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Economic profitability of yellow passion fruit in organic cultivation under different input levels and irrigation

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Abstract

Passion fruit yield is low compared to its productive potential, which, in organic systems, is due to rainfed cultivation and low input levels. This study aimed to evaluate the profitability of organic yellow passion fruit production under different input levels and irrigation. The experiment was conducted in Rio Branco - AC, at the Seridó Ecological Site, from November 2016 to August 2018, following a randomized block design with a 3x2 factorial arrangement and four replications. The factors evaluated were: three input levels (fertilizers and alternative pesticides) and the presence or absence of irrigation. Fertilization was performed based on the nutrient content of the soil analysis and according to the yield estimates of 5 t ha^{-1}, 10 t ha^{-1}, and 15 t ha^{-1}. A micro-sprinkler irrigation system was installed along the planting rows, with one emitter per plant. The production costs, profitability, simplified economic analysis, and total and operating coverage production were calculated based on capital depreciation, input levels, and labor during two cultivation years. The highest input level and irrigation increased the yield, the total revenue, and the production required to cover total and operating costs. Fixed cost is higher when using irrigation in association with input level 1, although it provided positive economic returns.

Keywords: operating costs, profitability indicators, *Passiflora edulis*

Introduction

Yellow passion fruit (*Passiflora edulis* Sims), also known as sour passion fruit, is a tropical plant with high genetic variability of the family Passifloraceae, grown mainly on small properties. An estimated 95% of the yellow passion fruit orchards in Brazil correspond to this species (Meletti, 2011). In 2018, Brazilian passion fruit production reached 602 thousand tons, with an average yield of 14.1 tha^{-1} (IBGE, 2018).

Yellow passion fruit cultivation stands out among the primary sector activities, with potential for job and income generation, allowing the development of agro-industries, and favoring the expansion of fruit-growing centers throughout the country (Santos et al., 2017). In the state of Acre, the average passion fruit yield in 2018 was 8.5 tha^{-1}, which is low compared to the national yield and to the potential of the crop. State production, therefore, is not sufficient to meet domestic consumption (IBGE, 2018).

Several factors can interfere with passion fruit yield and quality, such as crop management practices and environmental factors. The nutritional and water requirements of plants, if not properly met, are coefficients that may limit crop yield. This crop is highly responsive to fertilization (Rodrigues et al., 2017), and depending on the time of year, irrigation may become necessary, especially if the application is split, with irrigation management being essential to obtain higher yields (Araújo et al., 2012; Arêdes et al., 2009).

However, when new technologies are used, considering the high production costs and the low prices paid for the fruit, it is necessary to seek an in-depth diagnosis regarding crop investments in order to assess whether they can provide positive yield returns in the long term (Araújo Neto et al., 2012).

Cost assessment is required for planning and decision-making in order to improve economic returns.

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Profitability varies from region to region depending on production costs, input levels, labor availability, the distance to the consumer market, fluctuations in the price paid for the fruit, and variations in crop yield and in the planted area. Details on production costs are essential to evaluate investment returns in a production system (Furlaneto et al., 2011; Pimentel et al., 2009).

In organic farming systems, the annual crop yield can vary from 5.1 to 10.8 t ha (Uchôa et al., 2018; Araújo Neto et al., 2014); however, production costs are low, requiring yields as low 5.5 t ha^{-1} and 4.3 t ha^{-1} to compensate total and operating costs, respectively (Araújo Neto et al., 2008). Despite the low cost, the direct sale price of the organic fruit from family farming is higher than the price for the industry (Francisco, 2019).

Therefore, this study aimed to evaluate the production cost of yellow passion fruit in an organic farming system under different input levels and irrigation.

Material and Methods

The experiment was conducted at the Seridó Ecological Site, located in the Aquiry Settlement Project, Highway AC 10, km 4, branch José Rui Lino, Rio Branco, AC, 09°53'16 "S and 67°49'11"W, with 170 m of elevation above sea level.

According to the Köppen classification, the climate of the region is classified as Am (hot and humid), with annual average temperatures around 23.3 °C, relative air humidity of 72%, and annual rainfall ranging from 2,079.9 mm to 2,244.5 mm during the experimental period (INMET, 2019).

