	Mg	H+Al	CTC _{pH7}	V
CaCl ₂	g dm ⁻³	mg dm ⁻³		cmolc dm ⁻³					%
5.6	13.5	3.2	44	0.0	2.2	0.8	1.2	4.2	73
Texture g dm ⁻³									
Sand			Silt			Clay			
847			37			117			

Source: Elaborated by the authors (2021).

Table 2 – Characterization of macronutrient, carbon/nitrogen rate, pH, and micronutrients of blood meal, Ponta Porã, MS, 2021.

Macronutrients						O.C. /N	pH
N	P ₂ O ₅	K ₂ O	Ca	Mg	S		
%							
12.57	0.14	0.78	0.07	0.01	0.5	3.12	6.7
Micronutrients							
B	Cu	Fe	Mn	Mo	Na	Ni	Zn
mg/dm ³							
N.D	273.4	2346	4.59	N.D	8146	15.6	286.5

Source: Elaborated by the authors (2021).

This experiment used five different doses of blood meal which corresponded to 0 %, 40 %, 80 %, 100 %, and 120 % referring to the total N amount required for the topdressing fertilization equivalent to 120 kg ha⁻¹ N. Quantitatively, these doses were equivalent to 0 kg ha⁻¹, 381.90 kg ha⁻¹; 763.72 kg ha⁻¹; 954.66 kg ha⁻¹ and 1145.58 kg ha⁻¹ of blood meal, which contained 0 kg ha⁻¹, 48 kg ha⁻¹, 96 kg ha⁻¹, 120 kg ha⁻¹ and 144 kg ha⁻¹ N respectively and treatment using urea as a standard topdressing nitrogen fertilizer, in which 100 % of the required amount of nitrogen was used, totaling 6 treatments. The experimental plots consisted of four rows of 6 meters, with a spacing of 0.9 m between rows, considering as a useful area only the two central lines for data collection. The plant population used in the experiment was 55,000 ha⁻¹.

To analyze the production components of sweet corn, ten plants from the useful area were measured, from the milky grain (R3) to the dough (R4) stage (RITCHIE; HANWAY; BENSON, 1993). Also, the plant height (PH), the height of the plant stalk to the flag leaf, the height of the insertion of the first ear (IH) were measured using a ruler, and the stalk diameter (SD) measured in the middle of the second stem internode using a digital caliper. To check the characteristics of the ears, 10 ears were manually harvested from the useful area of the plot. Afterward, the length of the unhusked commercial ears (UCE) was determined with the aid of a measuring tape from the base of the ear to its end; the diameter of husked commercial ears (HCED) was measured from the middle of the ear using a digital caliper; the number of rows of grains (GR) was set based on the visual count and the weight of commercial husked ears (CHEW) and weight of unhusked commercial ears (UCEW) was determined using a scale, considering the commercial ears those that had a length greater than 15 cm and 3 cm in diameter and from these, the productivity (PROD) was obtained in kg ha⁻¹ of unhusked ears.

Assessments on the leaf disease severity were carried out in the VT stages, which consist of the tasseling and R3 at the milky grain stage. For these evaluations, the leaves were randomly selected within the useful portion, observing a leaf at the ear insertion height for visual analysis from the diagrammatic scale to assess the severity of the white spot in the percentage of the injured leaf area, shown by Sachs *et al.* (2011) and later, evaluations of the area under the disease progress curve (AUDPC) were carried out.

Data on production components, severity, and AUDPC were subjected to analysis of variance and when significant, regression analysis and Dunnett test at 5 % probability were performed for comparisons with the urea standard dose.

Results and discussion

The analysis on the data on plant height, ear insertion height, stalk diameter, and diameter of the commercial ear showed that there was no significant difference by the test of Dunnett at 5 % probability (TABLE 3) in comparison to the control treatment with the use of urea as topdressing nitrogen fertilization, that is, regardless the nitrogen dose used as blood meal, the treatment did not affect these production components.

Table 3 – Means of Sweet corn production component according to blood meal (BM) doses for plant height (PH), insertion height of the first ear (EH), and stalk diameter (DC). Ponta Porã, MS, 2021.

