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POD, STRAW AND ROOT MASS AFTER SOYBEAN PHYSIOLOGICAL MATURITY IN INTEGRATED SYSTEMS

Lucas Matheus Barros ASSIS [1]; Naiara Angelina NICOLETTI [2]; Moniky Suelen Silva COELHO [3]; Wender Mateus PEIXOTO [4]; João Batista Barbosa JUNIOR [5]; Roberto Giolo de ALMEIDA [6]; Livia Vieira de BARROS [7]; Joadil Gonçalves de ABREU [7]

[1] Animal Science. PhD Student in Animal Science. Federal University of Mato Grosso; [2] Agronomy. Master in Tropical Agriculture. Federal University of Mato Grosso; [3] Animal Science. Master's Degree Student in Animal Science. Federal University of Mato Grosso; [4] Agronomy. PhD Student in Tropical Agriculture. Federal University of Mato Grosso; [5] Agronomy. Agronomy Student. Federal University of Mato Grosso; [6] Agronomy. Researcher. Embrapa Beef Cattle; [7] PhD in Animal Science. Professor. Federal University of Mato Grosso

ABSTRACT

Soybean has a great economic impact for Brazil and with the growing search for sustainable systems the systems integration has gained increasingly space. Thus, the aim was to evaluate the effect of different integration systems on soybean grain mass, straw dry mass and root mass. The experiment it was carried out at the Brazilian Agricultural Research Corporation (Embrapa), Beef Cattle Unit, in Campo Grande – MS, Brazil. The experimental design used was a randomized block design with four repetitions. The treatments were agro-forestry-pasture system (ICL) in full sun; agro-forestry-pasture system with inter-row distance of 28 m ($ICLF_{28}$); agro-forestry-pasture system with inter-row distance of 22 m ($ICLF_{22}$). There was no significant effect for pod mass in the evaluated systems, however an effect was observed for straw and root mass in the systems, besides pod mass in the sampling sites of the ICLF systems. The pod mass is not affected by the integration system, but in the ICLF systems the distance from the row alters the mass. Straw and root mass are affected by the integration system.

Key words: Sustainable agriculture; *Glycine max*; shading

INTRODUCTION

Soybeans have presented, each year, an increase in its cultivation and yield area, and this has provided positive economic impact for Brazil that reached in the 2018/2019 harvest mean production of 3,359 kg ha^{-1} (CONAB, 2019).

However, the appeal of using sustainable production methods is growing every year. Integrated systems have gained increasing visibility, among them the Crop-Livestock-Forestry Integration (ICLF) system that stands out as a strategy for reducing greenhouse gas emissions (PEREIRA, 2019).

Crop yield in integrated systems with trees can increase or decrease depending on the spatial arrangement of the tree component, size and management of trees over time, crop species used (REIS et al., 2007; REYNOLDS et al., 2007).

This is due to the shading performed by the tree component. This shading is responsible for reducing the incidence of light, affecting the plants ability present in the field to perform photosynthesis, influencing the grains yield (VIANA et al., 2012). Thus, the aim was to evaluate the effect of different integration systems on soybean grain mass, straw dry mass and root mass.

MATERIAL AND METHODS

The experiment was conducted at the Brazilian Agricultural Research Corporation (Embrapa), Beef Cattle Unit, located in Campo Grande, MS, Brazil (latitude 20º 27' S; longitude 54º 37' W; 530 m altitude).

The climate is in the transition belt between Cfa (humid mesothermal without drought) and Aw (humid tropical), with an average annual rainfall of 1,560 mm, with rainfall during the hottest part of the year and drought during the coldest months. The average temperature observed during the period was 25 °C, with variations from 31.3 °C to 20.8 °C in maximum and minimum, respectively.

The experimental area has been used in succession cycle since 2008, using pasture in the winter period since the beginning and occurring crop variation in the summer, where in 2008 soybeans and sorghum were grown and in the following year eucalyptus was introduced in the area. In the years 2012 and 2018 soybeans were grown in the area and in the years 2010, 2011, 2013, 2014, 2015, 2017 and 2019 the pasture was the crop used in the summer, in addition in the years 2016 and 2017 a pruning and thinning was performed, respectively of eucalyptus.

The experimental design used was in randomized block design in a banded scheme with four repetitions. The treatments were arranged in subdivided plots, being agroforestry (ICL) with full sun cultivation; agroforestry-pasture system with distance between eucalyptus rows of 28 m ($ICLF_{28}$); agroforestry-pasture system with distances between eucalyptus rows of 22 m ($ICLF_{22}$). The subplots were composed of the sampling sites, being five sites between rows of eucalyptus trees (ICLF). These sites were demarcated on a transect perpendicular to the tree rows (east-west direction).

The sampling sites (north-south direction) were identified by the letters A; B; C; D and E, with the following distances from the nearest tree row: for $ICLF_{28}$, 7 m (A), 10 m (B), 11 m (C), 9 m (D) and 4 m (E). In the $ICLF_{22}$ system, the sampling sites were 3 m (A), 7 m (B), 10 m (C), 7 m (D) and 3 m (E). In both systems, 1 m distance between the rows of eucalyptus and the annual crop was respected.

