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Effect of use of blends of coverage plants consortiated with the arabic coffee

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Abstract:

Background*: As plantas de coberturaexercemfunçõesprotetivas do solo, amenizandoosprocessoserosivos, melhorando o armazenamento de água e infiltração no solo. O usoassociado de 2 oumaisplantas de cobertura é conhecidocomo blends osquaistem o intuído de associarosbenefícios de cadauma das espécies. Visandoumaagriculturamaissustentávelobjetivou-se nestetrabalhoavaliar o efeito de blends de plantas de coberturaemconsórciocafeeiro.*

Materials and Methods:*The experiment was carried out at SítioPrata, located in the municipality of Campos Gerais, south of Minas Gerais, during the months of December / 2019 to September / 2020. The Mundo Novo coffee tract was used, planted in 2012. For the implementation of the experiment, soil analysis (0-20 cm) and application of glyphosate herbicide were carried out, where later the blends were planted, treatments: 1 * (buckwheat + crotalaria + millet); 2 * (buckwheat + chicken foot grass + millet); 3 * (buckwheat + crotalaria + lupine); 4 * (crotalaria + millet + chicken foot grass); Treatment 5 * (control - without planting cover crops). The cover plants were mowed when they reached flowering. The variables were analyzed: biomass and weed density, soil moisture and growth of plagiotropic branches of coffee.*

Conclusion: *Through the obtained data it can be concluded that the use of cover plant blends in consortium with the coffee tree, contributed to the greater storage of water in the soil, and to the suppression of weeds. In this context, the blends studied are shown as a sustainable alternative for the practice of coffee growing.*

Key Words*: Sustainable Agriculture; Biomass; Weeds; Plagiotropic.*

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I. Introduction

Coffee cultivation has been living with problems with weeds that are difficult to control, which compete in water, light and nutrients, thus preventing a good development of the cultivar and consequently losses in the quality of the drink in addition to requiring a quantity of agrochemicals. However, the national coffee culture has been undergoing changes demanded by its increasingly demanding consumers, in quality and sustainable production and that do not harm the environment.

In this context, weed control has been increasingly evidenced in agricultural studies, in order to develop practices that allow the use of chemical pesticides to be minimized[18]. One of the studies that has been gaining prominence in the fight against these plants refers to the use of soil coverings, since they act directly on the sustainability of the crop [16].

The consortium with cover plants in coffee plantations works on the cover of the soil, aiming at its protection against erosion, as well as the improvement in soil fertility, with possibilities to reduce the consumption of mineral fertilizers[5]. Avoiding nutrient losses, contributing to maintenance and development, and enabling a beneficial environment for the reuse of nutrients. This practice also contributes to weed control [13] [18].

According to [14] cover plant plants favor soil and water conservation, contributing to the success of the no-tillage system. The produced straw plus residues from commercial crops, provide a favorable environment for plant establishment, contributing to the stabilization of production and recovery or maintenance of soil quality.

Given the importance of developing sustainable cultivation practices, the objective of this study was to evaluate the effects of the consortium of blends of cover plants on coffee crops.

II. Material and Methods

The experiment was carried out at SítioPrata, located in the municipality of Campos Gerais, South of Minas Gerais, during the months of December / 2019 to September / 2020. The experimental area has the following geographical coordinates: latitude 21° 13'54" S and longitude 45° 46'16" W, altitude 1,205 meters. The selected coffee tract was the cultivar Mundo Novo, which was planted in 2012, with a spacing of 3 meters between rows and 1 meter between plants, at a stand of 3,333 plants / ha^{-1}.

