Original Article

TEMPERATURE AND HUMIDITY OF SOIL COVERED WITH PERENNIAL HERBACEOUS LEGUMES IN THE SEMIARID REGION OF MINAS GERAIS STATE, BRAZIL

TEMPERATURA E UMIDADE DO SOLO COBERTO COM LEGUMINOSAS HERBÁCEAS PERENES NA REGIÃO SEMI-ÁRIDA DO ESTADO DE MINAS GERAIS, BRASIL

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ABSTRACT: Agricultural sustainability of areas in semiarid region, is directly related to soil management, emphasizing especially the continuous coverage strategy. In this sense, this study aimed to evaluate the influence of perennial legumes on soil coverage, temperature and moisture in the semiarid region of Minas Gerais, Brazil. The study used a randomized blocks experimental, with 9 m^2, design and treatments consisted of bare soil cultivated with the following legumes: tropical kudzu (*Pueraria phaseoloides*), calopo (*Calopogonium mucunoides*), perennial peanut (*Arachis pintoi*), perennial soybean (*Glycine wightii*) and stylosanthes Campo Grande (mixture of *Stylosanthes capitata* and *Stylosanthes macrocephala*), with four replications. Soil coverage, temperature and moisture rates were evaluated. Due to the soil protection provided by the biomass production, the use and management of cover plants in semiarid region of Minas Gerais contributed to the temperature reduction and to the conservation of soil moisture, both essential for the agricultural production in this region. Calopo, tropical kudzu and perennial peanut provided greater soil coverage and, consequently, they provided greater reduction in temperature and higher moisture retention in soil. In more advanced stages of the cycle, the perennial soybean also provided good soil coverage, temperature reduction and moisture retention in the soil.

KEYWORDS: Cover plant. Green manure. Caatinga. Sustainability.

INTRODUCTION

In tropical regions, agricultural soils exposed to climatic, thermal and water phenomena need continuous protection in order to maintain their productive conditions. The management and direct exposure result in an increase in temperature and evaporation, loss of soil and nutrients, reduction of soil organic matter and destruction of the original structure of the soil, with consequence on agricultural productivity (PERIN et al., 1998).

Soil degradation in the Brazilian semiarid region is directly related to its inadequate use and management, through the excess in the use of mechanization, especially the plowing and harrowing, bad programmed fertilization, being aggravated by prolonged drought. Despite the rains being sporadic, rainfall events occur at certain times and places with great intensity, coupled with the low efficiency of the agricultural systems to protect soils, resulting in degrading events of great magnitude (ALBUQUERQUE et al., 2002).

However, the sustainability of these Caatinga areas, a Brazilian biome located in the semiarid region, can be achieved through the proper management of the soil, with emphasis to the use of cover plants (FARIA et al., 2004).

The adoption of the green manure practice performed with species of the family Fabaceae may represent an important strategy in the pursuit of the sustainability of the agroecosystems in this biome, given the benefits to the soil such as: permanent protection against the major causative agents of soil degradation (LEITE et al., 2010), maintenance of moisture, decrease in maximum temperatures and thermal amplitude of the soil (TORRES et al., 2006), in addition to the supply of N by biological fixation (GAMA-RODRIGUES et al., 2007), among other benefits, especially with the use of perennial herbaceous species, which have great potential as soil coverage, for covering the ground for some months or throughout the year (PERIN et al., 2009).

In tropical climates, the water transpired by plants is often lower than that evaporated directly

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from the soil (PRIMAVESI, 2002). Thus, the use of cover plants in farming enables greater optimization of productive resources, especially water, a primary limiting resource for the agricultural activity of the Brazilian semiarid region (OLIVEIRA et al., 2002). Moreover, a bare soil will have its surface encrusted by rain, and as a consequence, the surface water runoff and, hence, the erosion will be more intense than the ones occurring in a soil covered by vegetation (PRIMAVESI, 2002).

