doi: 10.1590/S0100-83582016340100010

EUCALYPT GROWTH SUBMITTED TO MANAGEMENT OF *Urochloa* spp.[1]

Crescimento de Eucalipto Submetido a Manejos de ***Urochloa*** *spp.*

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ABSTRACT - The objective of this work was to evaluate the initial growth and the physiological characteristics of eucalypt submitted to different managements of signalgrass. The experiment was conducted in a protected environment, using a randomized blocks design with five repetitions. The treatments were arranged in a (5 x 2) + 1 factorial design, and the first factor corresponded to the types of weed management (no control; chemical control keeping the signalgrass shoot on the soil; chemical control with removal of the signalgrass shoot; mechanical control keeping the signalgrass shoot on the soil, and mechanical control with removal of the signalgrass shoot); the second factor corresponded to the two weeds species (*U. brizantha* and *U. decumbens*) and a control relative to the eucalypt in monoculture. The eucalypt growth was not affected by the presence of the *Urochloa* species until 50 days after treatments (DAT). However, the coexistence of these species with eucalypt for 107 DAT reduced the collar diameter, total dry matter, and the leaf area, but did not alter the characteristics related to photosynthesis and transpiration. The control method adopted, with removal or maintenance of the signalgrass shoot, regardless of species, did not change the initial eucalypt growth. It can be concluded that the coexistence of eucalypt with *Urochloa decumbens* or *Urochloa brizantha* for 105 days reduces the eucalypt growth. However, the use of chemical or mechanical control, with or without removal of signalgrass residue, were effective methods to prevent interference of these weeds.

Keywords: control methods, physiological variables, initial growth, *Urochloa* (syn. *Brachiaria*), eucalypt.

*RESUMO - O objetivo deste trabalho foi avaliar o crescimento inicial e as características fisiológicas do eucalipto submetido a diferentes manejos do capim-braquiária. O experimento foi realizado em ambiente protegido, no delineamento de blocos casualizados com cinco repetições. Os tratamentos foram arranjados em esquema fatorial (5 x 2) + 1, sendo o primeiro fator correspondente aos tipos de manejo da planta daninha (ausência de controle, controle químico mantendo no solo a parte aérea do capim-braquiária, controle químico retirando a parte aérea do capim-braquiária, controle mecânico mantendo no solo a parte aérea do capim-braquiária e controle mecânico retirando a parte aérea do capim-braquiária) o segundo às espécies de capim-braquiária (**Urochloa brizantha** e **Urochloa decumbens**), além de uma testemunha referente ao eucalipto em monocultivo. O crescimento do eucalipto não foi alterado pela presença das espécies de capim-braquiária até os 50 dias após a aplicação dos tratamentos (DAT). Todavia, o convívio dessas espécies com o eucalipto até os 107 DAT reduziu o diâmetro do coleto, a matéria seca total e a aérea foliar, mas não alterou as características relacionadas a fotossíntese e transpiração. O método de controle adotado com a remoção ou manutenção da parte aérea do capim-braquiária, independentemente da espécie, não alterou o crescimento inicial do eucalipto. Conclui-se que o convívio por 105 dias do eucalipto com **Urochloa decumbens** ou **Urochloa brizantha** reduz o crescimento do eucalipto. Contudo, os controles químico ou mecânico, associados ou não à retirada dos resíduos da capina do capim-braquiária, foram métodos eficientes para impedir a interferência dessas plantas daninhas.*

Palavras-chave: métodos de controle, variáveis fisiológicas, crescimento inicial, *Urochloa* (syn. *Brachiaria*), *Eucalyptus*.

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[1] Recebido para publicação em 24.2.2015 e aprovado em 13.7.2015.
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INTRODUCTION

The Brazilian forest sector is expanding, requiring the expansion of plantations for commercial purposes. In 2012, the *Eucalyptus* and *Pinus* plantations occupied 76.6 and 23.4%, respectively, of the 6,664,812 ha area intended for forest plantations (ABRAF, 2013). The favorable soil and climate conditions of the country, genetic enhancement, high phenotypic plasticity of the gender and the eucalypt plantations high productivity contribute to the growth of forestry companies production (Valverde et al., 2004).

