WCCLF 2021

II World Congress on Integrated Crop-Livestock-Forestry Systems

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WCCLF 2021 PROCEEDINGS

PROCEEDINGS REFERENCE

II WORLD CONGRESS ON INTEGRATED CROP-LIVESTOCK-FORESTRY SYSTEMS

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Roberto Giolo de Almeida; Luiz Adriano Maia Cordeiro, Davi José Bungenstab, Rodrigo Carvalho Alva and Lucimara Chiari

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PREFACE

Promoted by the Ministry of Agriculture, Livestock and Food Supply - MAPA; Brazilian Agricultural Research Corporation - Embrapa; ICLF Network Association; State Secretariat for the Environment, Economic Development, Production and Family Agriculture - SEMAGRO; Federation of Agriculture and Livestock of Mato Grosso do Sul - Famasul; and FB Eventos, the II World Congress on Integrated Crop-Livestock-Forestry Systems (WCCLF 2021) took place on the 4th and 5th May 2021 in a 100% digital format.

The objective of the Congress was to provide a forum for discussion, theoretical insights and practical applications related to technology as well as economic and environmental aspects of mixed agricultural systems that combine integrated production of crops, animals and trees in the same area, having an efficient use of inputs, all being essential for food security in the future.

ICLF is a production strategy that integrates crop, livestock, and forestry farming in the same area, in a consortium, rotated or in succession, so that there is interaction among components, generating mutual benefits.

For two days, we discussed issues related to challenges and opportunities for ICLF systems around the World; solutions and demands from Agribusiness Companies; scenarios and trends of ICLF in the World; current hot topics in ICLF; solutions and demands for ICLF from the farmer's view; Public Policies for Supporting ICLF; and innovation on ICLF systems.

The integrated agricultural production systems can be implemented combining two or three components, according to the particularities of each farm and region. They can also be adopted in small, medium, and large farms, in different biomes, using different crops, livestock and trees species. Among the many benefits of ICLF are increasing total yields of a given area, diversification of income sources, better use of inputs, improvement of soil chemical, physical and biological qualities, along with improvement of animal welfare as well as jobs and income generation. In addition, ICLF systems reduce pressure to clear new areas, it helps to recover degraded low yielding areas while mitigating greenhouse gas emissions, increasing carbon sequestration in soil and biomass. These benefits corroborate with three of the Sustainable Development Goals - SDGs:

- SDG 2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture;
- SDG 13 - Take urgent action to combat climate change and its impacts; and
- SDG 15 Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

These Proceedings report 166 scientific contributions approved by the scientific committee of the WCCLF 2021 and 18 papers from speakers that also contributed to this publication.

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THINNING EFFECT ON TREE GROWTH AND WOOD PRODUCTION IN INTEGRATED SYSTEMS

Lissandra Isabela Momoli da BOIT [1]; Gerson Uvida BARRETO [2]; Renato Campos de OLIVEIRA [2]; Emanuella Farias Santos SOUZA [3]; Marina Moura MORALES [4]; Maurel BEHLING [5]

[1] Forest Engineering. Graduation Student. Federal University of Mato Grosso / Scholarship PIBIC/CNPq - Embrapa Agrosilvopastoral; [2] Forest Engineering. Graduation Student. Federal University of Mato Grosso; [3] Forest engineer. MSc Agronomy candidate. Federal University of Mato Grosso; [4] Bachelor of Chemistry. Researcher. Embrapa Forestry; [5] Agricultural engineer. Researcher. Embrapa Agrosilvopastoral

ABSTRACT

In crop, livestock and forest integrated system (ICLF) tree thinning management is adopted to add value and minimize competition. This study aims to assess the effect of ICLF and thinning management on eucalyptus growth and wood productivity. The experimental design was in randomized blocks, with four replicates. The treatments were: (I) F, forest with 476 tree ha^{-1} before and 270 trees ha^{-1} after thinning (II) CF-S8, with 270 and 135 trees ha^{-1}; (III) ILF-T, with 270 and 101 trees ha^{-1} (IV) ICLF-S5, with 270 and 90 trees ha^{-1}; (V) ICLF-S4, with 270 and 90 trees ha^{-1} and (VI) ICLF-S8, with 270 and 45 trees ha^{-1}. The ICLF systems increased tree growth and production (clone H13), due to the lower tree density in these systems than homogeneous forest. The total wood production was lower in the integrated systems due to the lower initial tree density than homogeneous forest. The differences observed in the integrated systems are due to the thinning management, such as the season, intensity and type (selection or systematic). The integrated system with the largest number of trees remaining after thinning (ILF-T) presents the highest wood production, equal to 57% of the remaining wood in homogeneous forest.

