Impacts of burning on nutrient availability in the soil of the Chapada dos Guimarães National Park – MT

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ABSTRACT

The objective of this work was to investigate the impacts of Integrated Fire Management (IFM) in an area of the Chapada dos Guimarães National Park, to understand the effects of burning, both adverse and beneficial, on the availability of P and N, and to evaluate soil pH and moisture. Samples were collected in the Chapada National Park, which is located in the Midwest region of the country, in the state of Mato Grosso, located between the geographic coordinates 15°10' and 15°30'S and 56°00' and 56°40'W is within the Cerrado Biome, presenting a great biological diversity. The chemical parameters analyzed for the study area were: pH, moisture, phosphorus (P), total nitrogen and ammonia. The results were evaluated by Tukey's test ($p<0.05$) to compare the means when significant. Therefore, prescribed burning can alter the chemical characteristics of the soil without depending on the depth and seasonal period that was analyzed, in which it proves that fire is capable of altering them.

Keywords: Phosphorus, Soil organic matter, Soil chemistry, Nitrogen.

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INTRODUCTION

Integrated Fire Management (IFM) associates ecological, cultural, socioeconomic, and technical aspects in the execution, integration, monitoring, evaluation, and adaptation of actions related to the use of fire, through prescribed and controlled burning, to the prevention and fighting of forest fires (IBAMA, 2023).

The Chico Mendes Institute for Biodiversity Conservation (ICMBio) carries out here in the Cerrado region, Chapada dos Guimarães, the prescribed burns that are essential in the prevention of forest fires, especially in the months of June and July due to the climatic conditions of the region and thus minimize environmental impacts (ICMBIO, 2020).

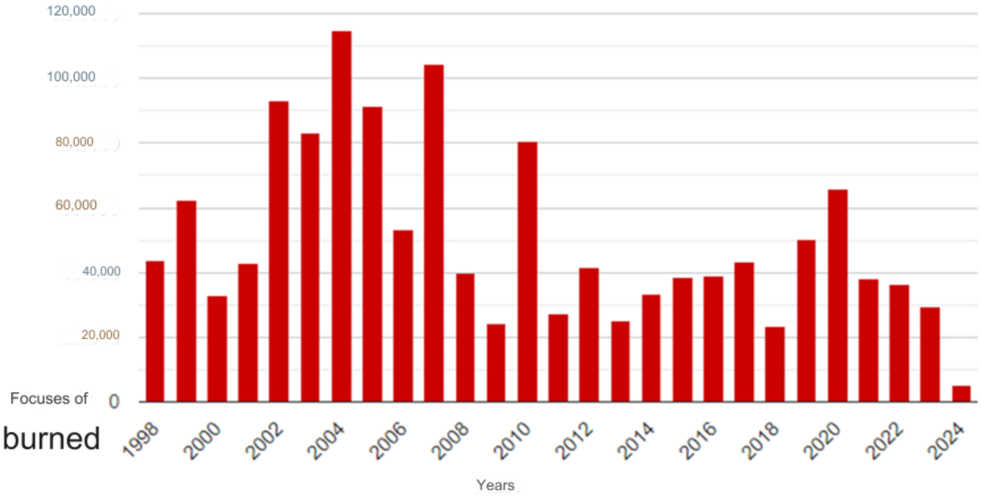
Prescribed burning is the use of fire in portions of vegetation creating a natural barrier to prevent the spread of flames when forest fires occur during the dry season. Burning and forest fires have a major contribution to the emission of air pollutants and this can cause direct and indirect effects on human health and the environment (IBAMA, 2023).

Tropical savannas are located in Asia, Australia, Africa, and Central and South America, corresponding to about 20% of the entire land surface (ICMBIO, 2020). They are characterized by the spatial and temporal heterogeneity of their physiognomies, discontinuous tree cover, herbaceous stratum vegetation, well-defined dry and rainy periods and frequent occurrence of fire. In Brazil, savannas are called by the term Cerrado, being the second largest Brazilian biome and the most biodiverse savanna on the planet, it presents a complex of phytophysiognomies, forming a mosaic in which grassland, savanna and forest formations are included (ICMBIO, 2020).

According to Bragança (2019), Brazil has 334 federal conservation units, of which 149 are full protection and 185 are sustainable use, in some regions of the country, in particular, the Cerrado Biome has one of the aspects that most require attention from managers is fire management in Conservation Units (UCs).

According to Figure 1, which shows the historical series in the country of fire outbreaks from 1998 to 2024, extracted from the Inpe website.