Parallel to the monoculture, agroforestry systems emerge as a promising alternative for forest production in small- and medium-sized farms, because they integrate crop and forest culture with livestock, optimizing and adding value to the property. The increasing adoption of these systems, especially agro-silvopastoral and silvopastoral, has encouraged the search for alternatives for weed management in their areas, to reduce the system maintenance costs, thus adding more value to the forestry component.

Despite having a high yield potential, some factors may compromise eucalypt productivity. Among them is weed interference, causing direct and indirect losses to the crop, the example of the competition for environmental resources such as water, light and nutrients, producing and releasing allelopathic substances and hosting pests and diseases common to the crop, which may interfere with the harvesting (Pitelli & Durigan, 1985).

In the South and Southeast regions of Brazil, eucalypt plantations generally occur in areas previously occupied by pastures, and it is possible to observe a high level of infestation of the Poaceae family species (Toledo et al., 1996; Silva et al., 1998), standing out *Urochloa brizantha* and *Urochloa decumbens*. These species negatively interfere in eucalypt cultivation because they have greater water-use efficiency, rapid early growth and high biomass productivity during the year, even in low fertility soils (Silva et al., 2000a), thus becoming good competitors, especially in the initial stage of eucalypt growth and development. The interference of these species can reduce the growth of plants, the dry matter of leaves, stems, branches and roots, leaf number and leaf area (Silva et al., 1997; Toledo et al., 2000, 2001). Moreover, it may have allelopathic effects, causing reductions in photosynthetic activities of eucalypt plants (Silva et al., 2000b; Souza et al., 2003).

In order to provide conditions for the culture of interest to grow and develop without resource constraints, an adequate and efficient weed management is important. The control methods can be used alone or together and aim to reduce weed populations, keeping the weed community at levels that do not affect crop productivity and its economic efficiency (Vidal et al., 2005).

Weed management comprises preventive measures and cultural, physical, biological, mechanical and chemical controls. In forest plantations, the most frequently used controls are the chemical and mechanical ones, which can be used alone or combined (Toledo et al., 2003). Chemical control has been mostly used for extensive planting areas due to greater convenience, the shortage of manpower and at the lowest cost (Machado et al., 2010b). Currently, the most widely used active ingredient has been glyphosate, and its application is postemergence, usually in side strip cropping to the seed row.

Mechanical control has also been widely used for weed control in crops on small farms and agroforestry systems (Ferreira et al., 2010). Usually, this control is done by hand weeding, performing the mechanical crowning with a radius of 1 m. When mechanical crowning is done, the weeds shoots surrounding the eucalypt plant are removed; thus, there is greater exposure of soil and temperature can be increased and moisture can be reduced. Moreover, if the weeding is not done correctly, there may be injuries in the eucalypt stem. The mulch effect on the eucalypt plants surroundings is no consensus yet. Results presented by Souza (2008) have shown that the presence of mulch has favored eucalypt growth, and allelopathic effects were not observed.

The hypothesis in this study is that eucalypt growth can be influenced by the control method and residue management of signalgrass weeding. Thus, the aim of this study was to evaluate the initial growth and physiological characteristics of eucalypt submitted to different managements of two species of signalgrass.

MATERIALS AND METHODS

The experiment was carried out at Universidade Federal de Viçosa, in the Brazilian municipality of Viçosa, MG, in a protected environment, from October 2012 to February 2013. The experimental design was randomized blocks with five replications. The treatments were arranged in a (5 x 2) + 1 factorial design, the first factor corresponding to the types of weed management (lack of control, chemical control by keeping the soil residue of desiccated plants, chemical control by removing the residue of desiccated plants, mechanical control by keeping over the soil the torn shoot, and mechanical control by removing the signalgrass shoot), and the second factor corresponding to the signalgrass species (*Urochloa brizantha* and *Urochloa decumbens*), plus an additional control regarding eucalypt in monoculture.