The identification of legumes species adapted to the edaphoclimatic conditions of the region where they will be inserted is essential to ensure the successful use of these plants as permanent coverage. These because the success of the practice depends on the knowledge related to the behavior, adaptation, requirement (nutritional, photoperiodic life, water) and residence time of the species in the environment in which it was introduced. In recent years, several studies regarding the behavior of herbaceous perennial legumes were performed (ESPINDOLA et al., 2005; GUERRA et al., 2007; PERIN et al., 2009). However, information on the behavior of these species in the Caatinga conditions are scarce, especially for the region of Jequitinhonha Valley (Vale do Jequitinhonha) in Minas Gerais, Brazil.

Thus, this study aimed to evaluate the influence of perennial herbaceous legumes on soil coverage, temperature and moisture in the semiarid region of Minas Gerais, Brazil.

MATERIAL AND METHODS

The study was conducted in the experimental area of the Escola Família Agrícola de Jacaré – EFAJ in city of Itinga, MG, Brazil, at latitude 16° 28' 04" South, longitude 41° 59' 50" West and altitude of 672 m, in the region of occurrence of Caatinga biome in the Middle Jequitinhonha. The region is characterized by its tendency to semiaridness, with an average annual temperature of 24.4°C and annual rainfall of 700 mm, with high concentrations in the summer months (OLIVEIRA et al., 2002), corroborating the meteorological data observed in this study (Figure 1).

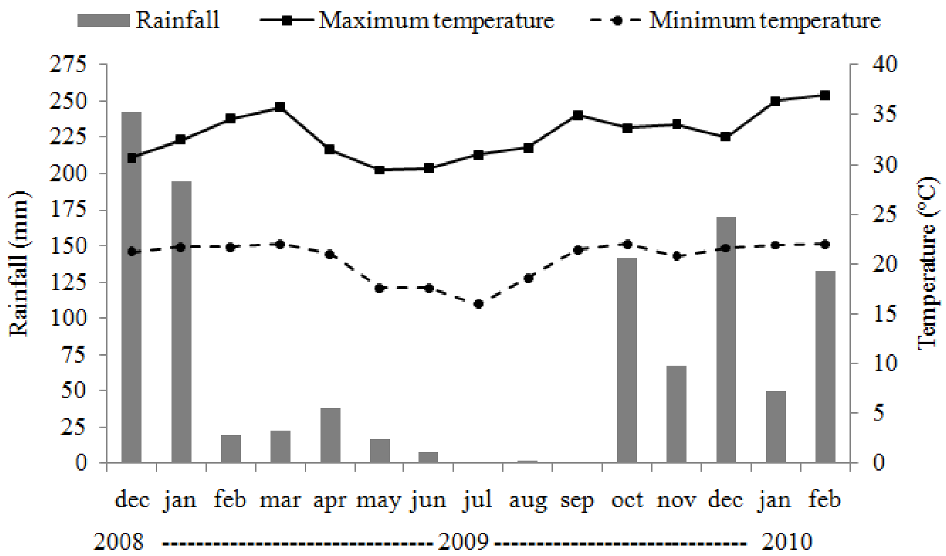

Figure 1. Average monthly rainfall (mm), maximum and minimum temperature (° C) observed in the period from December 2008 to February 2010, in Araçuaí-MG. Source: Data from INMET Network, 2014.

The area in which the experiment took place was in fallow, covered by spontaneous vegetation, predominantly *Cenchrus echinatus*, the Poaceae family, followed by *Bidens subalternans*, Asteraceae family, and the soil was classified as Yellow Argisol (EMBRAPA, 2014). Soil samples (0 to 20 cm) were collected and their chemical and granulometric characteristics showed the following values: pH 5.9 in water; 0.0029 dag kg^{-1} of P $_{(Mehlich\ 1)}$; 0.0426 dag kg^{-1} of K; 28.0 molc dm^{-3} of Ca; 18.0 molc dm^{-3} of Mg; 2.0 molc dm^{-3} of Al; 63% base saturation; 1.7 dag kg^{-1} of organic matter; 64% sand, 10% silt and 26% clay.

The study used a randomized blocks experimental design and treatments consisted of bare soil cultivated with the following legumes: tropical kudzu (*Pueraria phaseoloides*), calopo (*Calopogonium mucunoides*), perennial peanut (*Arachis pintoi*), perennial soybean (*Glycine wightii*) and stylosanthes Campo Grande (mixture of

Stylosanthes capitata and *Stylosanthes macrocephala*), with four replications. The area of each plot was 9 m^2 (3 m x 3 m), and central 2 m^2 was considered useful area.