The soil is classified as a YELLOW ARGISSOL (Ultisol) with gently undulating topography, no apparent erosion, and moderate drainage. The chemical attributes present in the 0-20 cm layer are: pH = 5.2; P = 1.7 $mg.dm^{-3}$; K = 1.8 $mmolc.dm^{-3}$; Ca = 28 $mmolc.dm^{-3}$; Mg = 12 $mmolc.dm^{-3}$; Al+H = 72 $mmolc.dm^{-3}$; O.M. = 17 $g.dm^{-3}$; SB = 41.4%; CEC = 113.4 $mmolc.dm^{-3}$; V = 36.5%.

The experiment was conducted from November 2016 to August 2018. The experimental design was in randomized blocks in a 3x2 factorial arrangement with four replications. The factors evaluated corresponded to three input levels (alternative fertilizers and pesticides) and the presence or absence of irrigation. The experimental unit consisted of four passion fruit plants at 3 m x 3 m spacing and trained on a vertical shoot positioning.

The passion fruit cultivar used was an F3 synthetic variety from the UFAC Germplasm Bank developed in Rio Branco, AC, Brazil. The seedlings were produced in August 2016 in trays containing organic substrate. After reaching 2 to 3 cm in height, with two definitive leaves, the seedlings were individually transplanted to plastic bags containing 1.5 L of organic substrate and kept in a greenhouse, receiving daily irrigation.

The area was prepared using a motorized backpack brush cutter to remove the spontaneous vegetation. After the natural drying of the straw, pits measuring 40 cm x 40 cm x 40 cm were opened to allow the application of the input levels through different fertilizer doses. Fertilization consisted of the application of 5, 10, and 15 liters of compost per plant and 500, 1,000, and 1,500 g of lime per plant, corresponding to the input levels 1, 2, and 3, respectively.

The organic compost was produced from signalgrass (*Urochloa* sp.) and spontaneous plants naturally decomposed on the property. Their chemical analysis revealed: N = 1.13%; P = 1.33%; K = 0.18%; Ca = 3.36%; Mg = 0.20%; S = 0.10%; pH = 6.55; organic matter = 11.97%; ash = 88.61%; density (kg m^{-3}) = 350; C/N ratio = 6.11. The compost and the lime were mixed with the soil and returned to the pit, without inverting the soil layers.

All crop management practices were conducted according to the ecological management of the system recommended by Uchôa et al. (2018), Silva et al. (2019), and by the MAPA Normative Instruction No. 46 of 2011 (BRASIL, 2011).

Topdressing fertilization was performed based on the nutrient content analysis of the soil and organic compost, according to the yield estimate for the crop recommended by Souza et al. (1999). In order to achieve the yields of 5 t ha^{-1}, 10 t ha^{-1}, and 15 t ha^{-1}, the levels of 118, 235, and 353 $g.plant^{-1}$ of thermophosphate and 59.1, 118.20, and 176.40 g $plant^{-1}$ of potassium sulfate were applied, corresponding to the input levels 1, 2, and 3, respectively. Fertilization was split into two applications, at 60 and 120 days after planting. In the second year of cultivation, fertilization was carried out in October 2017 and in January 2018.

A micro-sprinkler irrigation system was installed along the planting rows, with one emitter per plant, and the irrigation requirement was defined by the soil water matric potential, measured with tensiometers installed at 0.15 m from the plant and 0.20 m deep in the soil. A gross irrigation depth of 27.63 mm was used.

All crop management practices are in agreement with ecological management. The Bordeaux and lime sulfur mixtures were used to protect plants against pests and pathogens. These mixtures were sprayed only in the second year of cultivation, whenever necessary, according to the input levels: level 1 - every 30 days, level

2 - every 15 days, and level 3 - weekly.

Weed control was carried out by manual hoeing within a 0.50 cm radius from the plants, while the backpack brush cutter was used in the rows and between them. Flowers pollination occurred naturally. The pollinators were insects of the genus *Xylocopa* ssp., known as carpenter bees.

On harvest days, all fallen fruits and those still adhered to the plant were collected. The yellow color of the peel above 30% was used as a ripeness indicator.

Production costs and yield were estimated per hectare during two years of cultivation by considering the local price (direct or single intermediary sale) of fresh and processed passion fruits and the respective materials used in 2019.