The experimental units consisted of pots filled with 110 dm^3 (higher diameter: 58.5 cm; height: 51 cm; and lower diameter: 50.6 cm) of soil, with the following characteristics: 46% of clay; 16% of silt; 38% of sand; pH (water) of 5.3; organic matter content of 3.5 dag kg^{-1}; 47.4 mg dm^{-3} of P and 98 mg dm^{-3} of K; Ca, Mg, Al, H+Al and $CTC_{effective}$ with 2.2; 0.7; 0.0; 6.44; and 9.59 $cmol_c$ dm^{-3}, respectively. 110 g of dolomitic lime were superficially applied in each pot. The planting fertilizing was done by applying 120 g of NPK in the 06-30-06 formulation, divided into two side pits (at 10 cm at seedling side and 10 cm deep) per pot. The soil moisture control was done through weekly weighing the pots and water replacement in order to maintain humidity at 80% of field capacity determined by gravimetric method (Embrapa, 1997).

Eucalypt seedlings (*Eucalyptus urophylla* x *Eucalyptus grandis*, hybrid clone 386) were transplanted in the center of the pot and simultaneously *U. brizantha* and *U. decumbens* were seeded according to the treatments, remaining 10 plants per pot, equivalent to 50 plantas m^{-2}. At 10 and 30 days after transplanting (DAT) the eucalypt seedlings, fertilization took place with micronutrients in liquid at doses of 10, 17.5 and 100 mg per pot of boron, copper and zinc, respectively.

The growth of eucalypt plants was measured on 11/01/2012, 11/21/2012, 12/03/2012, 12/14/2012, 12/24/2012, 01/04/2013, 01/15/2013, 01/25/2013, 02/04/2013 and 02/14/2013, by plant height and stem diameter, with a graduated scale and a digital caliper, respectively.

At 50 DAT, control of the *Urochloa* species was held; *U. brizantha* and *U. decumbens* were at the time on average 39.31 and 33.37 cm high, and had 73.2 and 111.6 tillers, and 95.96 and 123.61 g of leaf dry matter, respectively.

For treatments in which there was a chemical control, this was accomplished by means of the application of glyphosate herbicide (1.944 g a.e. ha^{-1}) using a knapsack sprayer. At the time, the eucalypt plants were properly secured with plastic bags to avoid poisoning by contact of the leaves with the product. In the treatment providing the maintenance of *Urochloa* shoot (CC) after desiccation, there was a shoot accommodation on the pots surfaces after the weeds senescence. As for the treatment providing the withdrawal of the *Urochloa* shoots (CCR) after desiccation, weeds senescence was expected for cutting their shoot.

In treatments where manual control was held, this was done by cutting the *Urochloa* plants shoot with the help of a hoe, keeping (MCK) or removing (MCR) the signalgrass shoot, according to each treatment. When treatment provided the shoot removal, this was removed at about 3 cm below ground, lest it would regrow throughout the experiment.

At 105 DAT, stomatal conductance of water vapor (*Gs*), transpiration rate (*E*) and photosynthetic rate (*A*) were assessed and subsequently water-use efficiency (*WUE*) in eucalypt plants was determined. For this, a portable LI-6400 XT model infrared gas analyzer (IRGA) was used. Measurements were carried out between 9 and 11 am on the surface of two fully expanded leaves, in the upper third of the crown of each eucalypt plant. The irradiance for each measurement was 1,500 µmol of photons m^{-2} s^{-1}.

At DAT 107, the leaf area and the dry matter of leaves was evaluated. The leaf area was determined by means of the LI-3100 leaf area meter, using four samples collected in the lower, middle and top thirds of each plant. All the rest of leaves was removed from the plants, as well as the stem and root system, and this material was packaged in separate paper bags, which were placed in an oven with forced air circulation (70 ± 3 °C) until reaching constant weight. To obtain the leaf area, the total leaf dry matter was related to the leaf dry matter of the sample and the foliar area of the sample, resulting in the total leaf area. Subsequently, the percentage of dry matter distribution among the vegetative components of eucalypt was calculated by determining the relationship of the dry matter of each organ (leaf, stem and root) with the total dry matter of the plant. The final dry matter of the *Urochloa* species which remained during the experiment was also measured.