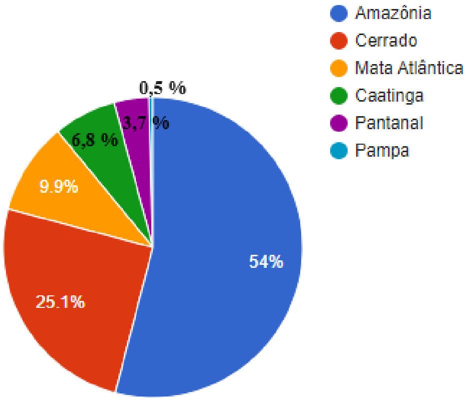
Figure 1. Historical series of the total active outbreaks detected by the reference satellite in the period from 1998 to 07/15/2024.



Source: Inpe, 2024.

In Brazil, it is observed that in the months of June and November there is an increase in the records of hot spots by the National Institute for Space Research (Inpe) and it happens in the Cerrado, Amazon and Pantanal Biomes and it is observed in this year of 2023 there is a great drought in the Amazon, the Pantanal with a large fire and this has been increasing deforestation indicators according to Figure 2.

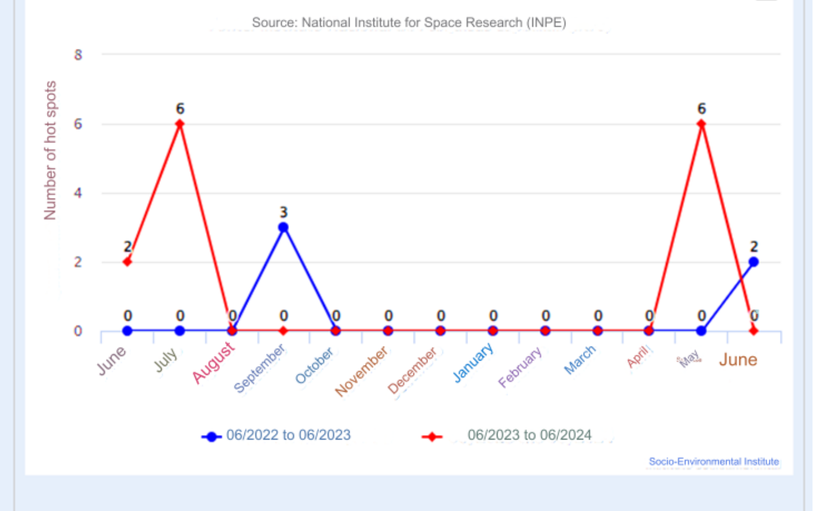
Figure 2. Fire outbreaks in the year 2024.



Source: Inpe, 2024.

Figure 03 shows the hot spots, a comparison of the last 24 months in which the area covered by the point is observed: a focus indicates the possibility of fire in an element in the pixel (image resolution) that varies from 1 km x 1 km to 5 km x 4 km. At this image resolution, one or several different fires can occur, but the indication will be a single focus. If the burn is too large, it will be detected in some neighboring pixels, that is, several fire outbreaks are associated with a large burn (INPE, 2024).

Figure 3. Heat sources: comparison of the last 24 months.



Source: Inpe, 2024.

According to the United States (2023), future projections for the regions where hot spots occur suggest that fire regimes will intensify and due to climate change, these regions have become more flammable and dry, they will double the area burned by forest fires by 2050.

During forest fires and the burning of biomass, pollutants are emitted, including particulate matter (PM 2.5), carbon monoxide (CO), sulfur dioxide (SO2), ozone (O3), hydrocarbons (HC), nitrogen oxides (NOx), black carbon (BC), and other toxic substances (ANDREAE, 1991). According to the World Health Organization (WHO), 90% of the world's population breathes air below safe levels. Thus, the risks of acute respiratory infections increase, especially in children and the elderly.

Nutrients are essential elements for soil development. The main components of soil fertilizer are: Phosphorus, Nitrogen, Carbon Knowing the current concentration informs environmental scientists of a nutrient deficiency or surplus in soils used to support plant production, and also provides an overview about the basic biogeochemical cycles of an ecosystem (PEREIRA, 2009).

Phosphorus (P) is considered a nutrient of low mobility in the soil, a behavior attributed to its "fixation" by clay minerals, and this element has a relevant presence in tropical soils that have high levels of iron and aluminum oxides – with which phosphorus has great affinity. Between 20 % and 30 % of the phosphorus applied as fertilizer is used by annual crops in tropical soils, and it is essential to apply quantities that, in general, far exceed the extractions of these crops (PEREIRA, 2009).