The total cost of passion fruit cultivation corresponds to the fixed costs with equipment depreciation, training system, facilities, and variable costs with the acquisition of inputs and services. In addition to these, the administrative cost (3%), the alternative capital cost (6%), and the opportunity cost of land use were also added to the calculation (Araújo Neto et al., 2008; CONAB, 2010; Francisco, 2019; Reis, 2007).

Depreciation (D) was included in cost analysis as the need to replace capital goods due to physical or economic wear. It can be calculated by the equation: D = (Va-Vr)/Vu.P, where: D - depreciation, (US$/crop), Va - current resource value (US$); Vr - residual value (final input value) (US$) Vu - useful life (the period during which the input is used in the activity); P – the period considered, production cycle.

The table of agricultural production costs provided by CONAB (2010) was used to determine the useful life of materials and equipment and their residual values.

ariable costs (CV) refer to resources that require spending during cultivation. They are considered to be modifiable in the short term, depending on production factors, and may change throughout cultivation according to the targeted yield or the need for intervention due to the emergence of pests and diseases.

The benefit/cost ratio (B/C) is defined by the reference value 1 (one). When B/C is greater than 1, it is economically viable; when B/C is equal to 1, revenue equals costs; and when B/C is less than 1, the activity is not economically viable. This indicator evaluates the financial return for each monetary unit of the cost of the enterprise, calculated by the formula: RB/C = (RT/CT), where: RB/C – benefit/cost ratio, RT - total revenue, CT - total cost.

Net revenue (RL) represents the income earned from the activity, including all costs. If the result is less than the total cost, it represents loss, determined by: RL = RT-CT, where: RL - net revenue; RT - total revenue; CT - total cost.

The profit margin (L) is the efficiency indicator of the enterprise, that is, how much the producer can generate from the activity developed, determined by the following equation: L = (RL/RT).100, where: L - profit margin; RL - net revenue; RT - total revenue.

Family labor remuneration (RMOF) is the income from family labor per number of working days. It indicates how much the system pays for the working day of the family, calculated by the formula: RMOF = RL/working days, where: RMOF - family labor remuneration; RL - net revenue.

The profitability index (ROI) determines the degree of enterprise attractiveness, allowing the farmer to check the return space/time of the invested capital, obtained by the formula: (ROI) = RL/(I + CG).100, where: ROI - profitability index; RL - net revenue; I - fixed investment; CG - working capital.

Working capital was used to purchase inputs and services, such as biological insecticides, transportation, fuel, and fertilizers, among others.

The calculation of the average revenue (RMe) considered the price of the fruit and pulp produced by ecological farmers and sold at open fairs in the study region. The linear price throughout the year was US$ 0.98 per kg for the fruits belonging to the extra and organic classes; for Class III fruits, which are the ones for the pulp industry, the price was US$ 0.75 kg, with US$ 0.95 kg as the weighted average price of all sales. The USD exchange rate as of December 15, 2020, was considered, which was R$ 5.08 = US$ 1.

Production cost and profitability analyses were conducted to verify whether the resources used in passion fruit production are profitable. Reis (2007) recommends the following indicators for a simplified economic analysis: average total cost (MSC), average total operating cost (CopTMe), and average variable operating cost (CopVMe). These indicators are calculated by the cost to yield ratio.

Operating coverage production (Pcop) and total coverage production (Pct) represent the amount of product that must be produced and traded in order to cover operating and total costs, respectively, being calculated by the following formulas: Pct = CT/Rme, where Pct - total coverage production (t ha^{-1}), CT - total cost (US$ ha^{-1}), Rme - average revenue (price US$ kg^{-1}).

Pcop = Copt/Price, where Pcop - operating coverage production (t ha^{-1}), Copt - total operating cost (US$ ha^{-1}), Price - average revenue (price US$ kg^{-1}).

Before analyzing data variance, the presence of outliers was assessed by the Grubbs test, normality of errors by the Shapiro-Wilk test, and variance homogeneity by Bartlett's test. Subsequently, ANOVA was performed by the F-test, transforming the operating coverage production (√x) and total coverage production (√x) data. The means were then compared by Tukey's test ($p<0.05$). Orthogonal contrasts were used to compare the means of some variables in order to analyze the effect of the groups on the experiment.

Results and Discussion

The L, B/C, RMOF, ROI, RL, CopVMe, CopTMe, CVMe, and CTMe variables were not significantly affected ($p>0.05$) by the input levels and by the presence or absence of irrigation. The total revenue differed between treatments (Table 1).