Data were submitted to analysis of variance by F-test at 5% probability. For comparison of results obtained between control and each treatment, Dunnett's test was used at 5% probability.

RESULTS AND DISCUSSION

There was no significant interaction between factors species of *Urochloa* and managements for variables total height, stem diameter and dry matter and leaf area of eucalypt plants. Among the factors, only management was significant, being deployed for study.

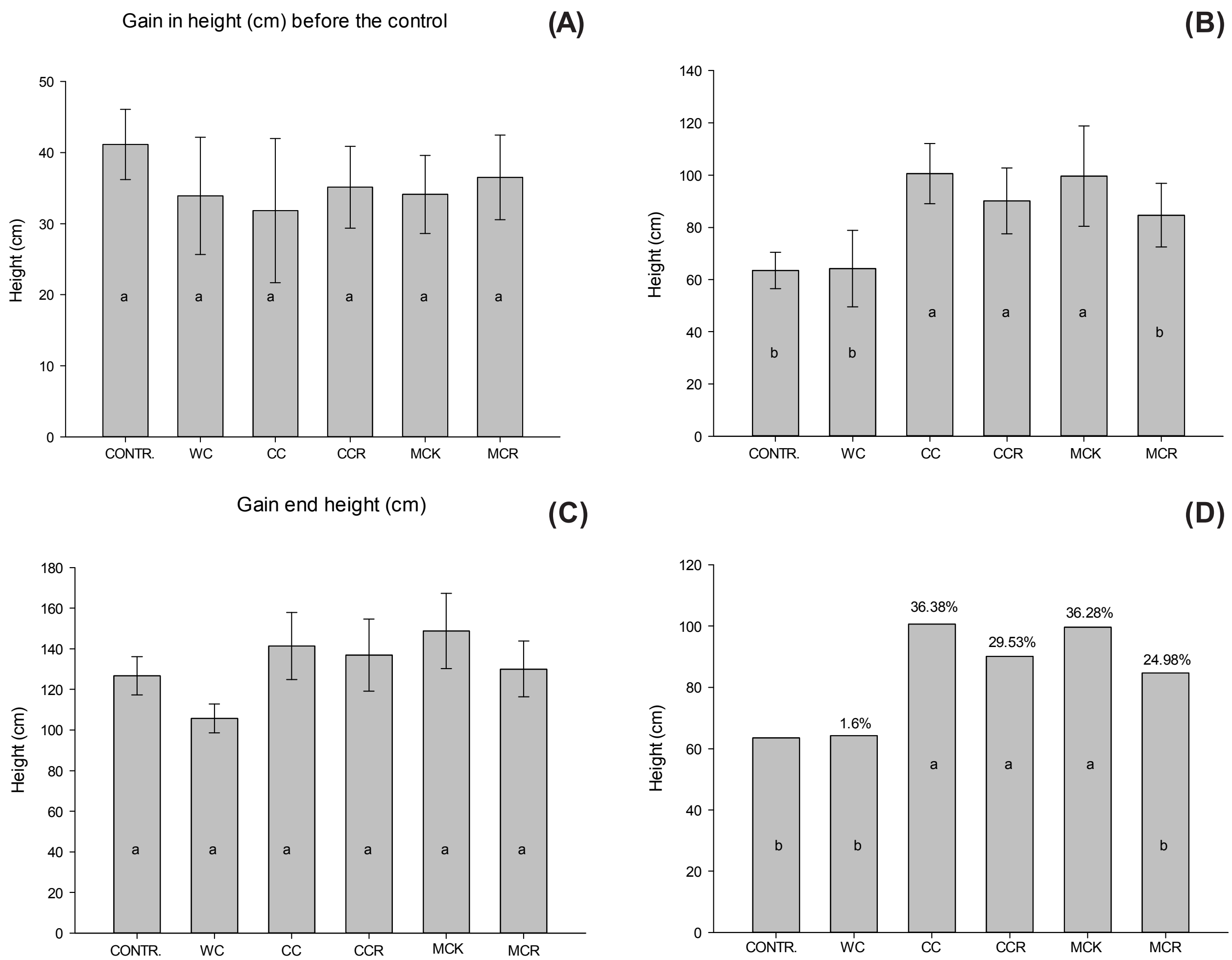
Eucalypt plants height was not affected by the coexistence with signalgrass plants up to 50 days after transplanting (DAT) eucalypt seedlings, and at this time the management of *Urochloa* plants was done (Figure 1A). However, it was observed that, after completing the controls (50 at 107 DAT), the gain in eucalypt height was higher in the treatments with chemical control, regardless of whether *Urochloa* weeding residues were kept (CC) or removed (CCR) from the pot, and when there was mechanical control by keeping residues on the ground (Figure 1B).