Key words: land use systems; sustainable intensification; diversification

INTRODUCTION

In Brazil, there are 11.5 million hectares being used as integrated crop-livestock-forestry (ICLF) systems, of which 1.5 million hectares are in Mato Grosso (EMBRAPA, 2016). Among the four possible production configurations, crop-livestock integration (ICL) is the most adopted by producers with 83% rate. The configurations involving the forestry component are little adopted, with crop, livestock and forestry integration (ICLF) with 9% livestock and forestry integration (ILF) 7% and crop and forestry integration (ICF) only 1% (EMBRAPA, 2016). Therefore, the consolidation of the forestry component in the expansion of integrated systems is a major challenge.

The main reasons for these low ICLF adoption configurations is the lack of silviculture information by producer as, the reduction of crop and livestock production (pasture) due to shadow effect, the needs of initial investment with returns in medium and long term, qualified labor, lack of technical assistance and, economic indicators as, market guarantee for wood products.

In ICLF, the forest can compete for water, light and nutrients, impairing the development of crops and forage accumulation (BUNGENSTAB et al., 2019). Therefore, the thinning management aims to reduce competition, both between individual trees and between trees population and other components of system (NICODEMO et al., 2016), maximizing the integrated system productivity and profitability of the integrated system.

Therefore, due to the complexity and dynamism of relationship between the components of ICLF system is necessary to monitor the trees growth and production to understand it, to make inferences about the local productive potential, to identify the optimum age to apply silvicultural practices to plan activities and to estimate production (BATISTA et al., 2014). So, to understand the effect of ICLF and thinning management on tree growth and wood production is important to carry out the proper planning of silvicultural practices and to maintain the synergistic relationship between system components. This study aims to assess the effect of ICLF and thinning management on eucalyptus growth and wood productivity.

MATERIAL AND METHODS

The experiment was carried out with hybrid H13 (*Eucalyptus urograndis*) in the experimental field of Embrapa Agrosilvopastoral, located in Sinop, MT, Brazil (11° 51'S, 55° 35'W, 370 m altitude), at Amazon biome in 2011. The climate is classified as Am (tropical with dry winter) (Alvares, 2014). The annual average temperature is 25,8 °C, the average annual air relative humidity is 82.5% and the accumulated precipitation is 2.250 mm, with higher intensity from December to March (Embrapa, 2019).

The treatments were: 1) F: Eucalyptus forest, with 952 trees per hectare (3.5 m x 3.0 m) which received 50% selective thinning in the fifth year (476 trees) and 50% in the eighth year, remaining 240 trees per hectare (~ 6.0 m x 7.0 m); 2) ICF-S8: Integrated crop and forestry, with triple rows of eucalyptus, spacing 30 m + 3'(3 m x 3,5 m) with 270 trees per hectare. In the fifth year received 50% selective thinning (135 trees ha^{-1}) and in the eighth year, the laterals lines were thinned, remaining 45 trees per hectare (~ 6 m x 37 m); 3) ILF-T: Integrated livestock and forestry, with triple rows of eucalyptus, spacing of 30 m + 3'(3 m x 3,5 m) with 270 trees per hectare. In the fifth year received 50% selective thinning and in the eighth year had 25% selective thinning, remaining 101 trees per hectare (~ 30 m + 3'(8 m x 3.5 m)); 4) ICLF-S5: Integrated crop, livestock and forestry, with triple rows of eucalyptus, spacing of 30 m + 3'(3 m x 3,5 m) with 270 trees per hectare. In the fifth year, the laterals lines were thinned, remaining 90 trees per hectare (~ 3 m x 37 m); 5) ICLF-S4: Integrated crop, livestock and forestry, with triple rows of eucalyptus, spacing 30 m + 3'(3 m x 3,5 m) with 270 trees per hectare. In the fourth year, the laterals lines were thinned, remaining 90 trees per hectare (~ 3 m x 37 m); and 6) ICLF -S8: Integrated crop, livestock and forestry, with triple rows of eucalyptus, spacing 30 m + 3'(3 m x 3,5 m) with 270 trees per hectare. In the fifth year received 50% selective thinning and in the eighth year, the lateral lines were thinned, remaining 45 trees per hectare (~ 6 m x 37 m).