Before sowing, only a hand weeding was carried out in the entire experimental area, followed by the opening of planting rows of legumes. Legumes were sown in December 2008 at a depth of 2 cm, furrow spacing of 40 cm, with an average density of 20 seeds per meter of furrow. The seeds did not undergo any kind of treatment to break dormancy.

The rate of soil cover was determined at 30; 60; 90; 120; 150; 180; 265; 325; 355; 375; 405 and 440 days after sowing (DAS) the legumes, by the method of number of intersections described by Fávero et al. (2001), using a wooden frame 1 m² strings containing a network, spaced 10 cm, 100 defining points on the area in which they wanted to determine the coverage. The intersection of two perpendicular strings defines a point and is an area, as adopted spacing. It is reported then the number of intersections that are on vegetation. The sum of these points, which means the sum of the areas that represent these points, in relation to the total area of the set points, estimates the soil cover.

Soil temperature was measured at the depths of 5; 10 and 15 cm, at 30; 60; 90; 120; 150; 355; 375 and 440 DAS, always at 2 p.m. Instant readings were performed by a digital thermometer, model SoloTerm 1200, which uses metallic probe.

Volumetric soil moisture was indirectly determined through the soil bulk density, by standard greenhouse method (BERNARDO et al., 2006.), at 30; 60; 90; 120; 150; 180; 265, 355 and 375 DAS. The collections were performed in the layer of 0 to 5 cm under the soil.

For verification of normality and homoscedasticity of data were used Liliefors and Cochran & Bartlett tests, respectively. Data were subjected to analysis of variance by F test and the means were compared by Tukey test at 5% probability. It calculated the Pearson correlation coefficients to determine the degree of relationship between the variables. Statistical analyses were performed using the SISVAR statistical software (FERREIRA, 2008).

RESULTS AND DISCUSSION

There was no difference among the legumes regarding the time of seedling emergence. Most species showed values which were greater than or equal to 80% emergence 7 days after sowing (DAS).

Calopo and perennial peanut had higher percentages of soil coverage, around 99% and 74%, respectively, at 90 DAS (Figure 2). Tropical kudzu showed slower initial growth when compared with calopo and perennial peanut, however, as it can be seen in Figure 2, from 120 days on, the three species completely covered the soil.

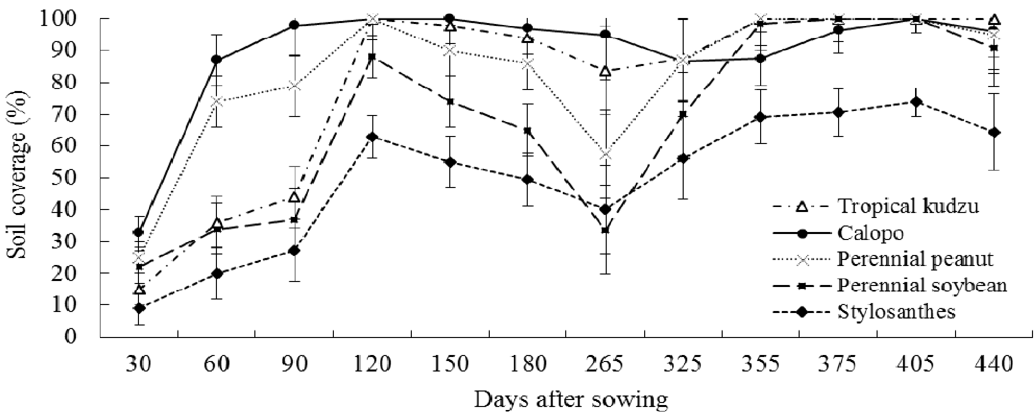

Figure 2. Soil coverage by herbaceous perennial legumes in the Caatinga region, in the Middle Jequitinhonha Valley. *Vertical lines indicate the least significant difference at 5% using the Tukey method to compare treatment means.