The interference of signalgrass plants (treatment without control – WC) decreased the eucalypt height by 16.58%, although difference in relation to other treatments was not noticed (Figure 2A). Probably the period of coexistence between eucalypt and signalgrass species was little for weeds to cause height reduction of forest species. Another important fact is that, in some cases, weeds can modify the forest species growth, promoting shading and/or providing mechanical support, which results in different responses to the competition (Rodrigues et al., 1991). Thus, there may be height gain and reduced stem diameter of the plants (Pitelli & Marchi, 1991). These results agree with those obtained by Toledo et al. (2001), wherein the height of eucalypt plants was less sensitive to interference imposed by *U. decumbens*.

The diameter of eucalypt stem was not affected by competition from *Urochloa* until the time control was adopted (Figure 2A). However, reduction in the accumulated stem diameter was found after the controls of the treatment without control (Figure 2B). This negative effect caused a reduction of 40.35% of the stem diameter, compared to the control (CONTR) (Figure 2C).

In a study conducted by Toledo et al. (2001), it was found that the coexistence of eucalypt with *U. decumbens* for 90 days, in a box with 50 L of substrate, provided an average reduction of 27.78% of stem diameter and 18.47% of plant height. Silva et al. (1997) have found that *E. citriodora* and *E. grandis*, coexisting with *U. brizantha* for 70 days in pots containing 3.25 L of substrate, showed lower growth in total height and stem diameter, regardless of soil water content. In the field, Toledo et al. (2000) have found that the coexistence of plants of *E. grandis* x *E. urophylla* with *U. decumbens* during the first year after planting eucalypt, decreased by 70.43% the stem diameter and 68.56% the height, compared to those free from coexistence.

Regarding the effect of keeping the *Urochloa* species weeding residues, the



CONTR: control free from coexistence of the *Urochloa* species; WC: eucalypt without control of *Urochloa* spp.; CC: chemical control by keeping the *Urochloa* spp. residue in the pot; CCR: chemical control by removing the *Urochloa* spp. residue from the pot; MCK: mechanical control by keeping in the pot the *Urochloa* spp. weeding residue; MCR: mechanical control by removing from the pot the *Urochloa* spp. weeding residue.

Figure 1 - Total plant height (cm) of eucalypt before controls (A); accumulated after the controls (B); final total height (C); and compensatory gain in height after the controls (D).

findings of this study are consistent with those observed by Dinardo et al. (1998). These authors have evaluated the effect of *U. decumbens* stubble presence on eucalypt for 230 DAT in 50 L cement boxes. The managements were done at 106 DAT by means of chemical (glyphosate herbicide) and mechanical controls, both keeping weed as mulch. No difference was observed among controls in the initial growth of eucalypt, and phytotoxicity symptoms of *U. decumbens* stubble on eucalypt were not found. Machado (2011), evaluating the chemical and mechanical crowning of eucalypt (both with 1 m radius) in a silvopastoral system, did not see differences in the eucalypt growth. However, Souza (2008), using the same control methods in the field for 280 days after planting, noted that mechanical crowning provided greater height growth for eucalypt.