The experimental design was in randomized blocks, with four replicates. The F systems were evaluated in 1 ha experimental plots and the other plots had 2 ha. The data were obtained in 24 plots containing three rows of trees totaling 81 trees, installed in the center of the central row for integrated systems and in the center of the plot for homogeneous forest.

The forest inventory was carried out at 108 months after planting, measuring diameter at breast height (DBH), with diametric tape total height (H), with electronic hypsometer. Basal area was calculated by $BA= \sum(\pi d^2/4)$ and wood volume by $V_{cc} = \sum(gHf)$, where BA, basal area ($m^2\ ha^{-1}$); d, diameter measured at 1.30 m from the soil (cm); g, tree individual area (m); H, total height (m); f, artificial form factor (0,45); and V_{cc}, wood volume with bark ($m^3\ ha^{-1}$).

The statistical analyses were performed after an evaluation of the normality of the data distribution by the Lilliefors test and the homogeneity of variances by the Hartley, Cochran and Bartlett tests. The means were compared by analysis of variance and Tukey's test ($p < 0.05$).

RESULTS AND DISCUSSIONS

The DBH, H, BA and wood volume were significant different between production systems for DBH was higher in integrated system than forest (Figure 1A), possibly due to the lower tree density, which implies less competition between trees (MONTE et al., 2009; MAGALHÃES et al., 2019). Similar results, greater growth in the diameter of a clone of *E. grandis* x *E. urophylla* in an ICLF production system than homogeneous forest also observed in Cerrado conditions (OLIVEIRA et al., 2015).

The ICLF-S4 system, presented highest average DBH (Figure 1A), because the early removal of laterals lines favored trees growth in diameter than to 50% selective thinning in 5th year and removal the laterals lines just in 8th year of ICLF-S8 system. Furthermore, no differences were observed between the ICLF systems treatments and also, between thinning managements (Figure 1A).

The highest height of trees was observed in the ILF-T and lowest in ICLF-S5 (Figure 1B). The ILF-T system received only selective thinning in 5th and 8th years (50 % and 25% respectively), in contrast the ICLF-S5 system was converted to simple rows in the 5th. Therefore, the higher height ILF-T may have occurred due to competition caused by the higher tree density (MONTE et al., 2009), in relation to system converted to simple rows. The greatest development in tree height at agrosilvopastoral systems occurs in the arrangements with thein highest tree density (OLIVEIRA et al., 2009).

Although the integrated systems promote greater individual tree growth, mainly from the DAP, the basal area and the wood volume per hectare are smaller (Figure 1C and 1D). This lower production is reflex of low initial tree density in ICLF systems which represented only 26% trees from homogeneous forest. Also, until the 4th year there was no effect of the integrated systems on trees growth, indicating that there was no effect of eventual trees benefits by fertilization done in annuals crops (MAGALHÃES et al., 2019). Thus, we can affirm that the differences observed at this time within the integrated systems are due to thinning management carried out, such as the season, intensity and type (selective or systematic), resulting in different remnant tree densities in each system.

The F system which presented the highest BA and Vtc at 108 months reflecting the highest tree density (240 trees ha^{-1}), while the ILF-S8 and ILPF-S8 systems which have the lowest averages have the lowest trees densities (45 trees ha^{-1}). In this case the IPF-T with highest tree density (128 tree ha^{-1}) presented wood production equivalent 57% of the remnant wood in the F system (Figure 1D). For eucalyptus trees, there is a high correlation between increase in available area and increase in individual trees dimensions, such as DBH, volume and aerial and radicular biomass (SANTANA et al., 2008; OLIVEIRA et al., 2009; OLIVEIRA et al., 2015; REINER et al., 2011).

The F produces higher wood volume then ICLF systems (OLIVEIRA et al., 2015) and in integrated systems greater BA and Vtc per hectare are observed in arrangements with a higher tree density (OLIVEIRA et al., 2009). These results are explained due to greater number of trees per area in both system, homogeneous and integrated systems with higher tree density. The wood volume is influenced by the height, DBH and tree number reflecting the differences found between systems (Figure 1).

