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UTILIZATION OF QUICKSTICK (*Gliricidia sepium* (Jacq.) Steud) IN ALLEY CROPPING SYSTEMS FOR THE PRODUCTION OF CASSAVA (*Manihot esculenta* Crantz)

ABSTRACT: The goal of this study was to verify the influence of quickstick (*Gliricidia sepium* (Jacq.) Steud) in ally cropping systems for the production of cassava (*Manihot esculenta* Crantz) in an experimental unit in Santarém, Pará, Northern Brazil. The experiment was carried out in interspersed blocks divided into two treatments with four repetitions each. The massava crop was collected after 8 months, when the number of living plants, the number of roots per plant and the weight of roots per parcel were quantified. The productivity of cassava cultivated in association with quickstick was equal to 2.3 t/ha versus 1.2 t/ha in the control treatment, considering the experimental conditions. The production of roots reached the best results in massava crops using fertilization with quickstick even though no statistical differences were reported among treatments. Therefore, further evaluation based on increased sampling is recommended to provide a more comprehensive dataset.

KEYWORDS: Green fertilization, Agricultural component, Sustainability.

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USO DE GLIRICÍDIA (*Gliricidia sepium* (Jacq.) Steud) EM SISTEMA *ALLEY CROPPING* NA PRODUÇÃO DE MACAXEIRA (*Manihot esculenta* Crantz)

RESUMO: Objetivou-se verificar a influência do uso da gliricídia (*Gliricidia sepium* (Jacq.) Steud) em sistema *alley cropping* na produção de macaxeira (*Manihot esculenta* Crantz) em unidade experimental em Santarém, Pará. O experimento foi conduzido em blocos intercalados, com 2 tratamentos, distribuídos em 4 repetições. Após 8 meses de plantio, foi realizada a colheita da macaxeira, quantificando-se o número de plantas vivas, o número de raízes por planta e o peso de raízes por parcela. Os

resultados denotam que a produtividade de macaxeira com gliricídia foi de 2,3 t/ha, enquanto na testemunha foi de 1,2 t/ha, nas condições expostas neste experimento. A produção de raízes apresentou o melhor resultado da cultura da macaxeira sob a adubação verde com gliricídia, mesmo não apresentando diferença estatística entre tratamentos. Portanto, visando maior abrangência dos dados, sugere-se o redimensionamento da amostragem para as futuras avaliações.

PALAVRAS-CHAVE: Adubação verde, Componente agrícola, Sustentabilidade.

USO DE GLIRICIDIA (*Gliricidia sepium* (Jacq.) Steud) EN SISTEMAS DE CULTIVO *Alley cropping* EN LA PRODUCCIÓN DE MANIOCA (*Manihot esculenta* Crantz)

RESUMEN: El objetivo fue verificar la influencia del uso de gliricídia (*Gliricidia sepium* (Jacq.) Steud) en un sistema de cultivo em franjas en la producción de yuca (*Manihot esculenta* Crantz) en una unidad experimental en Santarém, Pará. El experimento se llevó a cabo en un diseño completamente al azar, con 2 tratamientos, distribuidos en 4 repeticiones. Después de 8 meses de plantado, se cosechó el árbol de yuca, cuantificando el número de plantas vivas, el número de raíces por planta y el peso de raíces por parcela. Los resultados demuestran que la productividad de la yuca con gliricídia fue de 2,3 t/ha, mientras que en el testigo fue de 1,2 t/ha, en las condiciones expuestas en este experimento. La producción de raíces mostró el mejor resultado del cultivo de yuca bajo abono verde con gliricídia, aun sin mostrar diferencia estadística entre tratamientos. Por lo tanto, con el objetivo de una mayor cobertura de datos, se sugiere redimensionar la muestra para futuras evaluaciones.

PALABRAS CLAVES: Abonos verdes, Componente agrícola, Sostenibilidad.