Similar behavior was also identified by PERIN et al. (2000) and GUERRA et al. (2007) in the Atlantic Forest region, for calopo, tropical kudzu and perennial peanut, when the authors observed that the average time for the total soil coverage was 106; 106 and 114 days, respectively. In the current study, these three species were those that had the highest rates of soil coverage up to 325 DAS, highlighting the calopo. Up to 265 DAS, the driest period of the performed evaluations (Figure 1), the perennial soybean showed 88% maximum soil coverage, at 120 DAS, while the stylosanthes showed 63% maximum soil coverage (Figure 2).

All species started a reduction process in the rate of soil coverage at 120 DAS, which was more evident for Stylosanthes species, perennial soybean and perennial peanut. This occurred due to the high temperatures and shortages of rainfall, since it was the beginning of the dry season, which is characteristic of this region (Figure 1). As the dry season spread, the plants responded with significant senescence of leaves, which reduced soil protection. However, as the deposited leaves were not removed from the area and the low coverage rate that legumes offer, was due to the deposited organic material.

Another factor that probably contributed to the decline in the coverage rate was the beginning of the reproductive period of legumes. The stylosanthes presented, in all plots, flowering plants at 120 DAS. The perennial soybean and calopo had full bloom at 150 DAS. The later flowering was tropical kudzu which showed around 20% of flowering plants from 150 DAS, lasting up to 180 DAS. This behavior of the species, except for the tropical kudzu, strengthens the potential for their use as permanent living mulch in the studied environment, because the production of seeds prior to the dry period ensures the reseeding of areas and the maintenance of the species through their restoration when the rainy season returns.

At 265 DAS, in a period of complete drought in the region, August 2009 (Figure 1), calopo and tropical kudzu had higher rates of soil coverage (Figure 2) provided by the senescent phytomass of these legumes. However, the tropical kudzu was the only one that showed green cover in this period, around 10% of the phytomass covering the soil. The higher soil coverage provided by calopo and tropical kudzu can be explained by the increased production of both green and senescent phytomass by these species.

With the onset of the rainy season in October 2009 (Figure 1), at 325 DAS, legumes resumed growth. In this period, calopo showed lower soil coverage in relation to 265 DAS, a fact explained by the decomposition of senescent phytomass previously deposited to the soil and by the slow initial rate of coverage promoted by the growth of young plants, since calopo had little regrowth. On the other hand, regarding tropical kudzu, the increase in the rate of soil coverage was small, because this species already had soil coverage around 80% at 265 DAS (Figure 2), promoted by senescent phytomass.

In this period, the increase in the rate of soil coverage was greater for perennial soybean and perennial peanut. This was probably due to the lower accumulation of senescent phytomass on the soil during the dry season, providing less soil coverage at 265 DAS. However, with the onset of rains (Figure 1), these species began to grow again and recovered the soil reaching rates near 100% coverage at 355, 375 and 405 DAS, equaling the tropical kudzu.

With the onset of rains, differences were observed between the legumes regarding their way of recovery. All legumes sprouted, except calopo, which has been reestablished via germination of the seeds released after the fruiting occurred in the dry season. Among the sprouted species, tropical kudzu had excelled mainly by the rate of restoration of its vegetative mass, while calopo stood out for the high seed production, demonstrating its potential in reseeding the areas.

After the resumption of growth, with the onset of rains, calopo completely covered the soil only at 405 DAS (Figure 2). This is probably due to the physical barrier promoted by senescent phytomass itself, which remained in the area after the dry season, thus hindering the emergence of seedlings.

All legumes have fickle habit of growth, with the exception of perennial peanut which shows creeping habit (stoloniferous) and Stylosanthes Campo Grande, a mixture of *Stylosanthes capitata* which features a more vertical growth habit, and *Stylosanthes macrocephala*, which presents a more horizontal growth habit, which may have influenced the lower soil coverage observed in this last legume.

In general, the soil coverage provided by legumes at 440 DAS decreased (Figure 2). This fact is probably related to the low rainfall and high temperatures occurring during this period (Figure 1), which could have caused stress in the legumes, and as a result, decrease in soil coverage, except for the tropical kudzu, which maintained 100% coverage, showing its greater tolerance to high temperatures and low soil moisture.

It is noteworthy that, at 440 DAS, legumes restated their reproductive period, since flower buds were observed in all species. This behavior strengthens the potential for the use of some legumes as permanent cover in semi-arid environment, because seed production can ensure the reseeding of areas, representing an alternative for the species preservation.