The soil in the experimental area was classified as Red Dystrophic Latosol. Soil was collected from 0 to 20 cm deep for chemical analysis. In the full sun area the analysis revealed the following values: pH (CaCl2) = 5.36; P (Melich) = 4.91 mg dm^{-3}; K (Melich) = 8.52 mg dm^{-3}; Ca = 2.33 $cmol_c$ dm^{-3}; Mg = 1.49 $cmol_c$ dm^{-3}; Al = 0.01 $cmol_c$ dm^{-3}; S = 4.05 $cmol_c$ dm^{-3}; V = 46.46%. The following values were found in the understory: pH (CaCl2) = 5.08; P (Melich) = 11.03 mg dm^{-3}; K (Melich) = 148.68 mg dm^{-3}; Ca = 2.05 $cmol_c$ dm^{-3}; Mg = 1.19 $cmol_c$ dm^{-3}; Al = 0.07 $cmol_c$ dm^{-3}; S = 3.72 $cmol_c$ dm^{-3}; V = 41.69%.

The soybean crop management in the experimental area was initiated by desiccation of the total area with the use of non-selective herbicides of systemic and contact action known as glyphosate (Roundup®) and paraquat (Gramoxone®) in quantities of 1,225 g and 440 g of a.i. per hectare, respectively.

Sowing was performed on straw mulch in November 2017 with the soybean cultivar TEC7849 iPRO from Bayer. The cultivar's cycle is characterized as late, 7.8 maturity group, medium/high plant stature of indeterminate growth. The seeding rate used was 14.7 seeds per linear meter. Seeds were treated with biological peat inoculant Adhere® 60 - 1.5g m^{-1} (5x109 CFU g^{-1}), liquid inoculant Masterfix® - 4.5mL kg^{-1} seed (1.4 million bacteria per seed) and insecticide Standak Top® at a concentration of 2 mL kg^{-1} seed.

Fertilization was performed in installments using the formulation 00:20:20 in two applications, the first of 100 kg ha^{-1} in the field at the end of October and the second of 150 kg ha^{-1} in the sowing furrow, according to soil analysis. During the crop development applications of insecticides to control pests and fungicides to control diseases were made.

When the soybean crop reached physiological maturity (R8), the plants present in the two 2.0 m rows at a spacing of 0.50 m were harvested by hand. The pod mass was obtained by weighing and the values were corrected to 13% moisture. At the same time the root mass was obtained. After harvest, the straw mass was collected.

The results obtained were submitted to variance analysis by means of SISVAR 5.7 software and when the F test was significant the Tukey test was applied, adopting a probability level of 5%.

RESULTS AND DISCUSSIONS

There was no significant effect for the mass of pods in the three systems evaluated, however there was an effect for the soybeans straw and root mass (Table 1). The ICL system presented the highest straw and root masses among the systems with an increase of 22.72% and 51.96% in comparison to the ICLF, respectively.

Table 1. Productive characteristics of pod mass, straw dry mass and root mass after soybean physiological maturity in integrated systems.

Systems	**Pods** (g plant^{-1})	**Straw** (kg ha^{-1})	**Root** (g plant^{-1})
ICL	262.14 a	7,450.8 a	1.93 a
ICLF$_{28}$	279.82 a	6,204.9 b	1.39 b
ICLF$_{22}$	248.56 a	5,937.4 b	1.15 b
[1]CV (%)	9.73	4.3	4.33

ICL: Integration Crop-Livestock; ICLF$_{28}$: Integration Crop-Livestock-Forest com espaçamento de 28 m; ICLF$_{22}$: Integration Crop-Livestock-Forest com espaçamento de 22 m. [1]CV: Coefficient of variation. Means followed by the same lowercase letter in the column do not differ by the Tukey test (P>0.05).

Although root mass was lower in the ICLF$_{28}$ and ICLF$_{22}$ systems, this did not affect soybean pod mass. The systems with the tree component, soybean suffered from overgrowth affecting root mass production and consequently reducing the roots nutrient uptake capacity (FARIAS NETO et al., 2019).

In contrast, the lower straw mass in the ICLF systems demonstrate that the plant probably reduced its mass, which affected the straw due to the stress caused by shading (VIANA et al., 2012).

The sampling sites affected the pod mass in the ICLF$_{28}$ and ICLF$_{22}$ systems (Table 2). In both ICLF systems, it was possible to observe that the sampling sites closer to the rows showed the lowest pod mass production. This reinforces that the trees presence in the system are responsible for shading the crop, reducing the plant photosynthetic capacity (FARIAS NETO et al., 2019).

This reduction in photosynthetic capacity has a direct effect on the plant, directly affecting the mass of pods, straw and nutrient absorption capacity due to lower root mass, thus harming the yield of the system as a whole (ANDRADE et al., 2004).

Table 2. Pod mass (g) at different sampling locations in ICLF systems after physiological maturity.

Systems	**Sampling Locations**					**[1]CV (%)**
	A	**B**	**C**	**D**	**E**	
ICL	278.3 a	255.7 a	261.6 a	257.2 a	257.9 a	10.37
$ICLF_{28}$	240.5 c	303.8 ab	333.0 a	270.4 bc	251.4 c	8.37
$ICLF_{22}$	227.6 b	268.0 a	270.3 a	248.7 ab	228.2 b	7.38

ICL: Integration Crop-Livestock; $ICLF_{28}$: Integration Crop-Livestock-Forest com espaçamento de 28 m; $ICLF_{22}$: Integration Crop-Livestock-Forest com espaçamento de 22 m. [1]CV: Coefficient of variation. Means followed by the same letter in the row do not differ by Tukey test (P>0.05).

CONCLUSIONS

Straw and root mass are lower in systems with the tree component presence.

Sampling sites closer to the rows in the $ICLF_{28}$ and $ICLF_{22}$ systems reduce pod mass, reinforcing the idea that shading reduces the yield.

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