The B/C ratio showed that all treatments were economically viable, with a higher than 1 (one) financial return, resulting in 2.40 in the irrigated system and 2.44 in the non-irrigated system. Almeida et al. (2018) analyzed the economic viability of a small passion fruit production in Boca da Mata, Alagoas, and estimated a B/C ratio at 1.41, reinforcing the profitability of the passion fruit activity.

Family labor remuneration (RMOF) was US$ 76.82, considering that the day rate based on the current minimum wage was US$ 12.94 (man/day). This number is higher than the day rate in the region, which is approximately US$ 9.84. Yellow passion fruit cultivation is a good income alternative for family farming, satisfactorily remunerating small producers in addition to allowing production diversification (Francisco, 2019).

Table 1. Profit (L), benefit/cost ratio (B/C), family labor remuneration (RMOF), profitability index (ROI), net revenue (RL), total revenue (RT), average variable operating cost (CopVMe), average total operating cost (CopTMe), average variable cost (CVMe), average total cost (CTMe), and total cost (CT) of passion fruit cultivation under different input levels and with and without irrigation. Rio Branco, Acre, Seridó Ecological Site (2019).

	Input			Irrigation		CV (%)
	Level 1	Level 2	Level 3	Presence	Absence	
L (%)^{ns}	51.79	56.29	55.31	53.85	55.08	28.81
B/C ^{ns}	2.27	2.51	2.48	2.36	2.48	34.43
RMOF (US$/day) ^{ns}	61.22	80.26	88.97	78.52	75.12	52.15
ROI (%)^{ns}	141.05	166.95	163.12	149.82	164.26	58.54
RL (US$ kg^{-1})^{ns}	4,946.49	7,007,67	8,958.02	7,516.45	6,424.99	61.55
RT (US$ kg^{-1})^{1}	8,724.41b	11,727.41ab	14,926.22a	12,937.62a	10,647.74a	37.45
CopVMe (US$ kg^{-1})^{ns}	0.31	0.30	0.33	0.29	0.34	32.90
CopTMe (US$ kg^{-1})^{ns}	0.42	0.38	0.39	0.40	0.39	33.95
CVMe (US$ kg^{-1})^{ns}	0.34	0.32	0.36	0.31	0.37	32.84
CTMe (US$ kg^{-1})^{ns}	0.46	0.42	0.43	0.44	0.43	33.84
CT (US$)*	3,690.92	4,610.90	5,864.60	5,249.35	4,194.94	-

ns – means do not differ ($p>0.05$) from each other by the F-test; 1 - Means followed by the same letter do not differ ($p> 0.05$) by the F test; * - no statistical analysis of the indicator was performed because there was no sample variation.

Profit was over 50% regardless of the treatment used. The profitability index reflects the financial return provided by the activity. The average for all irrigated and non-irrigated treatments was 155.24% and 158.85%, respectively, representing the return on invested capital plus profit. According to Araújo Neto et al. (2012), economic profitability is essential for decision-making regarding technology adoption.

Considering both production years, both net and total revenue increased under high input levels and irrigation (Table 1), reaching the maximum values of US$ 8,237.23/ha and US$ 13,931.92/ha, respectively, which are excellent results for the standards of Brazilian agriculture. Compared with commodities such as maize and soybean, Vivan et al. (2015) obtained net revenue values of US$ 352.36/ha/two years and US$ 290.16/ha/two years, respectively.

In addition to irrigation, the yield values close to the national average, the margins obtained with product sale, and the use of organic inputs contribute to reducing costs and making the activity less dependent on external resources and inputs. Although providing higher yields, conventional production implies higher production costs and the intensified preventive use of pesticides, machinery, implements, and fertilizers, practices that demand greater investments and labor costs (Furlaneto et al., 2011). These authors evaluated the cost of yellow passion fruit production in the region of Marília, SP, and obtained a negative net revenue of US$ -2,195.21, even with a yield of 20 t ha^{-1}, due to high production costs.

The average fruit price was US$ 0.95 kg, and the CTMe was US$ 0.44 kg, resulting in what Reis (2007) calls *supernormal profit* (RMe> CTMe). According to the author, the simplified analysis of the activity may result in profit or residue situations. In this study, all investment in the activity was compensated and additional profit was obtained, making the activity profitable.