Before the installation of the treatments, the collection was carried out with 20 sub-samples in the between rows of the coffee tree, using auger with a depth of 0-20 cm, using auger, as shown in table 1.The herbicide Roundup (Glyphosate 445 g / L ia, dosage 2 liters / ha^{-1}) and Aurora (Carfentrazone 400 g / Lia, dosage of 100 mL / ha^{-1}) were applied. jet sprayer, Magno Jet 11002 nozzle. On 02/06/2020, blends were planted, treatments: 1 * (220 grams of buckwheat (*Fagopyrum esculentum*) + 220 grams of crotalaria (*Crotalaria juncea*) + 220 grams of millet (*Pennisetum americanum*); 2 * (220 grams of buckwheat + 220 grams of chicken foot grass (*Eleusine indica* L.) + 220 grams of millet; 3 * (220 grams of buckwheat + 220 grams of sunflower + 340 grams of lupine (*Lupinus albus*); 4 * (220 grams of crotalaria + 220 grams of millet + 220 grams of chicken foot grass; treatment 5 * (control - without planting d and cover plants). The plots were planted between the lines of the coffee tree, where there were 12 coffee trees, with 3 lines of planting of the covers, spaced at 50 cm, usable area per plot of 18 m^2 with 4 repetitions, totaling 20 experimental plots in a randomized blocks design.

On May 23, 2020, the cover plants were in full bloom, during which the mowing was carried out to analyze the parameters: biomass of the cover blends (fresh and dry mass - Kg / ha^{-1}), according to the methodology described by Souza et al. (2002). The moisture content in the soil and the density of invasive plants were described according to the methodology of [6]. The growth of plagiotropic branches of coffee was described according to the methodology proposed by [8]. After the apparent decomposition of the cover plant biomass (2 months after mowing), collection was performed for chemical analysis of the soil (at a depth of 0-20 cm according to the methodology described by [4] (Table 1).

Table 1. Result of the chemical analysis of the soil in the 0-20 cm layer, before planting the cover plant blends

pH	**MO**	**P**	**K**	**Ca**	**Mg**	**H + Al**	**S**
$CaCl_2$	**g/kg**	**mg/dm^3**	**mg/dm^3**	**$cmolc/dm^3$**		**$cmolc/dm^3$**	**$cmolc/dm^3$**
5,55	2,28	43,46	151,02	2,52	0,60	4,70	0,15
SB	**T**	**V**	**B**	**Cu**	**Fe**	**Mn**	**Zn**
$cmolc/dm^3$	**$cmolc/dm^3$**	**(%)**			**mg/dm^3**		
3,51	8,21	42,75	3,66	4,20	6,52	1,55	

The data obtained from the evaluations were submitted to statistical analysis using the SISVAR® software [8], with the significant difference between treatments determined by the F test, with the means compared by the Scott-Knott test at the level of 5% of probability.

The analysis of the biomass of the blends shows that these mixes can minimize the proliferation of weeds in the coffee crop. According to [9] cover plants show rapid initial development, contributing to soil cover, reducing exposure to light and thus acting on the soil seed bank, even promoting suppression of weeds.

III. Results and Discussion

For biomass production (Table 2), the cover plants were managed, when they started flowering, (05/23/20) this time a sampling was done, using a 1 x 1 m^2 template, and thus, cutting these plants to assess their biomass. Treatment 1 (buckwheat + crotalaria + millet) differed statistically from the other treatments in both fresh and dry mass. Treatment 3 (buckwheat + crotalaria + lupine) had a lower rate of fresh and fresh mass when compared to the other blends.

The analysis of the biomass of the blends shows that these mixes can minimize the proliferation of weeds in the coffee crop. According to [9] cover plants show rapid initial development, contributing to soil cover, reducing exposure to light and thus acting on the soil seed bank, even promoting suppression of weeds.

Table 2. Green and dry biomass weight of the blends (tons / ha^{-1})

Treatments		Green biomass	Dry biomass
1	Buckwheat + Crotalaria + Millet	13,56 A	4,76 A
2	Buckwheat + Chicken foot grass + Millet	4,30 C	1,6 B
3	Buckwheat + Crotalaria + Lupine	3,9 C	1,06 C
4	Crotalaria + Millet + Chicken foot grass	5,50 B	1,45 C
5	Control	0	0

Means followed by the same letters in the column do not differ statistically from each other by the Scott-Knott test at 5% probability.

The evaluation of the moisture content of the soil was carried out using the Gravimetric method [6], when handling cover crops, when they were cleared. Through the data obtained in the analysis of the moisture content of the soil (Table 3), it can be seen that all treatments with cover plants provided greater storage of water in the soil, compared to the control treatment (without cover).

