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II WORLD CONGRESS ON INTEGRATED CROP-LIVESTOCK-FORESTRY SYSTEMS

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TECHNICAL EDITORS

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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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CHEMICAL CONSTITUTION OF SOYBEAN GRAINS PRODUCED IN INTEGRATED SYSTEMS

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ABSTRACT
The integrated crop-livestock forestry system (ICLF) seeks to produce grains, milk, meat, and timber products in the same agricultural area in a conscious, intensive, and sustainable way. Although analyses point out its advantages and disadvantages for agricultural and wood production, animal welfare, and soil characteristics in integration systems, more research about their peculiarities regarding the grains' chemical composition is still needed. Thus, our goal was to evaluate the effect of the integrated crop-livestock forestry system in the chemical constitution of soybeans. For this, we evaluated two treatments: integrated crop-livestock forestry system with single jack (ICLF-S) and integrated crop-livestock forestry system with triple jack (ICLF-T); an exclusive crop was used as a control, in a randomized block design, with four replications. The soybean chemical quality was determined in terms of their chemical composition: ether extract, crude protein, ash, crude fiber, moisture, and carbohydrates. As a result, there was a variation in the chemical composition of grains produced in ICLF regarding those produced in the exclusive crops. In integrated systems, the grains had a higher protein content and a lower ash content.
Key words: Crop-livestock forestry system; *Glycine max*; quality

INTRODUCTION

The agricultural system has been looking for new production alternatives that meet the demands for food, fiber, energy, and other products with a minimal negative effect on the environmental resources. In this context, the integrated crop-livestock forestry system (ICLF) can be an appropriate alternative due to greater efficiency in the use of land and water resources, which enhanced the agricultural area productivity and reduces the consumption by inputs (NAIR, 2011; BALBINOT JUNIOR et al., 2011).

The ICLF is based on the concepts of crop rotation and the consortium between grain, forage, and tree species, to produce grains, milk, meat, and wood products in the same area throughout the year. Thus, integrated systems use the soil intensively, through the spatial and temporal integration of the components in the production system, to leverage the maximum quality and competitiveness of the product produced in a safe environment (BALBINO et al., 2011).

Commercial interest in soy is linked to its high protein (40%) and oil (20%) content, and its productivity. Besides, the grain has 34% carbohydrates and 5% minerals, making it an important raw material for the production of animal feed, bran, oil, and biodiesel (FARIA et al., 2018; HIRAOKA, 2008). While eucalyptus is related to wood sales, energy production, and sawmill (BALBINO et al., 2012).

Despite the interest in integrated systems, there is still little scientific information about the development of crops and, consequently, the chemical composition of grains in these systems. ICLF has exclusive environmental conditions, such as the reduction in the incidence of direct light in the area, the decrease in the temperature and wind speed, the increase in the relative humidity of the air, and the reduction in the evapotranspiration of agricultural cultivation (GOMES et al., 2015). Therefore, even if the proximate composition of soy is genetically defined (DELARMELINO-

FERRARESI et al., 2014), the climatic factors of the environment, such as temperature and precipitation (BARBOSA et al., 2011) and the shading in the cultivation area (BELLALOUI; GILLEN, 2010) can directly influence the content of its components and, subsequently, its commercial value.

Due to the complexity of the system after the introduction of the forestry component, studies are needed to assess the influence of trees on crops and the proximate composition of the grains produced. Thus, our goal was to evaluate the effect of the integrated crop-livestock forestry system on the chemical quality of soybeans.

MATERIAL AND METHODS

To evaluate the changes in the chemical constitution of soybeans grown in an integrated system, we obtained samples of grains from an area with an integrated crop-livestock forestry system (ICLF) with simple and triple rows of eucalyptus (treatments) and other samples from exclusive crops (control) in 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 with simple rows (ICLF-S), we planted them in bands, with 37 m spacing between rows × 3, 0 m between trees. In the integrated crop-livestock forestry system with triple rows (ICLF-T), eucalyptus (Eucalyptus urograndis - clone H13) we planted them in bands at a 30 m spacing between rows × 3.5 m between rows and 3, 0 m between trees. For both systems, we planted the eucalyptus lines following the east-west orientation, in 2011. The area between rows was used for soybean cultivation (cultivar BRS7380RR).

We arranged the treatments (ICLF-S and ICLF-T) and the control (exclusive crop) in a randomized block design with four replications, each block of 5 ha, and distributed them within each block as it follows: 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 10^{th} and 15^{th}, 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%). To determine the proximate composition (ether extract, crude protein, ash, crude fiber, moisture, and carbohydrates) of the soybeans, a subsample composed of at least 200 g of each sample was grounded in a cryogenic mill and the determinations carried out in triplicate, according to Instituto Adolfo Lutz (1985).

The data were submitted to analysis of variance and the means between the ICLF systems and the exclusive crop compared by the Tukey test ($p < 0.05$). The comparison between the positions in the transects and the production faces was also performed with the Tukey test ($p < 0.05$) considering the mean square of the Anova residue, according to the experimental design.

RESULTS AND DISCUSSIONS

The experiments showed that there was no difference between the integrated systems (ICLF-S and ICLF-T) and the exclusive crop in terms of ether extract, crude fiber, moisture, and carbohydrates, with an overall average of 25.75%, 5.14%, 17.25%, and 22.08%, respectively. Therefore, the production conditions of the integrated systems (lower incidence of light, temperature, competition for nutrients, and evapotranspiration) did not influence these soybean chemical characteristics when compared to the exclusive crop (Table 1).