The average fixed cost (CFMe) and the average fixed operating cost (CopFMe) increased as the use of irrigation increased by 0.04 US\$ kg^{-1} and 0.06 US\$ kg^{-1}, respectively (Table 2). Considering the results achieved with this system, the use of irrigation increases the yield and covers all additional costs with the adoption of this technology (Arêdes et al., 2009).

Table 2. Comparison by orthogonal contrasts between irrigation and input levels on the average fixed cost (CFMe) and average fixed operating cost (CopFMe). Rio Branco, Acre, Seridó Ecological Site (2019).

Orthogonal contrast	CFMe (US\$ kg^{-1})	CopFMe (US\$ kg^{-1})
No irrigation / level 1	0.08 a	0.06 b
Irrigation	0.12 a	0.12 a
No irrigation	0.06 a	0.06 a
Irrigation / level 3	0.10 a	0.08 a
Irrigation / level 1	0.16 a	0.14 a
No irrigation	0.06 b	0.06 b
No irrigation / level 1	0.08 b	0.06 b
Irrigation / level 1	0.16 a	0.14 a
Irrigation / level 1	0.16 a	0.14 a
Irrigation / level 3	0.10 b	0.08 b
Irrigation / level 3	0.10 a	0.08 a
No irrigation / level 3	0.04 a	0.04 a
CV (%)	41.12	42.22

Means followed by the same letter do not differ (p> 0.05) by the F-test.

The treatment with irrigation and input level 1 was the most expensive in both CFMe and CopFMe compared to the control and the absence of irrigation. Being a fixed system and requiring high investment in equipment acquisition, which increases fixed costs, the use of irrigation resulted in higher yields, reducing the CFMe and CopFMe compared to the treatment with rainfed cultivation and input level 1, a less productive system.

The CFMe and CopFMe were lower under irrigation and input level 3 than under irrigation and input level 1. These results are due to the yield value achieved, 17.4 t ha^{-1}, used as a denominator to calculate the CFMe and CopFMe.

The installation of the irrigation system is the main factor that contributes to increasing the CFMe (US\$ kg^{-1}). According to Pimentel et al. (2009), fixed costs may decrease with the increase of the cultivated area, optimizing the use of agricultural machinery, facilities, equipment, administration, and reducing input prices.

When the crop uses irrigation, the implantation of the system is responsible for 64.6% of the CFMe, while expenses with passion fruit cuttings represent 25.03% of the CFMe; with rainfed cultivation, the costs with cuttings reach 70.71%, although this expense is amortized over various crop cycles as they can be used for up to 25 years.

When analyzing the orthogonal contrasts (Table 3), it was verified that irrigated cultivation, regardless of the input levels, requires higher yields to cover both operating and total costs.

Table 3. Comparison by orthogonal contrasts between irrigation and input levels on the operating coverage production (Pcop) and total coverage production (Pct). Rio Branco, Acre, Seridó Ecological Site (2019).

Orthogonal contrast	Pct (t ha^{-1})	Pcop (t ha^{-1})	RT (US\$ kg^{-1})
No irrigation / level 1	3.2 b	2.9 b	6.79 b
Irrigation	5.7 a	5.2 a	12.93 a
No irrigation	4.4 b	4.0 b	10.65 b
Irrigation / level 3	6.9 a	6.3 a	16.63 a
Irrigation / level 1	4.7 a	4.2 a	10.65 a
No irrigation	4.4 b	4.0 b	10.65 a
No irrigation / level 1	3.2 b	2.9 b	6.79 a
Irrigation / level 1	4.7 a	4.2 a	10.65 a
Irrigation / level 1	4.7 b	4.2 b	10.65 a
Irrigation / level 3	6.9 a	6.3 a	16.63 a
Irrigation / level 3	6.9 a	6.3 a	16.63 a
No irrigation / level 3	5.6 b	5.1 b	13.21 a
CV (%)	1.42	1.44	37.45

Means followed by the same letter do not differ (p> 0.05) by the F-test.

The highest yield demand to cover total and operating costs was 6.9 t ha^{-1} and 6.3 t ha^{-1}, respectively, considering irrigated cultivation and input level 3. In this case, this higher request occurs mainly due to the higher fixed costs with irrigation and input acquisition.