Treatments 1 (buckwheat + crotalaria + millet); and 2 (buckwheat + chicken foot grass + millet) obtained the highest moisture levels. Millet can be used in the dry season, since it allows water to be conserved in the field, avoiding high temperatures on the ground [7]. Millet enriches the soil with organic matter and nutrients, reducing weeds, directly influencing coffee production [7]. In this perspective, it is observed that the blends used in this research provided a better moisture content of the soil, since it contributed with the best quality of nutrients in it.

The research by [10], used the blend of plants, composed of (oats + turnip + lupine + vetch and rye) in consortium with the coffee tree and observed a higher moisture content in the soil, showing the potential of these plants in the storage of water in the soil.

Table 3. Soil humidity content (%)

Treatments		% humidity
1	Buckwheat + Crotalaria + Millet	13,2 A
2	Buckwheat + Chicken foot grass + Millet	12,2 A
3	Buckwheat + Crotalaria + Lupine	11,9 B
4	Crotalaria + Millet + Chicken foot grass	10,1 B
5	Control	9,15 C

Means followed by the same letters do not differ statistically from each other by the Scott-Knott test at 5% probability.

For the analysis of weed density, we used the $1m^2$ evaluation template, which was randomly launched in each plot and the values obtained refer to weed density (number of plants / m^2) methodology proposed by [6]. When analyzing the weed density (Table 4) we observed that both blends minimized the density of the stargrass (*Rhynchospora*spp) when compared to the control. The blend is more effective (crotalaria + millet + chicken foot grass). The density of the pickle was not reduced only after treatment 1 (buckwheat + crotalaria + millet). The density of the bitter weed was also reduced with both treatments.

The present study corroborates the study by [2] who used in their experiment a mix of cover plants (millet, crotalaria, pigeon pea, brachiaria and buckwheat). The authors identified that the treatments provided a significant reduction in weeds compared to the control. According to [17] and [3], cover plants, contribute to the management of weeds, acting as a physical and cultural control and also biological control through allelopathy.

Table 4. Weed density (m^2)

Treatments		*Bidens pilosa*	Conyza bonariensis	*Digitariainsularis*	*Peperomia trasparens*	*Rhynchosporaspp*	Total
1	Buckwheat + Crotalaria + Millet	3 A	0 B	1,5 B	0 B	5,25 B	9,75 B
2	Buckwheat + Chicken foot grass + Millet	3 A	0,25 A	1 B	0 B	6,5 B	10,75 B
3	Buckwheat + Crotalaria + Lupine	3,75 A	0 B	0,5 C	0,25 B	5,5 B	10,00 B
4	crotalaria + millet + chicken foot grass	1,5 B	0 B	1,25 B	0 B	4 B	6,75C
5	Control	4 A	0,5 A	3,5 A	1 A	11 A	20,00 A

Means followed by the same letters do not differ statistically from each other by the Scott-Knott test at 5% probability.

After 30 days of mowing, the growth of plagiotropic branches was evaluated (Table 5), which had been marked at the time of the research installation, and in relation to this parameter, there was no statistical difference.

Table 5. Number of internodes

Treatments	Numberofinternodes
Buckwheat + Crotalaria + Millet	5,0 A
Buckwheat + Chickenfootgrass + Millet	5,0 A
Buckwheat + Crotalaria + Lupine	5,5 A
crotalaria + millet + chickenfootgrass	5,5 A

Control	5,0 A

Means followed by the same letters do not differ statistically from each other by the Scott-Knott test at 5% probability.

[11] in their research, observed that the treatment with cocktail of cover plants provided an increase in the number of internodes of plagiotropic branches, differing from the results found here, and this variation can be considered, for the period analyzed.

When weeding weeds per m^2 x height (m) (Table 6), we can observe a lower rate of stargrass among all blends treatments, differing from the control treatment. In relation to the pickle, the most effective treatment was blend 4 (crotalaria + millet + chicken foot grass).