The treatments with chemical control by keeping (CC) or removing (CCR) residues from desiccation, and treatments with mechanical control by keeping or removing the shoots increased by 36.38%, 29.53%, 36.28% and

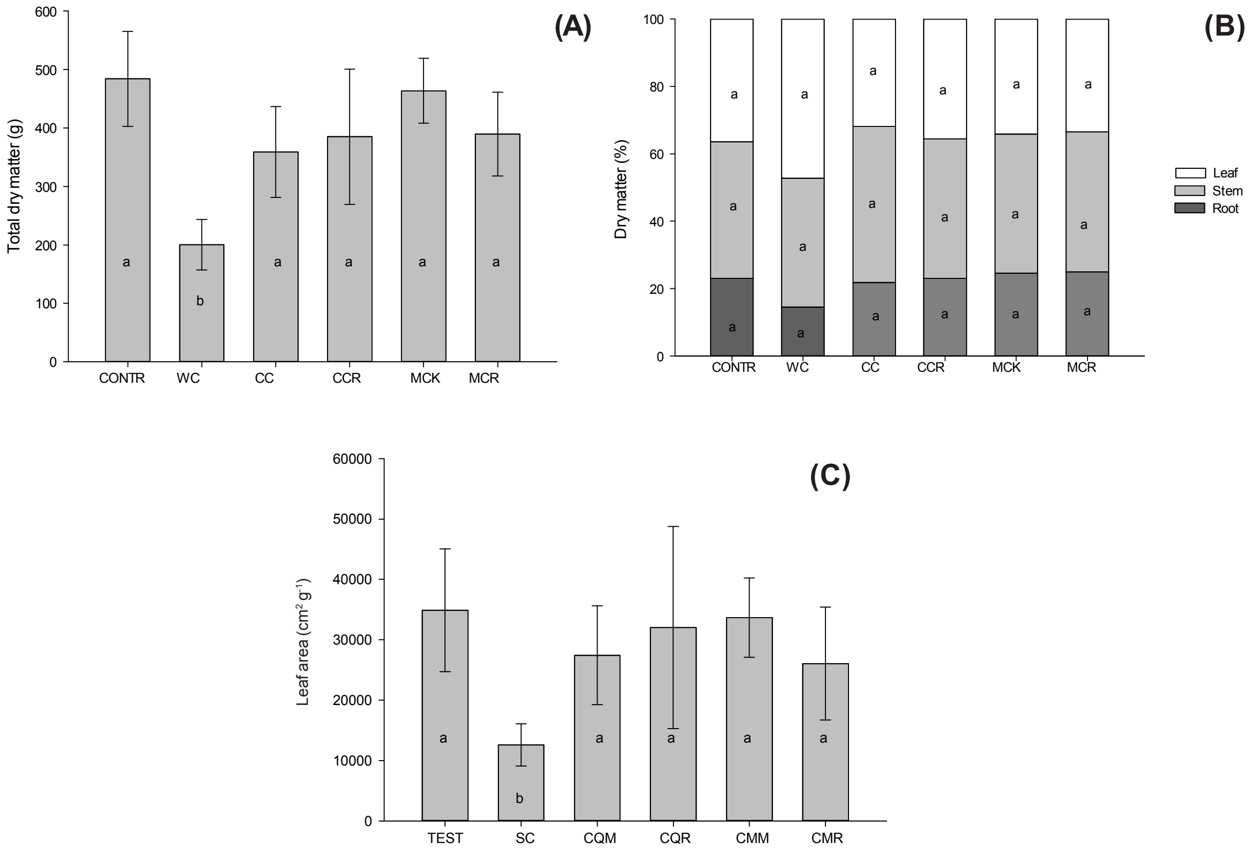


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Figure 3 - Total dry matter (g) of eucalypt plants subjected to *Urochloa* management (A); average percentage distribution of dry matter among the vegetative components of eucalyptus plants submitted to *Urochloa* managements (B); and leaf area (cm^2 g^{-1}) of eucalypt plants submitted to *Urochloa* managements (C).

24.98%, respectively, in height, compared with the control (CONTR). Divergent results were found by Bezutte et al. (1995), who reported that eucalypt does not show good resilience after the interference promoted by weeds early in its development.