BM doses (kg ha ⁻¹ N)	PH (m)	EH (m)	SD (mm)
0	1.49 ^{ns}	0.78 ^{ns}	20.42 ^{ns}
48	1.66 ^{ns}	0.92 ^{ns}	23.73 ^{ns}
96	1.65 ^{ns}	0.93 ^{ns}	24.21 ^{ns}
120	1.67 ^{ns}	0.96 ^{ns}	24.40 ^{ns}
144	1.61 ^{ns}	0.94 ^{ns}	23.66 ^{ns}
Urea 120	1.66	0.94	24.94

^{ns} not different from the control by the test of Dunnett at 5 % probability.

Source: Elaborated by the authors (2021).

For the length of the commercial ear, the weight of husked and unhusked ear, and the number of grain rows (TABLE 4), it was found that all doses of blood meal had no difference concerning fertilization with urea, indicating that it does not depend on the use of the other doses of blood meal, therefore showing that these results are as efficient as the use of urea, thus demonstrating the efficiency of this fertilization.

The comparison between N doses and blood meal revealed a significant effect for commercial ear length, husked and unhusked ear weight, and the number of grain rows. No significant effect was found for the other production components (FIGURE 1).

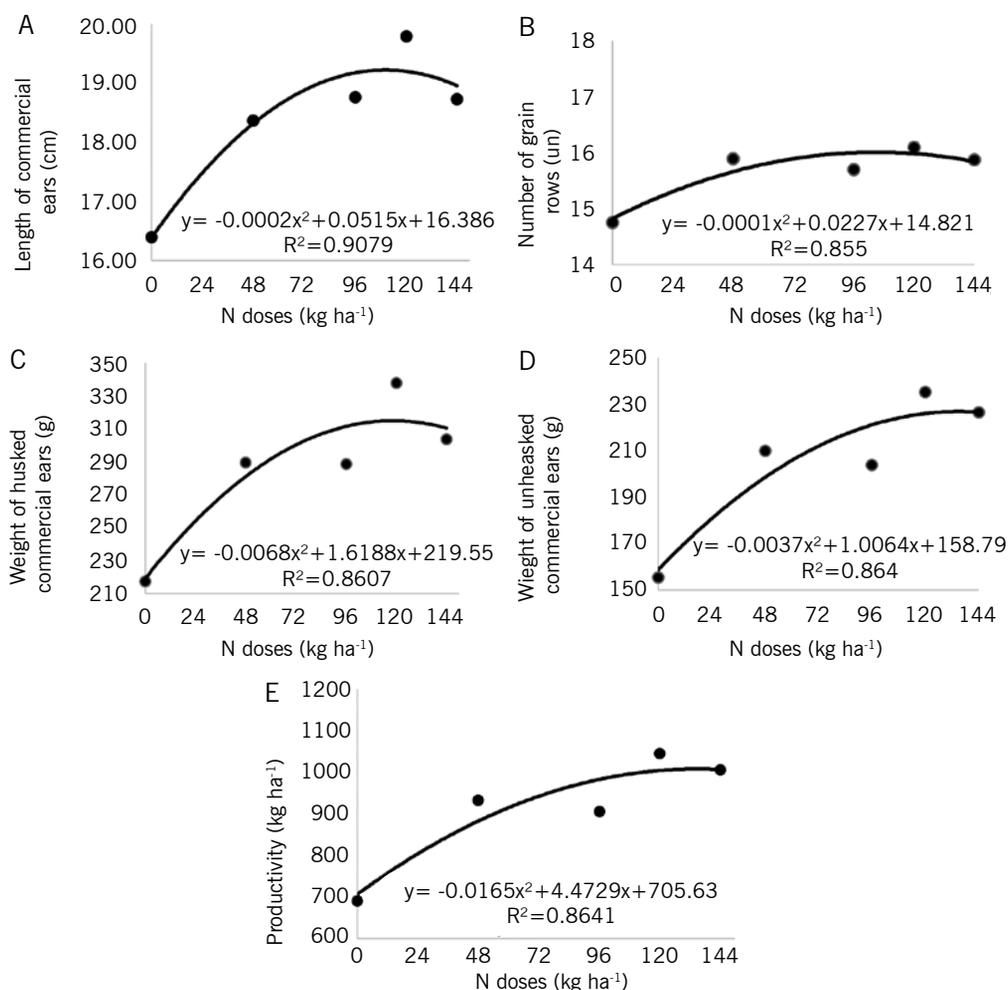
Table 4 – Means of the sweet corn production components according to the doses of blood meal (BM) for the characteristics of productivity (PROD), length of the commercial ear (CEL), ear diameter (CED), the weight of the husked commercial ear (CHEW), the weight of the unhusked commercial ear (UCEW), and the number of grain rows (ROW). Ponta Porã, MS, 2021

