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PRE-EMERGENT HERBICIDES BETWEEN THE ROWS OF COFFEE

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ABSTRACT

Brazil is currently established as the largest producer, exporter, and consumer of coffee in the world. The state of Minas Gerais alone represents more than half of the Brazilian coffee produced. However, the competition of coffee plants with weeds can generate a reduction in crop production, by promoting significant losses in the scale of coffee production. The objective of this study was to evaluate the weed control efficiency of four pre-emergent herbicides used in coffee crops. The design adopted was in randomized blocks, with four blocks and five treatments, with plots of 14.0 m². The use of flumioxazine + pyroxasulfone was tested; pyroxasulfone; indaziflam; and oxyfluorphen, which made up the treatments, in addition to the one where herbicides were not used. The evaluations took place 15, 30, 45, 60, 90, and 120 days after the application (DAA) of the treatments, which consisted of the quantification of weeds emerged by simple visual counting, using a 1.0 m² wooden square to be the representative plot of the area. The data collected until the end of the 120 DAA were submitted to analysis of variance and the means were compared by the Tukey test at 5% probability. At 15 DAA, there was no statistical difference between the treatments composed of flumioxazine + pyroxasulfone; and pyroxasulfone; inquire where all are efficient in weed control. After 30 days of treatment application, weed control was superior when flumioxazine + pyrosulfone was used about oxyfluorophem and control. The results showed the efficiency of the herbicides Flumioxazine + pyrosulfone and Indaziflam up to 45 days after application, consisting of herbicides with long-lasting residuals. At 60, 90, and 120 DAA, only the herbicide with the active ingredient Flumioxazine + pyrosulfone showed statistical difference about the control, but with control efficiency considered very low (50.0%; 45.0% and 38.8% respectively) about the control. Although there is a residual effect, it is necessary to reapply herbicides after 45 years post-application so that weed control is efficient so as not to promote competition between them and coffee plants. It was concluded that the herbicide Flumioxazine + pyroxasulfone demonstrated a greater capacity to suppress weed emergence in up to 45 days, after which it is necessary to reapply the product.

Keywords: Weeds. Coffee growing. Invasive Plants. Control Efficiency.

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INTRODUCTION

Coffee (*Coffea sp.)* It is a very important commodity for the Brazilian national economy. The country is the largest producer, exporter, and consumer of this crop, with about 32% of the world's production. It is estimated that the country has 2.2 million hectares of planted area between the Arabica and Conilon species, and production of 50.92 million bags, with Minas Gerais being the most active state with 1.2 million hectares planted. In 2023, it is estimated that the harvest has not yet been completed throughout the country until October, with production of 96.3 million 60-kg bags (CONAB, 2023).

Brazil has the greatest diversity of weed species, where they exert great competition with young and adult crops, significantly reducing production. In studies carried out in coffee plantations with an average of four harvests, results were obtained, where the plots that were not heeded had a loss of production of 43% (MATIELLO, 1991).

The presence of other species, even if weedy, between the rows, can bring benefits to the coffee crop, such as increased biological diversity and the protection of the soil surface against erosion (FIALHO et al. 2010). However, coffee is very sensitive to weed competition (ALCÂNTARA & FERREIRA, 2009), having reduced the macronutrient content by up to 50% and the development of young coffee plants by up to 41% (CARVALHO et al. 2013). Therefore, coffee plantations require efficient management that avoids competition from crops with weeds (ALCÂNTARA & FERREIRA, 2009).

Aiming at this fact, pre-emergent herbicides were introduced in crop management to minimize coffee and weed competition. According to research on the use of pesticides (KLEFFMAN, 2010), 78% of the area planted with coffee plantations in Brazil adopts the use of herbicides, 85% of which is with the product glyphosate, 6% with 2,4-D. According to Christoffoleti et al. (2012), preventing the entry of herbicide-resistant weeds in an area is a correct tactic, and the use of residual herbicides is recommended. Rotation of different mechanisms of action of herbicides, weed control in areas adjacent to the crop, crop rotation and avoidance of weed seed production, measures that are not usual practices in coffee growing, and, as it is known, there is already a considerable selection of weeds in many areas, as occurs with the viola rope, trapoeraba, pain, among others. The objective of the present study was to evaluate the efficiency of four pre-emergent herbicides used in coffee crops.