Large-scale agricultural systems have increased the degradation of Brazilian soils, suggesting that alternative cropping methods should be implemented for a proper soil management (QURESHI *et al.*, 2014; VISCHI FILHO *et al.*, 2021). Accordingly, practices that incorporate organic matter in soils have been developed, including the so-called green fertilization, recognized as a viable option to increase the sustainability in plant production (LEITE *et al.*, 2017).

The green fertilization refers to the addition of fresh vegetal biomass in order to recover the fertility and the productivity of soils (RAMPIM *et al.*, 2020). The plants used in this system might be produced either *in situ* or *ex situ* and their incorporation

increases the soil porosity, thus favoring water retention and the development of roots in crops (SOUZA *et al.*, 2012; HENDGES *et al.*, 2015). Traditionally, leguminous plants are widely used in green fertilization because they present high rusticity, increased production of dry matter, deep radicular systems, besides being able to incorporate nitrogen to the soil as a result of their symbiotic association with nitrogen-fixing bacteria (SINICIO, 2017).

On the other hand, alley cropping systems are characterized by the cultivation of commercial species in alleys interspersed with fertilizing arboreal or shrub-like plants of fast growth (MEIRELLES; SOUZA, 2015). The periodical pruning of fertilizing plants determines both the cycling of nutrients in agroecosystems and improvement of soil properties (MATTAR *et al.*, 2013; PUIATTI *et al.*, 2015).

The state of Pará accounts for 21% of agricultural production in Brazil, reaching the first ranking in national productivity, including 262.021 ha of cropped areas in 2019 (SEDAP, 2019). Similar to every agricultural activity, continuous studies are required to develop conservationist practices of soil management in order to combine productivity gains and the sustainability of production systems.

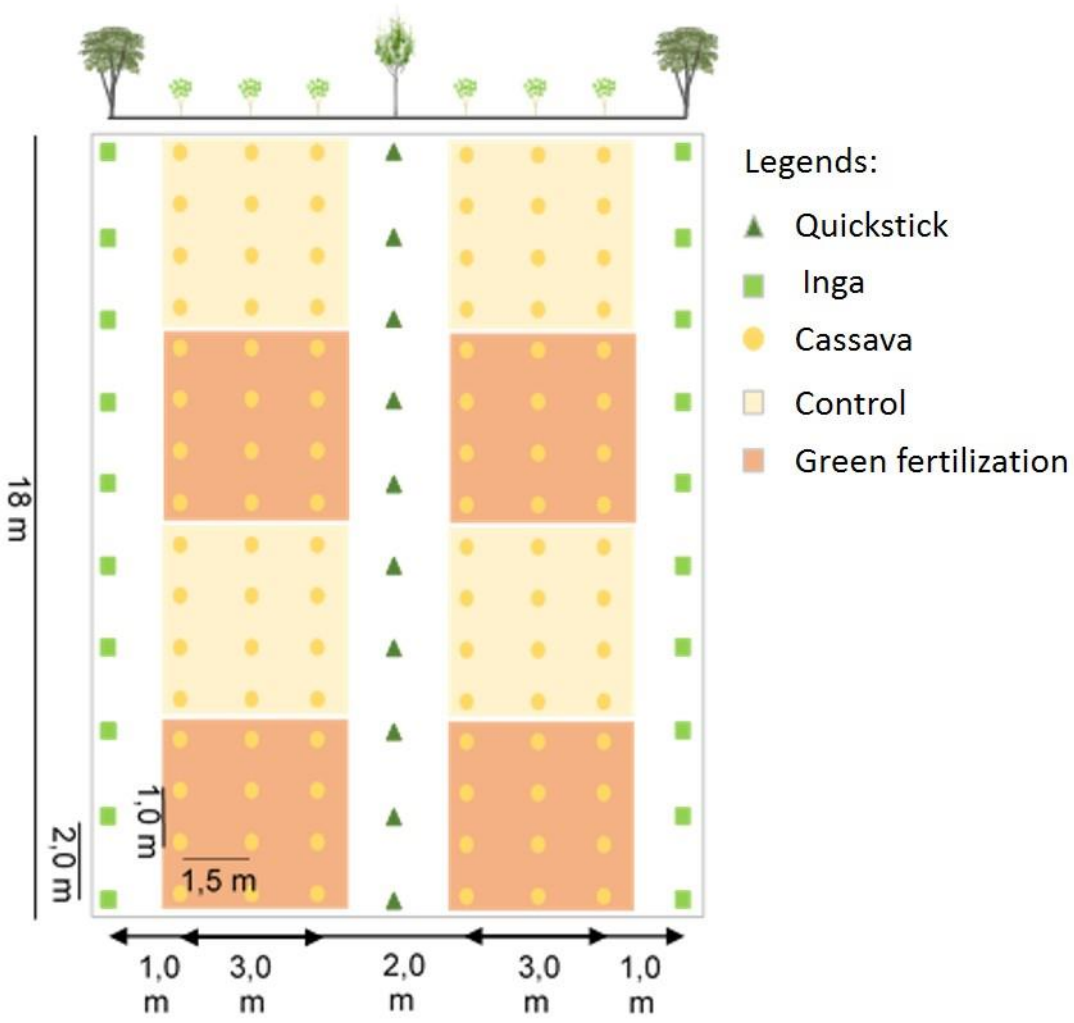
Therefore, the goal of this study was to evaluate the utilization of quickstick (*Gliricidia sepium* (Jacq.) Steud) cultivated along with massava (*Manihot esculenta* Crantz) in alley cropping systems along an experimental agroforestry unit in Santarém, Pará, Northern Brazil.

