WCCLF 2021

II World Congress on Integrated Crop-Livestock-Forestry Systems

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WCCLF 2021 PROCEEDINGS

Embrapa

AGRICULTURAL RESEARCH AND INNOVATION ON THE 2030 AGENDA

PROCEEDINGS REFERENCE

II WORLD CONGRESS ON INTEGRATED CROP-LIVESTOCK-FORESTRY SYSTEMS

ONLINE CONGRESS | BRAZIL | MAY 4TH and 5TH 2021

TECHNICAL EDITORS

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

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ISBN: 978-65-994135-4-4

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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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PHYSICAL QUALITY OF SOYBEAN GRAINS CULTIVATED IN INTEGRATED SYSTEMS

Fernando Mendes BOTELHO [2]; Maurel BEHLING [3]; Ícaro Pereira de SOUZA [1]; Tamiris Silva Guilherme de OLIVEIRA [4]; Kauani Cláudia SONNTAG [4]; Sílvia de Carvalho Campos BOTELHO [3]

[1] Agricultural engineer. Agricultural engineer. Federal University of Mato Grosso; [2] Agricultural engineer. Professor. Federal University of Mato Grosso; [3] Agronomists. Research. Embrapa Agrosilvipastoral; [4] Agricultural engineer. Student. Federal University of Mato Grosso

ABSTRACT
The integrated crop-livestock forestry system (ICLF) is a model of agricultural production that combines different activities in the same area, such as agriculture, livestock, and forestry. It aims at intensifying the use of land and enhancing the production of grains, wood, meat, milk, and other products, consciously and sustainably. The purpose of this study was to evaluate the effect of the integrated crop-livestock forestry system on the physical quality of cultivated soybeans integrated with eucalyptus. For this, we evaluated two treatments [integrated crop-livestock forestry system with single rows of trees (ICLF-S) and integrated crop-livestock forestry system with triple rows of trees (ICLF-T)] and the exclusive crop, used as evidence, in a randomized block design, with four replications. The physical quality of the soybeans was determined in terms of water content, the mass of a thousand grains, apparent specific mass, the electrical conductivity of the exudate solution, and color indices (Hue angle and chroma). There was no difference between the integrated systems and the exclusive crop in terms of water content, the electrical conductivity of the exudate solution, and color (Hue angle and chroma) of the grains. The ICLF increased the mass of a thousand grains and the apparent specific mass of soybeans.
Key words: Crop livestock forestry system; *Glycine max*; physical properties

INTRODUCTION

The physical quality of the grains is linked to their characteristics of color, mass, size, and shape. The greater the consumer market demands are, the more important these characteristics are, and influence the final value of the agricultural product (SILVA, 2008). Therefore, it is necessary to learn about the quality of the soybean grown in the integrated crop-livestock and forestry system (ICLF), as not much is known on how the variables used in the integrated systems can affect the quality of the grains.

ICLF is an innovative agricultural system to the traditional models of agricultural production and it is associated with the principles of crop rotation and consortium or succession of grains, forage, and tree crops, combined with livestock farming in the same area. The purpose of this system is to seek synergistic effects between the components for environmental adequacy, the valuing of men, and the economic viability of the agricultural enterprise (BALBINO et al., 2012). Inserting a tree component in the agricultural area causes several changes in the local microclimate, such as the reduction of the incidence of direct light, the decrease in the temperature and wind speed, increasing the relative humidity of the air, reducing the evapotranspiration of the agricultural cultivation and the increased soil moisture (BERNADINHO; GARCIA, 2009). These differentiated environmental conditions can directly influence plant development, embryo formation, and dry mass gain, and, consequently, the soybean quality (CARVALHO; NAKAGAWA, 2000).

In this sense, it is important to assess whether the quality of grains produced in integrated systems can positively or negatively interfere with their competitiveness in the market. Thus, the adoption of the ICLF could be expanded, based on solid, long-term, and farm-scale research results. Therefore, we aimed to evaluate the effect of the integrated crop-livestock forestry system on the physical quality of soybeans.

MATERIAL AND METHODS

To evaluate changes in the physical quality of soybean grown in consortium with eucalyptus, we obtained some grain samples from an integrated crop-livestock forestry system (ICLF) area with simple and triple rows (treatments) and another sample with exclusive crops (control), located at the experimental field of Embrapa Agrossilvipastoril, in Sinop, Mato Grosso, in the 2018/2019 harvest. To establish the eucalyptus trees (*Eucalyptus urograndis* - clone H13) in the integrated crop-livestock forestry system (ICLF) with simple rows (ICLF-S), we planted them in bands, with 37 m spacing between rows × 3, 0 m between trees. In an integrated crop-livestock forestry system (ICLF) with triple rows (ICLF-T), eucalyptus *(Eucalyptus urograndis* - clone H13) we planted bands at a 30 m spacing between rows × 3.5 m between rows and 3, 0 m between trees. We planted the eucalyptus lines, for both systems, in 2011 following the east-west orientation and used the area between rows for soybean cultivation (cultivar BRS7380RR).

We arranged the treatments (ICLF-S and ICLF-T) and the control (exclusive crop) in randomized blocks (5 ha each), designed with four replications, and distributed within each block in the following manner: 2 ha of ICLF-S + 2 ha of ICLF-T + 1 ha exclusive crop). To analyze the physical quality of the grains, we applied samples from eight positions in the plot (in the form of a transect), that is, four distances from the eucalyptus row (3, 6, 10, and 15 m) and two production faces (north and south). The sampling points were composed of two lines of 5 m. The grains produced in the exclusive crop (control), were also harvested in two rows of 5 m, but in five random positions in the cultivation area.