According to Arêdes et al. (2009), higher yields were obtained using irrigation, constituting an economically superior system to rainfed irrigation even in regions with favorable rainfall rates, reducing the risk of the activity.

If the technological option available requires fewer financial resources and lower use of inputs, as in the rainfed system with low input application, the necessary yields to cover total and operating costs are 3.2 t ha^{-1} and 2.9 t ha^{-1}, respectively. The resulting yield is low under these conditions, reaching 7.5 t ha^{-1} (Table 4). However, it is enough to cover production costs and keep the producer in the business, which contributes to the ecological, economic, and environmental diversification of the property in the case of family farming.

Although the low economic risk of rainfed cultivation and low use of inputs may be an alternative for passion fruit production, irrigation minimizes the damage that water deficit can cause to plants, especially in years with prolonged drought periods, which can cause negative economic results due to low yields, as observed by Uchôa et al. (2018).

Passion fruit shows little tolerance to water stress, and there may be significant reductions in vegetative growth and stomatal conductance with the intensification of water scarcity, reducing the number of leaves and the leaf area (Souza et al., 2018), consequently reducing the yield. Furthermore, depending on the water deficit level, damage may be irreversible (Gomes et al., 2012).

Table 4. Production costs and yield of yellow passion fruit produced with and without irrigation and under three input levels. Rio Branco, Acre, Seridó Ecological Site (2019).

Treatments	Total Cost (US$)[1]	Fixed Cost (US$)[1]	Variable Cost (US$)[1]	Yield ($t\ ha^{-1}$)	ROI (%)
Irrigation/level 1	4,173.38	1,345.80	2,886.64	11.3	154.51
Irrigation/level 2	5,095.96	1,345.80	3,750.17	11.5	129.09
Irrigation/level 3	6,419.65	1,345.80	5,073.85	17.4	165,90
No irrigation/level 1	3,149.42	533.56	2,615.86	7.5	127.58
No irrigation/level 2	4,125.83	533.56	3,592.27	12.2	204.86
No irrigation/level 3	5,309.56	533.56	4,776.00	13.9	160.35

Conclusions

Irrigation associated with input level 3 increased the yield for total and operating coverage, the total yield, and total revenue.

Irrigation associated with input level 1 increased the average fixed cost, the average fixed operating cost, and provided positive economic returns.

References

Almeida, L.S.B., Santos, A.C.G.P., Holanda, L.R. 2018. Análise de viabilidade econômica de um pequeno produtor de maracujá em Boca da Mata, Alagoas. *Revista Eletrônica Sistema & Gestão* 13: 357-365.

Araújo Neto, S.E., Ferreira, R.L.F., Pontes, F.S.T., Negreiros, J.R.S. 2008. Rentabilidade econômica do maracujazeiro-amarelo plantado em covas e em plantio direto sob manejo orgânico. *Revista Brasileira de Fruticultura* 30: 940-945.

Araújo Neto, S.E., Silva, E.M.N.C.P., Ferreira, R.L.F., Cecílio Filho, A.B. 2012. Rentabilidade da produção orgânica de alface em função do ambiente, preparo do solo e época de plantio. *Revista Ciência Agronômica* 43: 783-791.

Araújo, H.F., Costa, R.N.T., Crisóstomo, J.R., Saunders, L.C.U., Moreira, O.C., Macedo, A.B.M. 2012. Produtividade e análise de indicadores técnicos do maracujazeiro-amarelo irrigado em diferentes horários. *Revista Brasileira de Engenharia Agrícola e Ambiental* 16: 159-164.

Araújo Neto, S.E., Campos, P.A., Tavella, L.B., Solino, A.J.S., Silva, I.F. 2014. Organic polyculture of passion fruit, pineapple, corn and cassava: the influence of green manure and distance between espaliers. *Ciência e Agrotecnologia* 38: 247-255.

Arêdes, A.F., Pereira, M.W.G., Gomes, M.F.M., Rufino, J.L.S. 2009. Análise econômica da irrigação na cultura do maracujá. *Revista de Economia* 5: 66-86.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 46, de 6 de outubro de 2011. http://extranet.agricultura.gov.br/sislegis/action/detalhaAto.do?method=consultarLegislacaoFederal <Access on 04 Jul. 2019>

CONAB. Companhia Nacional de Abastecimento. 2010. *Custo de produção agrícola*: a metodologia da Conab. Conab, Brasília, Brazil. 60 p.