BM Doses (kg ha ⁻¹ de N)	PROD (kg ha ⁻¹)	CEL (cm)	CED (mm)	CHEW (g)	UCEW (g)	ROW (un)
0	690.5*	16.40*	42.63 ^{ns}	217.4*	155.4*	14.75*
48	932.8 ^{ns}	18.36 ^{ns}	45.76 ^{ns}	289.6 ^{ns}	209.9 ^{ns}	15.89 ^{ns}
96	906.1 ^{ns}	18.72 ^{ns}	44.51 ^{ns}	288.8 ^{ns}	203.9 ^{ns}	15.70 ^{ns}
120	1045.6 ^{ns}	19.78 ^{ns}	47.03 ^{ns}	338.0 ^{ns}	235.3 ^{ns}	16.10 ^{ns}
144	1006.3 ^{ns}	18.73 ^{ns}	46.73 ^{ns}	303.7 ^{ns}	226.4 ^{ns}	15.87 ^{ns}
Urea 120	978.9	19.22	45.89	320.6	220.3	15.90

Means followed by (*) are different from the control by the test of Dunnett at 5 % probability. Means followed by (^{ns}) do not differ from the control by the test of Dunnett at 5 % probability.

Source: Elaborated by the authors (2021).

Figure 1 – Regression of mean values of (A) commercial ear length (B) number of grain rows (C) weight of husked commercial ear (D) weight of unhusked commercial ear (E) and productivity according to N doses using blood meal as nitrogen fertilizer, Ponta Porã-MS, 2019.



*: equation significant at 5 % probability by the F test.

Source: Elaborated by the authors (2021).

The maximum value for commercial ear length was 19.7 cm with a dose of 128 kg ha⁻¹ N. According to Kappes *et al.* (2009), the average ear length, despite being a characteristic of high heritability and less dependence on the environment, is one of the production components that can directly interfere in the number of grains per row and consequently will affect corn productivity.

Pereira Filho and Cruz (2002) stated that the ideal ear length to meet both the interests of the filling industry and the production for fresh use is close to 20 cm, a value very close to the maximum length to be obtained with the fertilization of 128 kg ha⁻¹ N of the blood meal.

The largest number of grain rows was obtained using topdressing fertilization containing 113 kg ha⁻¹ N blood meal, with ears containing 16-grain rows. According to Fancelli and Dourado Neto (2000), the number of grain rows is defined in the V8 stage, a phase in which the nutrient availability, especially N, is very important as this moment is of greater demands for this nutrient by the plant, thus emphasizing the importance of the correct management of nitrogen fertilization and the efficient use of blood meal.

The maximum weight of the husked and unhusked commercial ear was 315.9 g and 227.2 g obtained by applying 119 kg ha⁻¹ and 136 kg ha⁻¹ N of blood meal, respectively. The average increases in-ear weight resulting from the application of N were 45.2 % in husked ears and 46.3 % for unhusked ears, when compared to the dose of 0 kg ha⁻¹ N. This behavior was also observed by Freire *et al.* (2010), who found an increasing trend in weight of husked ear according to the increment of N, in which higher doses of nitrogen provided greater volume of straw as this nutrient is directly linked with the growth and vegetative development, which will also affect the production of sweet corn ears due to increases in the average cob weights.

According to Damasceno *et al.* (2010), the weight of husked ears is very important for the commercialization of sweet corn, which is traded with the husk due to its culinary use since the consumer always tends to choose the largest and heaviest ears, both for consumption in fresh form and for the industry.

Nitrogen doses significantly influenced the increase in productivity, its production peak was 1027 kg ha⁻¹ of unhusked ears using the dose of 113 kg ha⁻¹ (FIGURE 1). Thus, the use of blood meal was as efficient as the use of urea as a nitrogen source. Freire *et al.* (2010) reported that because of the particularities of N, the dose recommendations for crops are based on response curves obtained locally, depending on the mineralization rate, the organic matter content, and the leaching of nitrate in the soil, and, in particular, due to the amount of rainfall in the period of its conduction.