Nutrients such as nitrogen and phosphorus are the ones that most limit agricultural production and are necessary in the initial development of plants. However, soils here in Brazil have a low amount of these nutrients. The nutrient phosphorus is associated with three biochemical processes such as: photosynthesis, energy production and respiration, participating in enzymatic processes that make up the structure of plant cells such as nucleic acids and cell membranes as well as being part of compounds responsible for the fixation of atmospheric CO2 and the metabolism of sugars (PEREIRA, 2009).

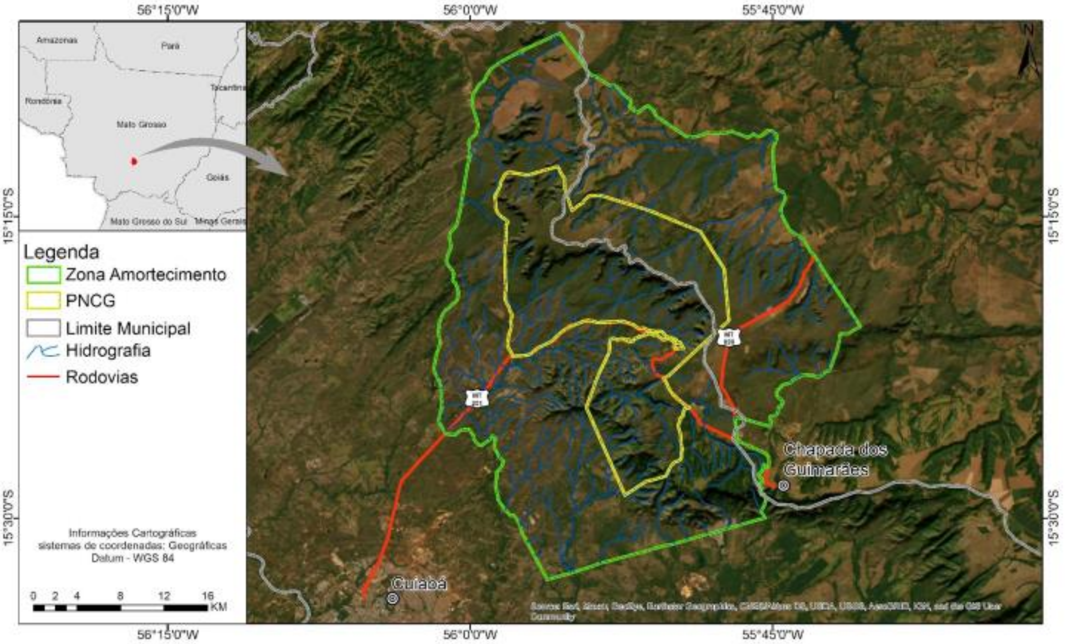
According to Vourlitis et al. (2014), soil fertility is a determining factor for the growth and increase of biomass. The presence of fire has been causing consequences in the existing Biomes, in which the Pantanal and Cerrado stand out. In the Cerrado, surface fires occur in the dry season and thus consume almost all soil biomass (MIRANDA et al., 2002).

It is of paramount importance to assess the impacts caused by fire on tropical soils. The purpose of this research is to: investigate the impacts of Integrated Fire Management (IFM) in an area of the Chapada dos Guimarães National Park, understand the effects of burning, both adverse and beneficial, on the availability of P and N; evaluate soil pH and moisture.

METHODOLOGY

The Chapada dos Guimarães National Park was created by Federal Decree 97.656, of April 12, 1989, to ensure the full protection of the fauna, flora, water resources and natural beauty of the region. In this context, several local groups, representatives of civil entities, have been developing environmental education projects aimed at reversing the current situation of degradation, which is visible in several places in the region. The park has a rich diversity of watercourses, many of them with waterfalls, which are its main tourist attraction (OLIVEIRA and HARDOIM, 2010). The Chapada dos Guimarães National Park (PNCG) is one of the main conservation and protection units of the Cerrado biome in Brazil. It is located in the Midwest region of the country, in the state of Mato Grosso, within the municipalities of Chapada dos Guimarães and Cuiabá (Figure 4) (MENGUE, 2022). Located between the geographic coordinates 15°10' and 15°30'S and 56°00' and 56°40'W, it is located within the Cerrado Biome, presenting a great biological diversity (IBAMA, 2002).

Figure 4. Location of the study area.



Sources: Conservation Units (CNUC, 2015); ZA – Proposal (PCCG/ICMBio, 2009); Hydrography (SEPLAN/MT, 2022); Municipal Limits (IBGE, 2021); Satellite Image (ESRI, 2022).