The experiment was carried out in the Experimental Unit from Federal University of Western Pará (UFOPA) close to PA 370 road (Curuá-Una) in the municipality of Santarém, Pará, Northern Brazil (2°41'16" S and 54°31'55" W). This region is characterized by Am climate according to Köppen climate classification, with annual rainfall from 1,900 to 2,200 mm and mean annual temperatures between 25 and 27ºC (ALVARES *et al.*, 2013). The mean humidity is about 85%, including a dry season (July to November) and a wet season (December to June) (INMET, 2020).

The experimental area encompassed 360 m^2, where four alleys were established in February 2017. These alleys were interspersed with perennial species, being divided

into two alleys composed of inga (*Inga heterophylla* Willd.) and two alleys of quickstick trees, following a 6-m distance pattern between alleys and 2-m distance between plants, thus totaling 20 specimens per species (Figure 1). The cassava crops were established two years later, in 2019. The green fertilization was performed in the alleys cultivated with quickstick (Figure 1).

Figure 1. Experimental design of alley cropping system established in the Experimental Unit at UFOPA in Santarém, Pará, Northern Brazil.



The experimental distribution comprised two interspersed blocks and two treatments (quickstick and control) with four repetitions. The 5 m x 6 m parcels were randomly distributed between the alleys of perennial species, based on 1,5 m distance

between alleys and 1.0 m between plants, encompassing 12 plants per parcel and a population density of 48 plants per treatment.

The soil was prepared using semi-automated methods where the field was cleaned with a backpack mower and harrowed using a tractor. After cleaning, 2 t/ha of limestone was applied onto soil and uniformly spread over the field. Thirty days after the limestone treatment, 12-cm cassava stems with three immature nodes were manually inserted at horizontal position in each harrow, followed by covering with a soil layer.

After the seedlings started growing, we applied a uniform layer of fresh quickstick biomass over the soil throughout each treatment parcel. This biomass was composed of sticks, leaves and flowers of quickstick tree applied twice right after pruning in 40-day intervals, comprising 24 kg/m^2 in each parcel.

To quantify the quickstick biomass, four samples were dried in oven at 60°C for 48 h to obtain the measurements of dry matter and humidity.

After 8 months of cultivation, the crops were harvested, establishing the number of living plants, the number of roots per plant and weight of roots per parcel. To estimate the productivity, the weight of roots (in kg) per parcel was generalized to a hectare.