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METHODOLOGY

The experiment was carried out in the research area of Santinato and Santinato Cafés. Headquartered at the Auma cafés farm, in the municipality of Patos de Minas - MG, under the geographic coordinates 18°44'13"S, 46°39'36"W and with an average altitude of 887.0 meters. The area was planted with the red catuaí 144 variety, with a spacing of 4.0 x 0.5 m. The coffee plantation was implanted in 2013, then having ten-year-old plants.

The climate of the region is classified as a tropical climate (Aw), with a high temperature and the division of two seasons, rainy in summer and dry in winter, maintaining an average temperature and rainfall of 21.8°C and 1,296 mm per year (CPTEC, 2022). The Eutroferric Red Latosol predominates in the location of the experiment, which is characterized by deep soils, allowing good root development in depth, with low natural fertility, clays of low activity, and high acidity, according to EMBRAPA (2021).

A randomized block design (DBC) was adopted for the qualitative test of pre-emergents, with four blocks with five treatments (herbicides). The floor area of each plot was 14.0 m², the implementation of the experiment took place in February 2023, right when the first rains of the year occurred.

Four herbicides registered for the coffee crop were chosen, thus constituting the treatments (Table 1), following the dosage recommended in the package insert for each product, and then the volume of mixture for the plots of the experiment was calculated. The experimental area underwent previous desiccation management with glyphosate herbicide and later used an agricultural brush cutter to eliminate dry clumps between the rows of coffee plants.

Table 1: Herbicides used to control weeds between coffee rows. UNIPAM. Patos de Minas - MG, 2023.

Treatment	Herbicide	P.C* Dose(L/$^{ha-1}$)	Dose applied (mL/14m2)
1	Control (without herbicide)		
2	Flumioxazine + Pyroxasulfone	1	4,2
3	Pyrosulfone	0,4	1,68
4	Indaziflam	1	0,63
5	Oxyfluorfem	0,3	4,2

*P.C = (Commercial Product)

The application of the products occurred after a rainfall of 26.0 millimeters, recorded by the rain gauge of the experimental station the day before the implementation of the experiment. Aiming at the presence of moisture in the soil for the best functionality of pre-

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emergent herbicides. The application was made with a 20.0 L backpack pump, with a JDF red jet fan-type spray nozzle with an application angle of 130º with a flow rate of 1.60 L $^{min-1}$. Napoleon's hat was also used, which is responsible for breaking the drift, preventing the winds from interfering with the application of the products, in addition to preventing the herbicides from causing injuries to the coffee plants.

At 15, 30, 45, 60, 90, and 120 days after application (DAA), the efficiency of each treatment was evaluated. Visually using simple counting. With the help of a wooden square measuring 1x1 meter, where was thrown into the plot at random, and inside it the weeds that emerged were quantified, and a percentage control survey was carried out in the plot, in which a visual scale ranging from 0 to 100% was used, in which one hundred (%) represented the absence of weeds and zero (%) represents an infested area, following the methodology described by Carvalho (2009).

The results were submitted for analysis of variance. Subsequently, with the help of the SISVAR software (FERREIRA, 2019), means were compared by the Tukey test with 5% significance.

RESULTS AND DISCUSSION

The results show that weed control was efficient up to 45 days after herbicide application compared to the control plot, as shown in Table 2. Although there is some weed control, the efficiency with only 50% control efficiency indicates the need for a new herbicide application to suppress these plants that can reduce coffee productivity and compromise the activity.

Table 2: Efficiency (%) of pre-emergent herbicides in the control of weeds between coffee rows, UNIPAM, Patos de Minas-MG, 2023.