It covers approximately 32,630 hectares and includes numerous springs, trails, streams, rivers, backwaters and waterfalls, and whose rivers flow into the Cuiabá River, one of the main tributaries of the Pantanal (LOPES et al., 2009). The climatic conditions of the PNCG have a transitional character, mainly due to the differences in altitude between the regions of the Cuiabana Depression (350 m) and the Plateau (800 m), which have a climate classified, respectively, as Aw and Cw, according to Köppen. Both are characterized by being hot and humid, with two well-defined periods, one rainy from October to March (spring and summer) and the other dry between April and September (autumn and winter) (ICMBIO, 2009). The average annual temperatures vary from 25ºC (in the Baixada Cuiabana) to 21.5ºC (in the high peaks of the Chapada dos Guimarães), with the maximum daily temperatures in the Baixada Cuiabana exceeding 38ºC and the minimums, at the top of the Chapada, falling to less than 5ºC (ICMBIO, 2009).

The average annual rainfall remains between 1300 and 1600 mm of rainfall in the Baixada Cuiabana and reaches 2100 mm annually in the highest portions of the Chapada dos Guimarães, with the occurrence of precipitation concentrated in the first three months of the year. In the dry months, the relative humidity can reach levels below 20% (ICMBIO, 2009).

The Chapada dos Guimarães Park is visited by tourists from different places, as it has beautiful waterfalls and landscapes. In 2016, it received 158,365 visitors, ranking seventh in the ranking of the most visited National Parks in the country (ICMBIO, 2016). Thus, the importance of tourism in the conservation and management scenario of these conservation units and in the sustainable economic development of the region can be highlighted, since the economic impact of public use calculated for the park can reach R$ 43.3 million (RODRIGUES et al., 2018). But, despite the park being a conservation unit and having significant importance for the population of the municipalities of Chapada dos Guimarães and Cuiabá, it suffers several threats, including fire, especially in the dry season, which can modify the structure and floristic composition of the vegetation in a much more drastic way than the fires that occur in the rainy season.

Human occupation is also a threat, as there are private properties and possessions within the National Park, as well as logging and illegal extraction of plant products, in addition to the advance of agriculture (ICMBIO, 2009). The Chapada dos Guimarães National Park is part of the Upper Paraguay Hydrographic Basin (BAP) and is part of the Pantanal Biosphere Reserve as a Core Zone, due to its important main function, which is the protection of biodiversity (ICMBIO, 2020).

The samples were collected in July 2023 in the dry season, but it was not possible to collect the rainy season of the same year, due to the climate changes that happened in the same with a deep drought. In 2024, samples were collected from the rainy season (February) and May 2024 (dry season).

DETERMINATION OF GRAIN SIZE

The screening method was carried out in which coarse and fine sieving is done and stored in waterproof and sealed bags.

DETERMINATION OF HUMIDITY

Soil moisture is defined as the ratio between the mass of water (Ma) contained in a given volume of soil and the mass of the solid part (Ms) existing in that same volume (CAPUTO, 2017).

$$\%\mathrm{U} = \frac{M_a}{M_s} * 100$$

The collected soil was transported in impermeable and sealed packaging. It was placed in a freezer until the analyzes were performed.

GREENHOUSE METHOD

It is the most accurate and traditional method in which its determination is very simple: the mass of the sample is determined in its natural state and the complete mass after drying in an oven at 105 ºC to 110 ºC. It has an advantage over the others because it presents reliable results. In Brazil, the determination of soil moisture is standardized by the NBR 6457/2016 standard – Soil samples – Preparation for compaction tests and characterization tests. The following is the procedure for performing the test:

- After passing through the sieve in the granulometry, 10 g of the sample was weighed in containers and taken to the oven for 24 h at a temperature of 105 ºC.
- A new weighing was carried out after removing the set from the greenhouse.
- After that, the moisture was calculated (EMBRAPA, 2017).

Determination of pH

- The potential was measured electronically by means of the immersed electrode (pHmeter) in ground suspension.
- 5 g of sieved soil was weighed, 10 mL of distilled water was added to the numbered 100 mL plastic cup.
- The sample was shaken with an individual glass rod and the pH was read.
- Before taking the pH meter reading, turn on the potentiometer 30 minutes before it starts to be used. The potentiometer was measured with the standard solutions of pH 4.0 and pH 7.0 (EMBRAPA, 2017).