The data were analyzed using the Lilliefors normality test to verify their normal distribution. Afterwards, T-test was performed to evaluate the statistical differences between both experimental and control samples. The statistical analyses were carried out in the software Bioestat (AYRES *et al.*, 2007).

The mean survival of cassava plants in the parcels fertilized with quickstick was 81% while it was equal to 73% in the control unit. These values correspond to an average of 10 to 9 plants per parcel (30 m^2), respectively, being mainly attributed to losses of specimens due to predation by wild animals.

The analyzed variables in cassava crops (number of plants and roots, mean number of roots, mean weight and productivity) showed no statistical differences between experimental and control parcels (Table 1), even though the quickstick biomass resulted in higher values for all variables. The T-test revealed homoscedasticity

between treatments with superior p-bilateral values (0.1022; 0.2160; 0.2401; 0.4180 and 0.5334) at 5% level.

Table 1. Tested variables of both experimental treatments in crops of *Manihot esculenta* Crantz cultivated in alley cropping systems on the Experimental Farm at Federal University of Western Pará, Santarém, Pará, northern Brazil.

Treatment	Number of plants/parcel	Number of roots/parcel	Mean roots per plant	Mean weight (kg)	Estimated productivity (t/ha)
Quickstick	9.8±2.0 a	29 ± 13.2 a	2.9 ± 0.8 a	0.6 ± 0.2 a	2.3 ± 1.1 a
Control	8.8±2.2 a	17.8 ± 9.5 a	2.2 ± 1.4 a	0.4 ± 0.3 a	1.2 ± 0.51 a

Mean values followed by the same letter in each column indicated no significant statistical differences in T-test at a 5% level.

The productivity estimated per hectare ranged from 1.2 to 3.67 t/ha for the treatment using quickstick biomass and from 0.55 to 1.62 t/ha I the control unit. The data also revealed a coefficient of variation above 30% (44% and 46%, respectively) which indicates high variation within the analyzed samples.

The average production of cassava in the control unit (1.2 t/ha) was lower than that observed in the treatment using quickstick biomass as fertilizer (2.3 t/ha). Nonetheless, both treatments presented no significant differences according to the Tukey's test at a 95% confidence level. This result is similar to that reported by Primo *et al*. (2012), in which the total production of biomass and corn grains was higher when quickstick matter was applied, thus favoring an increased productivity when compared to control experiments.

Taking into account the estimated production per hectare, it was possible to verify that the use of quickstick as green fertilizer under the conditions followed in the present experiment could imply in increased production of nearly 1 t/ha. Most likely, these estimates are related to decomposition processes that benefit the target crops in as much as the leaf degradation of quickstick in the same experimental area was

within 76 to 85% of leaf mass in 120 days, with the highest losses being observed during the first 30 days (SOUSA *et al*., 2020).

Since the present experiment revealed no statistical differences between treatments, but rather expressive variation between mean values, we reinforce the need for further temporal and quantitative expansion of similar assays to provide a better understanding about the putative influence of quickstick biomass on cassava production. Thus, additional researche focusing on this leguminous tree are strongly recommended to be carried out in tropical Amazonian crops because of their apparent potential to improve production.

Accordingly, previous reports have already shown the benefits of using quickstick biomass in other cultivated systems. For instance, Barreto *et al.* (2012) showed that crops interspersed with quickstick trees benefits from increased productivity due to the enhancement of chemical and physical properties of the soil, particularly along the most superficial layers covered by the latter. Likewise, a study by Santos *et al*. (2011) reported higher values in the diameter and weight of carrot roots covered with a biomass of quickstick and pigeon pea. Furthermore, Filho *et al*. (2016) observed improved quality in strawberry (*Fragaria vesca* L.) cultivated using quickstick as green fertilizer.

The values in the production of cassava roots were higher using quickstick biomass as green fertilized even though no significant differences were reported between experimental and control treatments. Therefore, we suggest that the present study should be expanded to increase the sampling design for further evaluation.

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