In general, with the return of the rainy season and the subsequent resumption of growth of legumes at 325 DAS, it can be stated that tropical kudzu, calopo, perennial peanut and perennial soybean had a satisfactory soil coverage rate for the semiarid region where the study was performed, especially the tropical kudzu.

As for the variation of soil temperature, we can observe differences between the soil covered with some legumes and bare soil, at all periods and depths evaluated (Table 1). It was observed that from 30 to 90 DAS, the highest soil coverage observed for calopo, tropical kudzu and perennial peanut (Figure 2) also promoted greater reduction of soil temperature compared with the bare soil at all depths evaluated (table 1). However, from 120 DAS, the coverage of all legumes, with less intensity in stylosanthes, caused reduction of soil temperature, compared with bare soil.

Table 1. Temperature (°C) of soil with different plant covers, at 2 p.m., measured at the depths of 5, 10 and 15 cm, in eight periods.

Cover plants	Temperature (°C) Days after sowing							
	30	60	90	120	150	355	375	440
5 cm								
Tropical kudzu	35.3 bc	38.0 b	42.6 b	25.4 cd	31.7 b	28.6 bc	24.9 d	26.7 c
Calopo	32.3 d	29.9 d	36.9 d	23.9 e	31.1 b	32.2 b	27.2 c	29.7 b
Perennial peanut	34.1 cd	32.5 c	39.5 c	24.5 de	30.2 b	27.3 c	26.0 cd	26.7 c
P. soybean	36.6 abc	39.0 ab	43.6 ab	26.3 c	31.8 b	26.5 c	26.6 c	26.5 c
Stylosanthes	36.6 ab	39.7 ab	43.9 ab	28.3 b	33.7 b	31.9 b	30.7 b	31.3 b
Bare soil	38.0 a	40.8 a	45.2 a	34.2 a	42.4 a	45.8 a	44.3 a	45.1 a
CV%	5.8	4.3	4.7	4.2	5.7	5.3	2.2	3.6
10 cm								
Tropical kudzu	31.9 bcd	37.2 a	40.2 bc	24.7 c	30.1 bc	27.5 bcd	24.3 d	25.9 cd
Calopo	29.8 d	29.1 c	34.1 d	23.4 d	28.7 c	30.8 b	26.6 c	28.7 bc
Perennial peanut	31.1 cd	31.5 b	38.1 c	23.5 d	29.2 c	25.8 d	25.1 cd	25.4 d
P. soybean	33.7 ab	37.5 a	41.8 ab	25.7 c	30.8 bc	27.1 cd	25.9cd	26.5 cd
Stylosanthes	33.6 ab	38.3 a	41.1 ab	27.2 b	32.5 b	29.9 bc	29.2 b	29.5 b
Bare soil	35.4 a	39.4 a	42.9 a	30.9 a	39.6 a	40.5 a	38.1 a	39.2 a
CV%	4.8	4,0	3,7	3.7	5.6	5.0	2.8	4.3
15 cm								
Tropical kudzu	29.5 bc	35.6 a	38.0 ab	24.1 c	28.4 bc	26.6 bc	23.7 c	25.1 bc
Calopo	28.2 c	28.5 b	34.8 c	23.0 d	27.1 c	28.9 b	25.7 bc	27.3 bc
Perennial peanut	29.1 bc	30.4 b	36.2 bc	23.3 d	27.8 c	24.6 c	24.4 c	24.5 c
P. soybean	31.1 ab	35.8 a	39.6 a	25.1 c	29.2 bc	25.9 bc	25.7 bc	25.8 bc
Stylosanthes	30.8 ab	36.2 a	38.8 a	26.4 b	30.9 b	28.9 b	27.5 b	28.1 b
Bare soil	32.2 a	37.2 a	40.1 a	27.6 a	37.1 a	38.1 a	35.3 a	36.7 a
CV%	4.2	3.6	3.5	2.3	5.5	4.5	4.7	4.6

Values followed by the same letters, in the columns, do not differ from each other according to Tukey test ($p < 0.05$)

Temperatures observed at a depth of 5 cm were greater than the ones observed at 10 and 15 cm, which is related to a higher incidence of sunlight on the soil surface. The highest values of soil temperature were observed at 90, 355, 375 and 440 DAS, which is directly related to the observation of higher values for maximum temperature (Figure 1). Up to 120 DAS, the calopo coverage provided lower soil temperatures at the evaluated depths, which shows that the species has a greater ability to reduce soil temperature in less time (DAS) compared with the other evaluated legumes. However, in older age, from 355 to 440 DAS, the lowest temperatures were observed in soils covered by perennial soybean, tropical kudzu and perennial peanut (Table 1).