Determination Total Nitrogen (N)

- Digestion method with sodium and copper sulfates and determination of N by volumetry after retention of NH3 in boric acid, and steam distillation.
- 0.7 g of fine earth was weighed, placed in a 100 mL Kjedahl flask, weighed at approximately 0.001 g;
- 15 mL of the acid sulfate mixture was added and digestion was carried out, boiling the contents for 1 h or more, until the organic matter was completely destroyed;
- Allowed to cool, together with 25 mL of distilled water, stirred to homogenize and added 2 drops of syrupy ferric chloride solution;
- The 30% NaOH solution was gradually added until the solution was light brown (beginning of the formation of basic iron compounds);
- Allowed to cool, place the balloon on the scale, add water until the weight of the balloon is more than 60.35 g and mix the solution well;
- 12 g (10 mL) of the partially neutralized solution (extract from N mineralization) was transferred to the Kjedahl microdistiller;
- At the same time, 25 mL of 4 % boric acid solution was placed in a 125 mL Erlenmeyer Erlenmeyer solution, adding 5 drops of the mixed indicator to this solution;
- The free end of the distiller was inserted into the solution, taking care to keep it immersed at all times until the end of the distillation;

- 2 mL of 30 % NaOH was added to the partially neutralized solution (extract from N mineralization) and the ammonia was distilled by steam for 5 minutes;
- The distillate volume was titrated after cooling with a standardized solution of H2SO4 0.01 N until the color changed from purple or bluish to pink;
- Finally, the blank test and calculations were carried out (EMBRAPA, 1997).

Determination of Ammonia Nitrogen

Nessler's colorimetric method

1. Principle of the method: The Nessler reagent (alkaline potassium iodine-mercurate) is decomposed, in the presence of ammonia, into a compound (dimercuryammonium iodide) of color varying from red-orange to brown, forming a precipitate. The reaction is done in basic means. Double potassium and sodium tartrate is added to delay the appearance of the precipitate. The compound formed can be measured in a spectrophotometer with a wavelength of 450 nm.

Reagents

- Potassium tartrate;
- Mercury iodide II;
- Potassium iodide;
- Sodium hydroxide 6 N;
- Ammonium chloride.

Preparation of Solutions

- Reagent 1: 50% potassium tartrate, with distilled water (50 g potassium tartrate for 100 mL distilled water).
- Reagent 2: mix 100 g of mercury iodide II with 70 g of potassium iodide and dissolve in 300 mL of distilled water. Add slowly and with constant stirring 500 mL of 32 % sodium hydroxide (160 g of NaOH to 500 mL of distilled water), after cooling, fill the volume to 1000 mL with distilled water. Stability of ± 2 months in the refrigerator.
- Standard solution (1000 mgN/L): dissolve 3.82 g of ammonium chloride in distilled water and complete the volume to 1000mL.

Procedure

- Centrifuge or filter the sample;
- Transfer 5 mL of sample to a test tube;
- Add 1 drop of Reagent 1 and shake;

- Add 2 drops of Reagent 2 and shake;
- Wait 10 min and read at 450 nm;
- Calibrate the device with white (EMBRAPA, 2017).

Phosphorus Determination (P)

- Colorimetric method by ascorbic acid using 0.05 N HCl and 0.025 N H_2SO_4 extractor solution;
- 10 mL of fine earth was placed in the 125 mL erlenmeyer and 100 mL of the extractor solution was added;
- Shake in a horizontal circular stirrer for 5 minutes;
- The sample was left to rest for one night, taking care to dismantle the mounds of earth that form in the central part of the Erlenmeyer bottom;
- 25 mL of the supernatant part was pipetted without filtering and placed in plastic containers of approximately 30 mL;
- 5 mL pipetted, 125 mL Erlenmeyer was placed to determine phosphorus;
- 10 mL of dilute ammonium molybdate acid solution and a pipette of ascorbic acid powder were added;
- Place in a horizontal circular stirrer and shake for 1 to 2 minutes;
- The sample was left developing the color for 1 h and then read at a wavelength of 660 nm;
- The amount of phosphorus in the sample was calculated (EMBRAPA, 1997).

RESULTS AND DISCUSSION

According to the transects demarcated in the Chapada dos Guimarães Park, the measurements carried out are in which Table 1 follows the measurements of pH and humidity in the dry season, July (2023) and May (2024) and in the rainy season, in February (2024).

Table 1. pH and Humidity for the month of July 2023 and May 2024 (dry season) and February 2024 (rainy season).