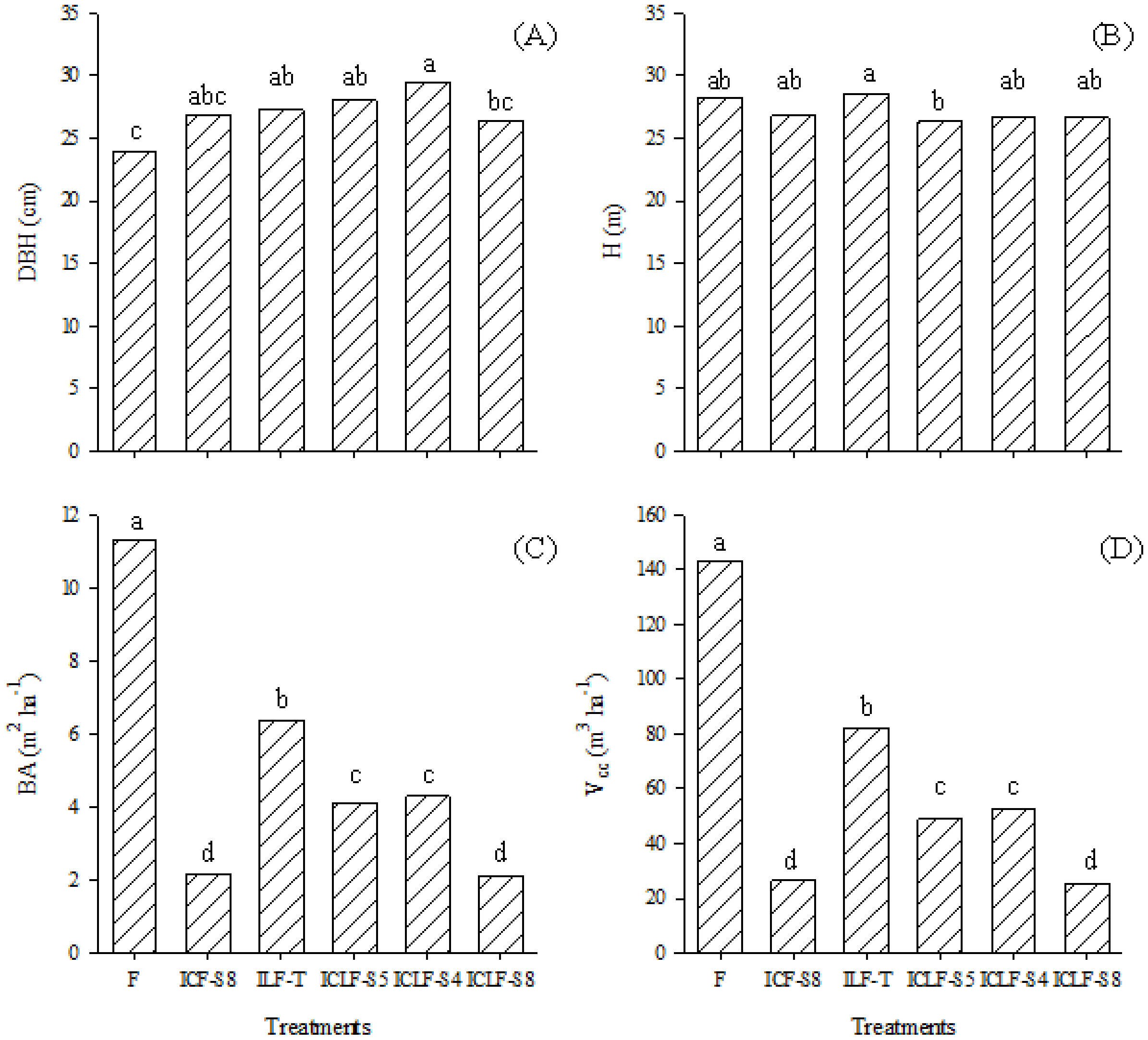

Figure 1. Diameter at breast height (DBH), total height (H), basal area (AB) and wood volume (clone H13) in production systems with eucalyptus, at nine years after planting. Columns with different letters indicate significant differences (Tukey's test, $p < 0.05$).

CONCLUSIONS

The ICLF provides greater growth and individual tree production.

Thinning management in ICLF system determines final wood production.

The ILF-T system, with higher trees density after thinning management present higher wood production, equal 57% of remnant wood in F.

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