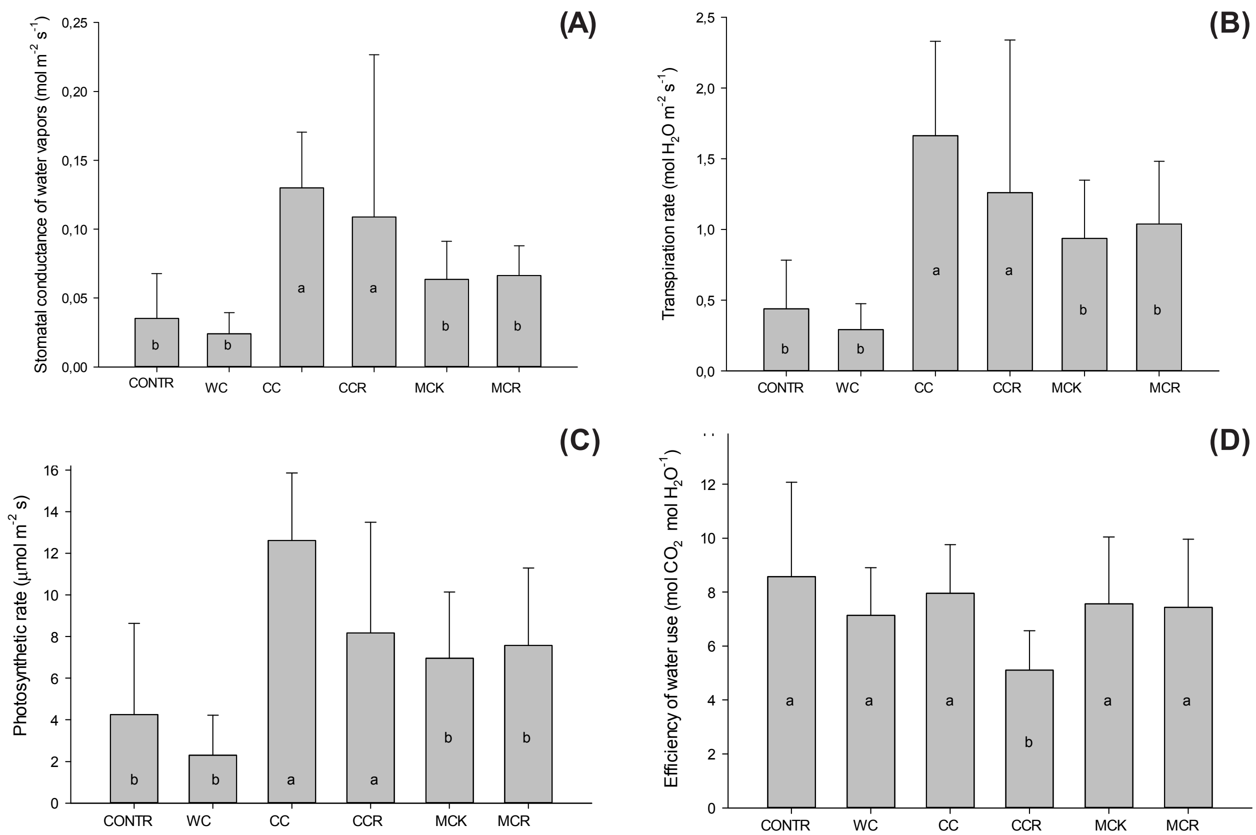
Species *U. brizantha* and *U. decumbens* that coexisted with eucalypt for 107 DAT had 645.04 and 807.92 g of total dry matter, respectively. It was found that the eucalypt total dry matter in the treatment without weed control (WC) showed lower values compared to the control (CONTR) (Figure 3A). Likewise, Toledo et al. (2001) have observed that eucalypt plants coexisting with four *U. decumbens* plants m^{-2} for 190 DAT showed a dry matter reduction of 55.22% of the stem, 77.29% of branches, 55.30% of leaves, as well as reducing 63.26% of the leaf area and 70.56% of the number of leaves.