Year 2023 - July (dry)			**Year 2024 - February (rainy)**		**Year 2024 - May (dry)**	
Samples	**ph**	**% Moisture**	**ph**	**% Moisture**	**pH**	**% Moisture**
A1S1	5,44	1,22	5,88	2,35	4,98	1,55
A2S1	5,33	0,28	5,30	2,51	4,83	1,27
A3S1	4,78	1,69	5,41	1,57	4,29	1,09
B1S1	4,95	1,29	5,51	2,73	4,80	1,14
B2S1	4,61	1,04	5,29	4,62	5,06	2,03
B3S1	4,61	1,96	5,41	4,82	4,90	2,63
C1S1	4,58	0,4	5,61	3,28	4,68	2,68
C2S1	4,53	1,02	5,46	4,11	4,86	2,17
C3S1	4,65	1,29	5,32	3,37	5,09	1,68

It is observed that the pH presented acidity ranging from 4.53 to 5.44 in the dry period in July 2023, that is, the pH of the soils reflects the presence of H+ and Al+3 ions present in the exchange complex that represents the active acidity of the soil (KIEHL, 1979). For the collaborators Ritcher et al. (2011), the low spatial variability of pH is associated with the application of limestone.

According to Neto (2011), it presented a high acidity, because acidity is common in soils in regions where precipitation is high enough to leach appreciable amounts of interchangeable bases such as calcium and magnesium, another cause of acidity is intensive cultivation, because plants remove from the soil the essential nutrients for their development and production, Erosion can also be a cause, as it removes topsoil compared to the soil in the research.

It is observed that the pH presented acidity ranging from 5.29 to 5.88 in February 2024 in the rainy season, that is, the pH did not show changes in the sampled area or in the periods studied, remaining with values that present acidity that is common for the soil conditions of the Cerrado (MALAVOLTA and KLIENMANN, 1985) say that the Latosols, which are the vast majority in the Cerrado, have low fertility, high acidity and low base contents, and have a high degree of weathering, in which the release of H+ in the soil solution is an acidity agent (DA ROS et al., 2005).

According to Farias et al. (2013), the small increase in pH values can be explained by the fact that burning generates oxides and thus neutralizes acidity and adds these nutrients to the soil. And in the year in which the burning takes place or after one year of burning, there may be an increase in the pH due to the increase in the levels of ash produced from the combustible material present in the study area. This increase will be momentary, and thus, the pH will be altered due to the loss of these ashes, considering that burning can reduce acidity, close to the soil surface and this change may be enough to stimulate nitrification and vegetative growth of the area.

For Saggar et al. (2013), pH is an important factor that controls the denitrification process due to the sensitivity of the enzymes involved to soil acidity. Therefore, in this condition, the reduction in nitrous oxide reductase activity will increase in relation to N2O/N2 emitted from the soil. Thus, pH will also affect the structure of the community and the proportion of groups of microorganisms involved in the production of N2O.

However, for Huang et al. (2014), there is no consensus regarding the effect of pH on the activity of bacteria and archaea in ammonia oxidation. For some collaborators, they have shown greater activity of archaea in acidic soils and in calcareous soils, however responses contrary to these have also been obtained (YING et al., 2010).

According to Gleeson et al. (2011), moisture content should be considered in relation to the abundance of microorganisms involved in nitrification. Archaea appear to be more tolerant to water stress than bacteria and this may be related to O2 availability.

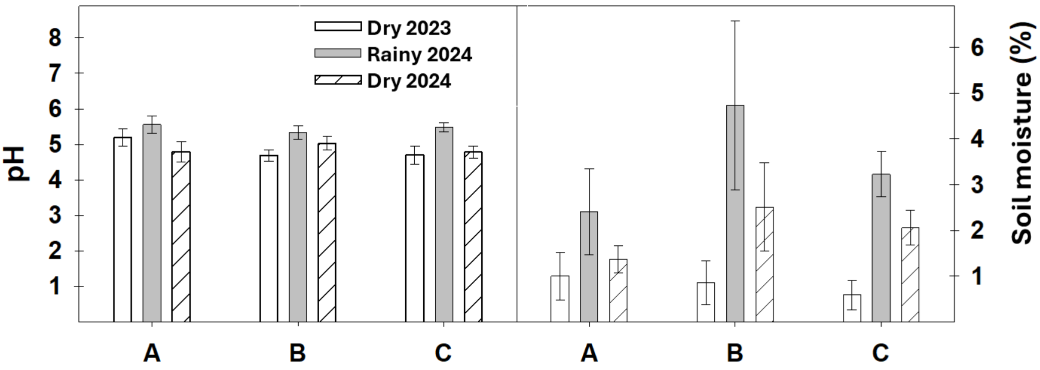
In conditions of an increase in acidity, root growth can be affected, making plants more sensitive to water deficiency compared to the minimum moisture content that was 0.28 and maximum of 1.96, and consequently in the effect of liming that can have the effect in conditions of this deficiency, the greater growth of roots and thus the greater possibility in crop yield. Another effect is the decomposition of organic matter in the production of organic acids of low molecular weight, acting on the decrease of the activity and toxicity of Al+3 in the deep and superficial layers of the soil (SIRTOLI, 2006).