These results demonstrate that the cover plants directly contribute to the decrease of soil temperature. However, they exhibit different behaviors, which are directly related to the rate of soil coverage, in which calopo, tropical kudzu and perennial peanut stood out, as well as perennial soybean from 355 DAS.

The legumes' growing living mass added to the senescent biomass covering the soil surface constitute a physical barrier to sunlight and to energy transfer, which hinders the heat exchange between the soil and the atmosphere (STRECK et al., 1994). This reinforces the importance of using these species as permanent soil coverage, since soil temperatures above 40°C are considered unsuitable for plant growth (SIDIRAS; PAVAN, 1986).

According to Bragagnolo; Mielniczuck (1990), lower soil temperatures were observed when higher amounts of straw were applied on its surface, indicating the importance of the presence of permanent coverage on the soil in order to maintain lower temperatures. As for the Caatinga, where high temperatures cause stress in plants and increase crop evapotranspiration, often limiting some agricultural activities, the strategy of using species in permanent coverage can represent an interesting alternative for the farmer, aiming at reducing the soil temperature.

A significant difference was observed in the volume of water accumulated in the soil in relation to the coverage with different legumes (Table 2), highlighting the calopo, in which higher values from 30 to 405 DAS were observed. From 120 DAS, larger volumes of water were observed in the soil in all areas covered by the other legumes in relation to bare soil, with the exception of soil covered by stylosanthes, which showed the lowest coverage rates (Figure 2), and, therefore, only at 120 and 355 DAS it showed larger volumes of water compared with bare soil.

Table 2. Water volume ($mm^3\ cm^{-3}$) in the 0 to 5 cm layer of soil with different cover plants in ten periods.

Cover plants	Water volume ($mm^3\ cm^{-3}$)									
	Days after sowing									
	30	60	90	120	150	180	265	355	375	405
Tropical kudzu	79 c	87 ab	30 b	92 bc	66 b	43 b	27 b	64 a	78 c	59 ab
Calopo	121 a	99 a	68 a	136 a	82 a	69 a	34 a	58 a	103 a	64 a
Perennial peanut	101 b	90 ab	64 a	106 b	66 b	51 b	23 b	64 a	89 b	51 b
Perennial soybean	87 c	97 a	34 b	105 b	65 b	43 b	25 b	63 a	85 bc	59 ab
Stylosanthes	78 c	74 b	31 b	74 c	52 bc	38 bc	16 c	40 b	52 d	32 c
Bare soil	76 c	75 b	27 b	63 d	40 c	31 c	11 c	32 c	46 d	32 c
CV%	7.0	11.2	13.6	11.0	10.0	15.3	10.7	6.0	6.0	9.6

Values followed by the same letters, in the columns, do not differ from each other according to Tukey test ($p < 0.05$)

These results demonstrate the greater ability of some cover plants to preserve soil moisture in the Caatinga area of Minas Gerais. The best performance of calopo compared with other legumes may be related to its greater coverage capacity (Figure 2) and reduced soil temperature (Table 1) as well as the increased deposition of senescent leaves recorded throughout the experiment. These effects increase soil protection against direct sunlight, and, thus, alleviate the temperatures, decrease thermal amplitude, and entail lower evapotranspiration and higher soil moisture conservation. It is known that heatstroke in bare soil increases when compared with the protected soil, which causes more warming and, consequently, greater water evaporation (PRIMAVESI, 2002). According to Streck et al. (1994), any kind of coverage on the soil surface constitutes a physical barrier to the transfer of energy and water vapor between the atmosphere and soil, thereby, increasing the capacity of maintaining soil moisture.