Francisco, W.M. 2019. *Produtividade, qualidade e economia do maracujazeiro amarelo orgânico irrigado e em plantio profundo*. 69 p. (Ph.D. Thesis) – Federal University of Acre, Rio Branco, Brazil.

Furlaneto, F.P.B., Martins, A.N., Esperancini, M.S.T., Vidal, A.A., Okamoto, F. 2011. Custo de produção do maracujá-amarelo (*Passiflora edulis*). *Revista Brasileira de Fruticultura* 33: 441-446.

Gomes, M.T.G., Luz, A.C., Santos, M.R., Batitucci, M.C.P., Silva, D.M., Falqueto, A.R. 2012. Drought tolerance of passion fruit plants assessed by the OJIP chlorophyll a fluorescence transient. *Scientia Horticulturae* 142: 49-56.

IBGE. Instituto Brasileiro de Geografia e Estatística. Produção agrícola municipal: culturas temporárias e permanentes. 2018. http://www.sidra.ibge.gov.br/ bda/ tabela/ listabl.asp?c=1613&z=p&o=28 <Access on 11 Aug. 2019>

INMET. Instituto Nacional de Meteorologia. Banco de Dados Meteorológicos para Ensino e Pesquisa. 2019. http://www.inmet.gov.br/portal/index.php?r=bdmep/

Bdmep < Access on 11 Aug. 2019>

Meletti, L.M.M. 2011. Avanços na cultura do maracujá no Brasil. *Revista Brasileira de Fruticultura* 33: 83-91.

Pimentel, L.D., Santos, C.E.M., Ferreira, A.C.C., Martins, A.A., Wagner Júnior, A., Bruckner, C.H. 2009. Custo de produção e rentabilidade do maracujazeiro no mercado agroindustrial da zona da mata mineira. *Revista Brasileira de Fruticultura* 31: 397-407.

Reis, R.P. 2007. *Fundamentos de economia aplicada*. FAEPE, Lavras, Brasil. 95 p.

Rodrigues, D.L., Viana, A.P., Vieira, H.D., Santos, E.A., Silva, F.H.L., Santos, C.L. 2017. Contribution of production and seed variables to the genetic divergence in passion fruit under different nutrient availabilities. *Pesquisa Agropecuária Brasileira* 52: 607-614.

Santos, V.A., Ramos, J.D., Laredo, R.R., Silva, F.O.R., Chagas, E.A., Pasqual, M. 2017. Produção e qualidade de frutos de maracujazeiro-amarelo provenientes do cultivo com mudas em diferentes idades. *Revista de Ciências Agroveterinárias* 16: 33-40.

Silva, N.M., Araújo Neto, S.E., Souza, L.G.S., Uchôa, T.L., Ferreira, R.L.F. 2019. Organic cultivation of yellow passion fruit using tall seedlings with long root systems. *Comunicata Scientiae* 10: 477-483.

Souza, M., Guimarães, P.T.C., Carvalho, J.G., Fragoas, J.C. 1999. Maracujazeiro. In: Ribeiro, A.C., Guimarães, P.T.G., Alvarez, V.H.V. (ed.) *Recomendações para o uso de corretivos e fertilizantes em Minas Gerais 5ª aproximação*. UFV, Viçosa, Brazil. p. 242-243.

Souza, P.U., Lima, L.K.S., Soares, T.L., Jesus, O.N., Coelho Filho, M.A., Girardi, E.A. 2018. Biometric, physiological and anatomical responses of Passiflora spp. to controlled water deficit. *Scientia Horticulturae* 229: 77-90.

Uchôa, T.L., Araujo Neto, S.E., Selhorst, P.O., Rodrigues, M.J.S., Galvão, R.O. 2018. Yellow passion fruit performance in organic crop under mulch. *Revista Brasileira de Fruticultura* 40: 212.

Vivan, G.A., Robaina, A.D., Peiter, M.X., Parizi, A.R.C., Barboza, F.S., Soares, F.C. 2015. Rendimento e rentabilidade das culturas da soja, milho e feijão cultivados sob condições de sequeiro. *Semina: Ciências Agrárias* 36: 2943-2950.

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