The lowest pH was observed in the dry period of 2023 was 4.53 and in 2024 with a minimum of 4.29, corroborating that pre-burning promotes a reduction in soil pH due to the combustion of organic material. In the dry period, there was no significant variation in soil pH.

The reduction in pH in the native area may be related to the fact that the soil in the region is naturally acidic, and this causes the process of degradation of organic matter and its rapid mineralization that acidifies the soil naturally (SILVA JUNIOR et al., 2012).

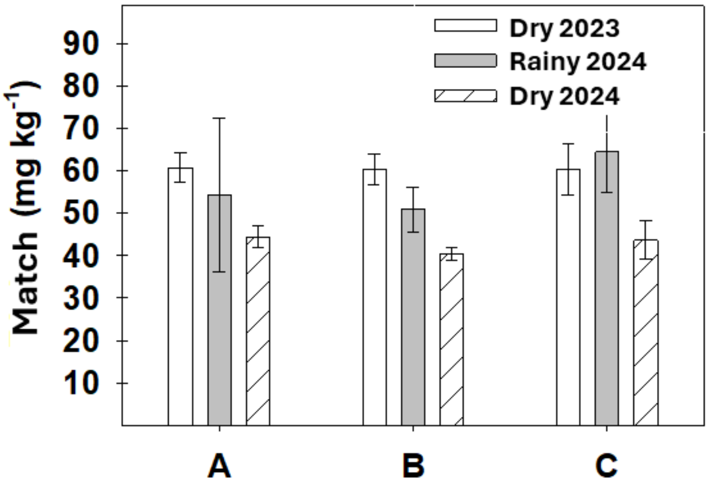
According to Figure 5, the minimum moisture content was 1.09 and the maximum was 2.68, so the low moisture in the soil corresponds to the fixation of N2 in legumes and is highly sensitive to water deficiency in the soil. The response of the symbiotic process to moisture stress depends on the growth stage of the plant. In general, it is more harmful to N2 nodulation and fixation when it occurs during the vegetative growth of the host (GLEESON et al., 2011).

Figure 5. pH and Humidity for the years 2023 and 2024.



According to Figure 6, the phosphorus values in mg kg1 are observed for the dry period of 2023 and 2024 and the rainy season, the P contents in the research were minimum was 40.36 and maximum of 60.78 for the entire period studied in the years 2023 and 2024, when compared to the work of Neto (2011), that the P level was very low, reaching 4.0 $^{mg.kg-1}$, which indicates the absence of use of nutrient sources. Phosphorus is the nutrient that most limits crop production in soils that are little or never fertilized, these limitations at the beginning of the vegetative cycle can result in restrictions in development in which plants do not recover later even if the P supply increases to adequate levels.

Figure 6. Phosphorus in the years 2023 and 2024.



Compared to the collaborators Ritcher et al. (2011), the P content was low, and after several years of adoption the availability of phosphorus tends to be higher in the superficial layers of the soil, due to the low mobility of the nutrient and the non-disturbance of the soil by repair operations (MUZILLI, 2002).

The P contents were higher in the rainy season of 2024, reaching a maximum of 75.33 mg $^{kg-1}$ and in the dry period the maximum was 60.78 mg $^{kg-1}$, which allows observing the fire event even with high intensity in the dry period decreases the availability of P, that is, the P contents are within the range considered very low, which is consistent with what is observed for soils in the Brazilian Cerrado (SOUSA and LOBATO, 2004). In 2023, there was a reduction, with low values, and according to Meurer (2007), phosphorus is a macronutrient that limits plant growth in most Brazilian soils because it is little available in acidic conditions.