We observed differences for the crude protein and ash content between the ICLF systems with single and triple rows, and the exclusive crop. The grains grown in the ICLF systems showed higher averages for crude protein content (34.63%) when compared to exclusive crops (33.85%). For the ash content, the average in the exclusive crop (5.87%) was higher than in the ICLF systems (5.62%).

Table 1. Average proximate composition of soybeans in different production systems.

Production Systems	**EE (%)**	**CP (%)**	**A (%)**	**CF (%)**	**UM (%)**	**CA (%)**
EC	25.72[1] A	33.85 A	5.87 A	5.67 A	6.91 A	21.98 A
ICLF-S	25.65 A	35.00 B	5.65 B	5.13 A	6.89 A	21.64 A
ICLF -T	25.88 A	34.27 B	5.59 B	4.62 A	6.99 A	22.63 A
Average ICLF	23.76	34.63	5.62	4.88	6.94	22.13
General average	25.75	34.37	5.7	5.14	6.93	22.08
c.v. (%)	0.63	1.03	0.57	7.43	0.73	5.13

Where: EE = ether extract; CP = crude protein; A = ash; CF = crude fiber; UM = humidity; CA = carbohydrates; EC = exclusive crop; ICLF-S = integrated crop livestock forestry system with simple lines; ICLF-T = integrated crop livestock forestry system with triple row. [1]Means followed by equal capital letters in the columns do not differ statistically from each other, by the Tukey test, at 5% probability.

Integrated systems were not a limiting factor for protein synthesis in soybeans, with the average protein content in the ICLF of 34.63%. This result was similar to that reported by Werner et al. (2017) who evaluated the quality of soybean grown in consortium with eucalyptus and concluded that the position concerning the row and the production face (east-west) did not influence the protein content in the grains, obtaining averages of 36.5% and 41.6% for the first and second year of production.

The ICLF systems did not show variation for crude fiber, moisture, and carbohydrate content in soybeans, with averages of 4.88%, 6.94%, and 22.13%, respectively. According to Faria et al. (2018), soybeans with 5% moisture content, present, on average, 4% fiber and 25% carbohydrate, corroborating the data found in this study.

There was no difference concerning the distances in the eucalyptus rows (3, 6, 10, and 15 m) and the production faces (north and south) in the ICLF systems for the content of crude protein, crude fiber, moisture, and carbohydrates. However, the same did not happen for the content of ether extract and ashes (Tables 2).

The integrated systems provided variation in the ether extract content averages. On the ICLF-S south face, the 10 m distance showed the highest average, differing from the others, while the grains grown near the eucalyptus rows obtained the lowest averages. On the north face, no difference was observed concerning the distance from the row.

On the ICLF-T south face, the highest ether extract averages were recorded at distances of 15 and 3 m, with no difference between them. On the north face, the distances of 6, 10, and 15 m showed no difference between them, with an average of 26.27%. The lowest average was recorded at the distance of 3 m, but this did not differ from the distance of 15 m.

Table 2. Ether extract and ash content averages (%) in soybeans produced in the integrated systems concerning the production faces and the distances of the eucalyptus rows.

Distances (m)	Ether Extract (%)				Ashes (%)			
	ICLF-S		ICLF -T		ICLF-S		ICLF-T	
	SF	NF	SF	NF	SF	NF	SF	NF
3	24.84[1] C	25.71 A	25.87 AB	25.68 B	6.36 A	5.28 C	5.70 A	5.65 B
6	25.18 C	25.81 A	25.07 C	26.28 A	5.47 C	5.29 C	5.51 B	5.47 C
10	26.12 A	25.91 A	25.46 BC	26.40 A	5.88 B	5.46 B	5.59 B	5.21 D
15	25.65 B	25.99 A	26.14 A	26.11 AB	5.51 C	5.96 A	5.36 C	6.21 A
Averages	25.45	25.86	25.64	26.12	5.80	5.50	5.54	5.64

Where: ICLF-S = integrated crop-livestock forestry system with simple lines; ICLF-T = integrated crop-livestock forestry system with triple row; SF = south face; NF = north face. [1]Means followed by equal capital letters in the columns do not differ statistically from each other, by the Tukey test, at 5% probability.

Integrated systems, also promoted differences in ash contents. On the ICLF-S south face, the highest average was at the 3 m position, differing from the other averages. On the north side, it was the opposite, the 15 m distance presented the highest average, therefore, differs from the others. The ICLF-T south face was similar when compared to the south face of the ICLF-S, the greater the distance from the furrows the lower the ash content. Thus, the 3 m position had the highest ash content, differing from the other distances. On the north face, there was a greater variation in the average values, with the distances of 15 and 3 m obtaining the highest averages for the ash content, differing from each other and the other distances.

We noted that for both systems there was no definite trend for the ash content variation concerning the distances of the eucalyptus rows. However, we observed an ash content reduction due to the distance between the trees, towards the south face, and the north face, and that there was an increase in the ash content as the distance from the trees increased.

CONCLUSIONS

There is variation in the chemical composition of grains produced in ICLF concerning those produced in exclusive crops.

In integrated systems, the grains have higher protein content and less ash content.

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