Treatments	15 DAA	30 DAA	45 DAA	60 DAA	90 DAA	120 DAA
Control (without herbicide)	90.0 c	30.0 c	0.0 c	0.0 b	0.0 b	0.0 b
Flumioxazine + pyro sulfone	100 to	96.8 to	93.3 to	50 to	45 to	38.8 to
Pyrosulfone	99 AB	87.5 AB	84.8 abs	21.3 abs	17.5 ab	10 abs
Indaziflam	99.8 to	87.5 AB	86.3 ab	28.8 abs	27.5 abs	25 abs
Oxyfluorfem	98.5 b	70 b	65 b	15 b	7.5 b	5 b
CV (%)	1	12	15	59	78	92

Means followed by the same letter in the columns did not differ from each other by Tukey's test (p>0.05).

The statistics resulting from the study at 15 DAA time showed no difference between the treatments used with Flumioxazine + pyrosulfone; Pirosulfone; and Indaziflam, in none of the times evaluated, differing only from the portion treated with oxyfluorphen. This result demonstrates that chemical weed control is a useful tool that

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helps coffee growers.

The herbicide oxyfluorfen obtained control of 98.5%, 70.0%, and 65.0% respectively for 15, 30, and 45 DA. Where after this period there was a loss in weed control efficiency, and after this period a new application was necessary to keep the area clean for longer. However, in a study carried out by Santinato et al. (2016), it was found that oxyfluorfem applied successively after desiccation and mowing management presents better product functionality and that it achieved better efficiency when applied doses higher than those recommended between 4.0 and 8.0 L ha^{-1} of the product, being verified by the same satisfactory control up to 150 days after application. Still, Santinato's work is verified that the pre-emergent is responsive to the higher dosage, conferring better control efficiency for a longer time.

Also in the second comparative work on oxyfluorfen, carried out by Magalhães et al. (2012), it was observed that the application of the herbicide oxyfluorfen (2.5 L ha^{-1}) was effective in controlling pre-emergence weeds in the planting row of young coffee since they controlled satisfactorily for more than 60 days.

The discrepancy between the data from 45 to 60 days after application may have occurred due to the intense rainfall between the evaluation periods, where there were a total of 15 rainy days and an average of 150 millimeters between March and April, according to climatological data from the Center for Weather Forecasting and Climatological Studies CPTEC (2023). The rain contributed to the percolation of the herbicides to deeper layers of the soil. It also contributed to the deepening of the residual range and the shallower layers to be unprotected, favoring the germination of weed seeds present in the soil, causing the residual of the products to not be able to suppress the weeds that were emerging.

The control of weeds with the use of indaziflam in the application had results that were satisfactory with up to 45 DAA, after this period it was noted the loss of effectiveness in the use of the product in the area, so a new application was already recommended so that the inter-rows remain free of large infestations. In a study by San Juan, (2012) the application of indaziflam at a dose of 150 mL ha^{-1} was efficient in controlling the main weeds commonly present in coffee plantations, both in applications in the total area, between the rows, and in a jet directed to the fertilization range, in the projection of the skirt of the coffee trees. The dose of 50 mL ha^{-1} of indaziflam showed a gain in control in difficult-to-control plants such as rag and viola string.

In an evaluation of weed control efficiency at 45 days post-application, greater weed

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suppression was identified in plots applied with the herbicide pyroxasulfone + flumioxazine at up to 45 DAA. In results proposed by Vasques (2021), it was observed that pre-emergent herbicides based on pyroxasulfone + flumioxazine provided greater weed suppression, even in atypical climatic conditions. Data found by this author reinforce the results found in the present study since the ability of weed suppression with pre-emergent herbicide of this formulation brings with its use very satisfactory results.

After evaluation at 60 days post-application, a drastic reduction in the efficiency of herbicide control is noted. However, when compared to the control portion, there is still an active residual on the pulverized plots with pre-emergents. However, the results are below the ideal control for weeds, where critical competition with coffee plants already occurs, causing productivity to be significantly reduced. At the end of the evaluations in the 120 DAA, a certain residual presence of herbicides is still perceived in the treated plots.

CONCLUSION

Given the results of the present study, it was evident that the herbicide flumioxazine + pyroxasulfone obtained satisfactory results for the control of invasive plants in up to 45 days, and after this period a new application was necessary to avoid weed competition between the rows of the coffee plant.

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