Table 6. Weeds per m^2 x height (m)

Treatments		*Bidens pilosa*	*Conyza bonariensis*	*Digitariainsularis*	*Peperomia trasparens*	*Rhynchosporaspp*	Total
1	uckwheat + Crotalaria + Millet	3,9 A	0,37 A	0,75 B	0 A	3,4 C	8,05 B
2	uckwheat + Chicken foot grass + Millet	2,7 B	0 A	0,9 B	0 A	4,8 B	8,77 B
3	uckwheat + Crotalaria + Lupine	3,6 A	0 A	0,3 C	0 A	3,6 C	7,5 B
4	crotalaria + millet + chicken foot grass	1,4 C	0 A	0,75 B	0 A	2,6 D	4,75 C
5	Control	3,6 A	0,1 A	3,2 A	0 A	7,16 A	13,88 A

Means followed by the same letters do not differ statistically from each other by the Scott-Knott test at 5% probability.

The present study corroborates the research by [16] where they identified that brachial cover plants, hog bean and dwarf mucunã reduced the amount of weed species between the lines and the coffee line, as well as the number of individuals.

The present study also analyzed the soil after planting the treatments (Table 7). It is noted that the blends contributed to the better nutrition of the soil, when compared to the control soil. Treatment 1 (Buckwheat + Crotalaria + Millet) provided a greater increase in the levels of phosphorus, calcium and magnesium in the soil. Treatment 2 increases calcium and magnesium levels. The present study corroborates the study by [11] where cover crops contributed to the increase of potassium and magnesium in the soil.

According to [12], cover crops contribute to the biological activity in the soil, contributing to the biological control of pests and diseases, thus enabling the increase of organic matter that can account for about 80% of the exchange capacity soil cationic.

For [20] cover plants such as millet and brachiaria contribute to the formation and preservation of soil coverings contributing to the rapid cycling of nutrients.

Table 7. Soil analysis (0-20 cm) after handling with blends

Treatments	pH	MO	P (resina)	K	Ca	Mg	H+Al	SB	T	V	B	Zn
	$CaCl^2$	g/kg	mg/dm^3	mg/dm^3	$cmolc/dm^3$	$cmolc/dm^3$	$cmolc/dm^3$	$cmolc/dm^3$	$cmolc/dm^3$	%	mg/dm^3	mg/dm^3
Implantação	5,5	2,3	43,5	151,0	2,5	0,6	4,7	3,5	8,2	42,8	3,7	
1 T C M	5,4 A	2,7 A	44,5 A	183,3 A	4,0 A	1,1A	2,5A	5,7 A	8,2 A	69,3 B	0,56 A	7,4 C
2 T P M	5,4A	2,5 A	22,4 B	165,6 A	4,2 A	1,3 A	1,8B	5,9 A	7,7 A	76,5 A	0,6 A	9,1 B
3 T C T	6,0 A	1,8 B	11,5 C	178,6 A	3,6 B	1,0 B	2,1A	5,0 B	7,1 A	70,6 B	0,55 A	13,5 A
4 C T P	5,8A	2,3 A	18,7 B	184,2 A	3,4 B	1,0 B	1,8B	4,9 B	6,7 B	73,2 A	0,61 A	7,1 C
5 Control	5,3A	2,7 A	24,9B	149,7 A	3,3B	1,0 B	2,2 A	4,7 B	6,9 B	67,9 C	0,55A	6,9C

1- Buckwheat + Crotalaria + Millet, 2 - Buckwheat + Chicken foot grass + Millet, 3 - Buckwheat + Crotalaria + Lupine, 4 - Crotalaria + Lupine + chicken foot grass. Means followed by the same letters do not differ statistically from each other by the Scott-Knott test at 5% probability.

IV. Conclusion

It was concluded that the use of blends of cover plants in consortium with the coffee tree, contributed to the greater storage of water in the soil, blend 1 (buckwheat + crotalaria + millet), which presented a greater biomass production, thus contributing to the improvement of soil fertility. All blends contributed to the suppression of weeds. In this context, the blends studied are shown as a sustainable alternative for the practice of coffee growing.

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