The average percentage distribution of dry matter among the vegetative components (leaf, stem and root) of eucalypt was not changed by the treatments (Figure 3B). However, it is observed that the treatments where eucalypt plants coexisted with the *Urochloa* species (WC) for 107 days had a higher percentage of leaves, without statistically differing from the other vegetative components.

The leaf area decreased by 75.69% compared to the control (CONTR) when control of the *Urochloa* species (WC) was not held (Figure 3C), but no differences were observed in the dry matter of leaves for treatments. Toledo et al. (2001) have found that in the coexistence of eucalypt with 4 plants m^{-2} of *U. decumbens* for 90 days, boxed with 50 L of substrate, there was a reduction of 63.26% in the leaf area. Plants in interaction with competitors present water stress, and there is increased plastrochrome of new leaves; with this, they develop slowly and the older leaves quickly show senescence, and consequently reduction of the area and of the photosynthetic rate per leaf area (Kramer, 1983).

Eucalypt stomatal conductance (*Gs*) was higher when using chemical control in the management of signalgrass, regardless of withdrawal (CCR) or not of residues (CC) resulting from desiccation (Figure 4A). It is noteworthy that the degree of stomatal closure directly influences the plants transpiration and photosynthetic rates. Probably this was the reason for the plants subjected to chemical management of signalgrass to be subjected to the higher transpiration (*E*) (Figure 4B) and photosynthetic rates (*A*) (Figure 4C). These results may be related to the plants recovery after removing the competitive agent (*Urochloa* spp.), for in the WC treatment these rates were lower.

Chemical control of signalgrass in eucalypt plantations has been carried out predominantly with the use of glyphosate herbicide in a controlled manner, avoiding reaching the crop, because it is a non-selective herbicide. As in this work eucalypt plants



CONTR: control free from coexistence of the *Urochloa* species; WC: eucalypt without control of *Urochloa* spp.; CC: chemical control by keeping the *Urochloa* spp. residue in the pot; CCR: chemical control by removing the *Urochloa* spp. residue from the pot; MCK: mechanical control by keeping in the pot the *Urochloa* spp. weeding residue; MCR: mechanical control by removing from the pot the *Urochloa* spp. weeding residue.

Figure 4 - Stomatal conductance (Gs- mol m^{-2} s^{-1}) (A); transpiration rate (E- mol H_2O m^{-2} s^{-1}) (B); photosynthetic rate (A- µmol m^{-2} s^{-1}) (C); and water-use efficiency (WUE- mol CO_2 mol H_2O^{-1}) of eucalypt plants submitted to different *Urochloa* managements.

were protected from the drift of the herbicide, it is expected that the results have no direct effects from contact with glyphosate, since Machado et al. (2010a) have reported negative effects of herbicide drifting on *Gs, E* and *A*.

Water-use efficiency (*WUE*) was negatively affected only when using chemical control with removal of residues (CCR) from *Urochloa* species (Figure 4D). Water-use efficiency is characterized as the amount of water evapotranspired by a plant for the production of a certain amount of dry matter. Therefore, if these effects are maintained for a long period, eucalypt growth can be reduced, which was not observed in this study.

The weed management methods used in this work were efficient in maintaining eucalypt growth at levels close to the control (CONTR). In general, a compensatory growth was found at eucalypt plants height that were competing with the two species of *Urochloa.* Possibly this gain is due to the higher photosynthetic rates of these treatments.

It can be concluded that the coexistence for 105 days of eucalypt with *Urochloa decumbens* or *Urochloa brizantha* reduces eucalypt growth. However, the chemical or mechanical controls, associated or not to the removal of residue from signalgrass, were efficient methods to prevent interference of these weeds.

ACKNOWLEDGMENT

To CNPq [Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Counsel of Technological and Scientific Development)], CAPES [Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination of Improvement of Higher Education Personnel)], and FAPEMIG [Fundação de Amparo à Pesquisa do Estado de Minas Gerais (Research Support Foundation of the Brazilian State of Minas Gerais)], for the financial support and scholarships granted.

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