The grains were harvested between February 10th and 15th, 2019, and, after being traced, they were manually cleaned to remove all types of impurities and unexpected material and, when necessary, we submitted the samples to dry in the greenhouse until they reach the commercial water content (14%).

After that, we evaluated the samples for water content, by the gravitational method (BRASIL, 2009), for the mass of a thousand grains, by grain count (BRASIL, 2009), for apparent specific mass, on a hectoliter scale (BOTELHO et al., 2018), for electrical conductivity of the exudate solution (BRASIL, 2009) and also for color index (Hue angle and chroma), calculated after directly reading the L *, a * and b * coordinates in a tristimulus colorimeter. The data were submitted to analysis of variance and the means between the ICLF systems and the exclusive crop compared by the Tukey test ($p < 0.05$).

RESULTS AND DISCUSSIONS

The experiments showed that there was no statistical difference between the integrated systems (ICLF-S and ICLF-T) and the exclusive crop for the following physical properties: water content, the electrical conductivity of the grain imbibition solution, chroma, and Hue angle. They presented a general average of 12.98%, 142.15 µS cm^{-1} g^{-1}, 17.25° and 74.15. Thus, the environmental conditions of the integrated systems (lower incidence of light, temperature, competition for nutrients, and evapotranspiration) did not influence these physical characteristics in the grains when compared to soybeans produced in exclusive crops (Table 1).

There was a qualitative improvement in the mass of a thousand grains and in the bulk density in the integrated systems compared to the exclusive crop. The average observed in the exclusive crop was 156.67 g and 679.78 kg m^{-3} while in the ILPF it was 168.95 g and 700.06 kg m^{-3}, respectively, for the mass of one thousand grains and apparent specific mass. Therefore, the conditions imposed by the integrated systems may have favored the grain formation, justifying higher mass indexes.

Table 1. Averages of the physical properties in soybeans in different production systems.

Production systems	WC (%)	M100 (g)	BD (kg m^{-3})	ECE (μS cm^{-1} g^{-1})	Hue (º)	Croma
EC	12.32 A	156.67 A	679.78 A	138.37 A	17.15 A	75.05 A
ICLF -S	13.95[1] A	167.62 B	694.13 B	152.45 A	16.84 A	73.66 A
ICLF -T	12.67 A	170.29 B	705.99 B	135.63 A	17.35 A	73.86 A
ICLF Average	13.31	168.95	700.06	144.04	17.09	73.76
General average	12.98	164.86	693.0	142.15	17.25	74.45
c.v. (%)	11.96	2.15	1.70	11.20	4.13	0.60

Where: WC = water content; M1000 = mass of a thousand grains; BD = bulk density; ECE = electrical conductivity of the exudate solution; Hue = angle Hue; EC = exclusive crop; ICLF-S = integrated crop-livestock forestry system with simple lines; ICLF-T = integrated crop-livestock forestry system with triple rows. [1]Means followed by equal capital letters in the columns do not differ statistically from each other, by the Tukey test, at 5% probability.

The water content of soybeans grown in the ICLF systems was 13.31%. The water content is widely pointed out in the literature as the factor that most influences the physical properties of grains (SOUSA et al., 2016; BOTELHO et al., 2015), which was not the case in this study since the water content in the samples showed no difference. The average mass of a thousand grains of soybean grown in the integrated systems was 168.95 g. The low light conditions of the most shaded areas, especially close to the eucalyptus row, did not compromise the filling of those grains that these plants set out to granulate. This is because, according to Magalhães et al. (2019), the number of pods and grains is lower in those plants located in the most shaded areas. Also, according to Fioreze et al. (2013), for having C3 metabolism, soybean plants seem to be more adaptable when subjected to this limitation.

The apparent specific mass of grains of the integrated systems was 700.06 kg m^{-3}. This result is important, as it shows that, even though it is not used as an indicator for the commercialization of soybeans, increments in the apparent specific mass can be associated with a higher quality of grains. Seeds with a higher specific mass are those that are better nourished during the development phase, thus presenting better-formed embryos and reserve tissues (CARVALHO; NAKAGAWA, 2000). Therefore, the results found show that the changes in the light conditions, imposed by the eucalyptus trees crowns, did not interfere in the physical aspects of the grains, maintaining their quality. For the exudate solution electrical conductivity, the average obtained in the integrated systems was 144.04 μS cm^{-1} g^{-1}. This result indicates that there was no change in the formation of soybeans, maintaining their quality, both physical and physiological, corroborating the data presented for the mass of a thousand grains and apparent specific mass. In other words, the tree component associated with the crop contributed to the production of higher quality grains.

Chroma and Hue angle showed averages of 73.76 and 17.09º, respectively. The environmental conditions inside the integrated systems did not influence the color of the soybean. This result is important because, although the color is a genetic factor for each cultivar, it is one of the main physical characteristics used in classifying a sample. By evaluating the color of the grains, it is possible to identify possible damage caused while still in the field, in addition to the separation of immature, moldy, and burnt grains.

CONCLUSIONS

Soybean grown in the integrated systems and the exclusive crop shows no difference in terms of water content, the electrical conductivity of the solution of the grain exudates, and color. ICLF increases the mass of a thousand grains and the apparent specific mass of soybean.

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