Regarding AUDPC, no difference was found between nitrogen doses when compared to the control treatment using urea as a source of nitrogen in topdressing (TABLE 5).

According to Silva (2002), the establishment of the disease on the plant after reaching the stage of maturation does not cause significant damage, so the effect of the disease on production varies according to when the plant was infected. Regarding white spot, Godoy *et al.* (2001) observed that only the visual quantification of the severity of the disease cannot present an exact indication of the effect of the pathogen on the photosynthetic content of the host, since phytosanitary efficacy is reduced not only in the injured tissue but also in parts of the remaining green tissue of the infected leaf.

For the severity of the disease, a significant difference was observed in the control treatment at the R3 stage (TABLE 5), in which the topdressing nitrogen fertilization had not been carried out, leading to an increase in the severity of the white spot. According to Durães *et al.* (2004), the use of high concentrations of fertilizer, such as 200 kg ha⁻¹ of nitrogen, resulted in a decrease in the

incidence of the disease, which is also confirmed by the work of Corrêa *et al.* (2007) in which they emphasized that N interferes with the severity of the white spot.

Table 5 – Means of severities and AUDPC were analyzed in Sweet corn according to the blood meal (FS) and urea doses. Ponta Porã-MS, 2019.

BM doses (kg ha ⁻¹ N)	Severity at VT stage (%)	Severity at R3 (%)	AUDPC (%)
0	1.00 ^{ns}	2.05*	50.4 ^{ns}
48	0.9 ^{ns}	1.725 ^{ns}	47.1 ^{ns}
96	0.9 ^{ns}	1.675 ^{ns}	44.2 ^{ns}
120	0.9 ^{ns}	1.25 ^{ns}	35.6 ^{ns}
144	0.9 ^{ns}	1.25 ^{ns}	39.6 ^{ns}
Urea 120	0.9	1.15	28.8

Means followed by (*) are different from the control by the test of 5 % probability.

Means followed by (^{ns}) are not significant.

Source: Elaborated by the authors (2021).

Conclusion

The use of blood meal in topdressing fertilization in sweet corn crop produces results similar to urea from the dose of 48 kg ha⁻¹ N. The maximum yield was obtained using 112 kg ha⁻¹ N of blood meal in topdressing.

The corn crop responds positively to the increase in the dose of N using blood meal for ear length, husked ear weight, unhusked ear weight rows of commercial ear grains, and yield.

There was no influence of blood meal for the area below the white spot disease progress curve in the corn Crop.

Farinha de sangue como fonte nitrogenada e seu efeito sobre a severidade de doenças no milho-verde

Resumo

A farinha de sangue é um subproduto de frigoríficos e pode ser utilizada como adubo nitrogenado devido ao seu teor mínimo de 10 % de nitrogênio. O objetivo deste trabalho foi avaliar o efeito de doses de farinha de sangue, como adubo nitrogenado em cobertura, sobre os componentes de produção e a severidade de doenças no milho-verde. O experimento foi desenvolvido no IFMS, *Campus* Ponta Porã, num Neossolo Quartzarênico. O delineamento experimental utilizado foi de blocos ao acaso, com cinco tratamentos de doses de farinha de sangue de (0 kg ha⁻¹; 48 kg ha⁻¹; 96 kg ha⁻¹; 120 kg ha⁻¹ e 144 kg ha⁻¹) e um tratamento utilizando ureia para adubação em cobertura com 120 kg ha⁻¹ de N. Foram analisadas a severidade de mancha branca nos estádios de pendramento e grão leitoso, a avaliação dos componentes de produção: altura de planta, altura da inserção da primeira espiga, diâmetro do colmo, comprimento das espigas comerciais despalhadas, diâmetro de espigas comerciais

despalhadas, número de fileiras de grãos, peso de espigas comerciais empalhadas, peso de espigas comerciais despalhadas e produtividade em kg ha⁻¹. A utilização da farinha de sangue se mostrou tão eficiente quanto o uso da ureia como adubo nitrogenado para as doses a partir de 48 kg ha⁻¹, a produtividade máxima foi obtida quando utilizada a dose de 112 kg ha⁻¹ de N de farinha de sangue em cobertura. A severidade da mancha branca não progrediu em tratamentos contendo a adubação nitrogenada em cobertura.

Palavras-chave: *Zea mays*. Adubo nitrogenado. Componentes de produção. Mancha branca.

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