From 120 DAS, decreasing values were observed in the volume of water stored in the soil, regardless of legume species. This is probably due to the high temperatures and low rainfall, since it was the beginning of the dry period in the region with the lowest rainfall recorded between July and September (Figure 1), confirming the observed smaller volumes of water in the soil at 265 DAS (Table 2). However, from 355 DAS, during the rainy season (Figure 1), larger volumes of water were observed in the soil, in relation to the 265 DAS.

All species, except stylosanthes, contributed to the maintenance of soil moisture. The higher humidity values were observed at 30, 120 and 375 DAS in the ground covered with calopo and minors were recorded at 265 DAS in soil covered with stylosanthes and bare soil (Table 2), demonstrating different potentials between the species on maintaining soil moisture.

The low soil moisture identified in the different legumes soil covers can be explained, in part, because the studied soil had franco-sandy texture, which has low water retention capacity. However, in the case of a biome where drought is one of the major limiters for the development of agricultural activities, the use of these cover plants can alleviate water losses during critical periods, especially legumes with greater potential for natural leaf fall, as it is the case of calopo, kudzu tropical and perennial soybean. Wastes of vegetable toppings promote retention of water in its structure, releasing it gradually to the soil and making it more humid in the surface layer, as it is in direct contact with them (OLIVEIRA; SOUZA, 2003).

By calculating the Pearson coefficients, one can confirm the influence of coverage on the temperature and soil moisture, as was observed positive and significant correlation coefficient for the variables cover and soil moisture, demonstrating an increasing linear relationship between land cover and soil moisture. It was also observed correlation between coverage and soil temperature, meaningful, however, negative, showing an inversely proportional linear relationship in which with increasing the ground floor there is a drop in temperature of the soil (Table 3).

Table 3. Pearson correlation coefficients (r) between the characters, cover, soil moisture and temperature.

	Cover	Moisture	Temperature
Cover	1	0,69*	-0,80**
Moisture		1	-0.37^{ns}
Temperature			1

*Significant (p <0.05); ** Significant (p <0.01); ^{NS} not significant (p> 0.05).

Considering the results, it was possible to note the importance of the management of cover plants in the studied region, since the high temperatures and the incidence of winds increase the evapotranspiration in the cultivated areas (PRIMAVESI, 2002), and such effects can be minimized by the shading and physical barrier provided by these legumes.

CONCLUSIONS

The use and management of cover plants in the semiarid area of Minas Gerais contribute to the relief of temperature and to the preservation of soil moisture.

Calopo, tropical kudzu and perennial peanut provide greater soil coverage and, hence, greater reduction in the temperature and greater retention of soil moisture, demonstrating the potential for permanent use as cover crops in soil semiarid region.

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RESUMO: A sustentabilidade agrícola das áreas na região semiárida está diretamente relacionada ao manejo do solo, ressaltando-se principalmente a estratégia de cobertura contínua. Neste sentido, esse trabalho foi realizado com o objetivo de avaliar a influência de leguminosas perenes sobre a cobertura, temperatura e umidade do solo no semiárido mineiro, Brasil. O delineamento experimental foi o de blocos ao acaso, e os tratamentos constituídos pelo solo descoberto e cultivado com as leguminosas: cudzu tropical (*Pueraria phaseoloides*), calopogônio (*Calopogonium mucunoides*), amendoim forrageiro (*Arachis pintoi*), soja perene (*Glycine wightii*) e estilosantes campo grande (mistura de *Stylosanthes capitata e Stylosanthes macrocephala*), com quatro repetições. Foram avaliados taxa de cobertura, temperatura e umidade do solo. Pela proteção ao solo proporcionada pela produção de biomassa, o uso e manejo de plantas de cobertura no semiárido mineiro contribuíram para a amenização da temperatura e a conservação da umidade do solo, essenciais para a produção agrícola nesta região. Calopogônio, cudzu tropical e amendoim forrageiro proporcionaram maior cobertura do solo e consequentemente promoveram maior redução da temperatura e maior retenção de umidade no solo. Em estágio mais avançado de ciclo, a soja perene também proporcionou boa cobertura de solo, redução da temperatura e retenção de umidade no solo.

PALAVRAS-CHAVE: Plantas de cobertura, Adubação verde, Caatinga, Sustentabilidade.

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