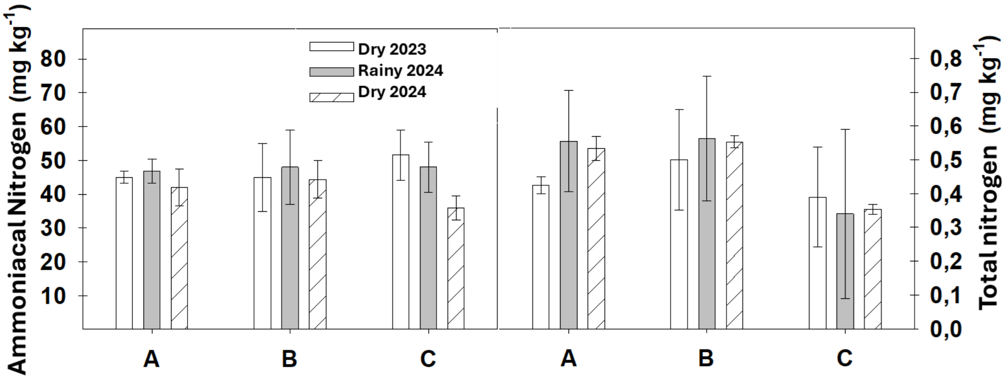
According to Sulieman and Tran (2015), phosphorus is used in several biochemical and molecular processes of the plant, in particular in the storage, acquisition, and use of energy. Insufficient levels in the soil are reflected in the reduction of the number and biomass of nodules, as well as in the decrease in nitrogenase activity.

It is possible to verify that the range of greatest availability of P in the soil occurs within the range of pH 5 to 6, when P is presented in the form of dihydrogen phosphate. At this pH there is a reduction in the precipitation of phosphorus forms linked to aluminum and also by the ion charge that is lower in this form. This contributes to clays, which, due to the variable charge, have a greater amount of negative charges at this pH, producing less energy of attraction of phosphorus by the clay minerals in the soil, resulting in a reduction in the electrostatic potential of the adsorption plane (HAYNES, 1984).

The authors in their studies verify that half of the phosphorus sorption capacity by the soil can be fixed with up to one month of contact after the application of the mineral to the soil. Highlighting the importance of knowing the behavior of phosphorus in different soils in relation to the sorption and desorption capacity of this element, enabling different managements, which promote greater efficiency in its use (NOVAIS and SMYTH, 1999).

According to Figure 7, the total N, minimum of 0.38 and maximum of 0.79, were low, a decrease in N availability is observed, due to the decrease in pH and this may be associated with a decrease in soil microbial activity, with a decrease in the population of bacteria, in which, on the other hand, the activity of fungi and actinomycetes may increase.

Figure 7. Total Nitrogen and Ammonia Contents.



Among the nutrients, nitrogen is the most studied, and its cycle changes with burning, and thus increases the amount of ammonia N, which is quickly nitrified and can be leached (DEBANO and CONRAD, 1979)

The recovery of plants after burning depends in part on the forms of nitrogen that remain available. Fire can cause small losses of nitrogen by volatilization (MROZ et al., 1980). The burning of dead vegetation enriches the topsoil in most nutrients, by accelerating mineralization, either biological or chemical. When comparing the burned areas, with or without grazing influence, they described a decrease in nitrogen in the superficial layer of the soil and no change to phosphorus (OWENSBY and WYRILL, 1973).

The effect of the fire will depend largely on its intensity. The results corroborate to show the incidence of high temperatures produced an increase in the pH and electrical conductivity of the soil, mainly by the accumulation of ash and release of nutrients. In the same way, the contents of mineral nitrogen and available phosphorus also increased, while organic matter and total nitrogen decreased (ANDRÉA and PETTINELLI, 2000).

According to Stevenson (1986), nitrogen is a widely studied element in relation to soil organic matter, being one of the nutrients with the most pronounced dynamics in the system. More than 90% is in the organic fraction where it is a large reservoir of more readily available forms, such as nitric and ammonia. These mineral forms, despite accounting for a small portion of the total nitrogen, are of fundamental importance from a nutritional point of view, as they are absorbed by plants and microorganisms.

According to Moreira and Siqueira (2002), the mineralization of soil organic matter, which includes the ammonification and nitrification reactions, transforms, on average, 2% to 5% of organic nitrogen per year, the process that influences soil use and management, as well as pasture areas, in which the ammonia form is favored by substances excreted by grass roots. in which they inhibit nitrification, and due to the existence of lower pH values, they occur under these conditions.

FINAL CONSIDERATIONS

Prescribed burning can alter the chemical characteristics of the soil without depending on the depth and the seasonal period that was analyzed, in which it proves that fire is capable of altering them.

The effects are rapid and it can be observed in the period studied after the passage of the fire, the chemical characteristics of the soil may have returned to its natural conditions.

However, prescribed burning is a fundamental and very efficient practice in reducing combustible material, and can be used in conservation units such as the Chapada dos Guimarães National Park, as it affects the chemical characteristics of the soil for a short time.

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