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Evapotranspiration of 'Roxo de Valinhos' fig under different mulches in the Cerrado-Amazon transition

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Abstract

Finding out subsidies for the production of perennial fruit trees in the northern region of Mato Grosso, were determined the crop evapotranspiration (ETc), crop coefficients (Kc) and water use efficiency of fig plants 'Roxo de Valinhos', cultivated under different soil mulches in the Cerrado-Amazon transition. The cultures were carried out in two consecutive dry seasons (2020 and 2021), using 2.5 kg m^{-2} of straw (vegetable waste) of Congo grass '*Brachiaria ruzziensis*' (BR), velvet bean '*Mucuna pruriens* L' (MP), pigeon pea '*Cajanus cajan* L.' (CC) and zoysia grass '*Zoysia japonica*' (ZJ) and bare soil 'without mulch' (BS). The ETc was obtained by soil water balance through tensiometry. The reference evapotranspiration (ETo) was obtained by the method of Penman Montheit Fao 56, with the crop coefficients given by the ratio between ETc and ETo. The efficiency of water use was established by the ratio between the mass of fruits produced per unit volume of applied water (m^3), taking into account the irrigated depth and the effective rainfall. The different mulches not influence the water needs of the fig plants, however, the ETc and Kc were higher when the plants had a greater number of productive branches. The use of mulch increased the efficiency of water use, regardless of the production cycle. The BR and BS mulch crops, in the second year (eight branches), produced 2.59 and 0.79 kg of rip fruit figs per m^3 of water depth, respectively.

Keywords: crop coefficients, *Ficus carica L.*, irrigation management, tropical horticulture, water use efficiency

Introduction

Water use in agriculture is among the main points of discussion regarding the sustainable future of the agricultural sector (Dinar et al., 2019), since agriculture is responsible for 70% of the surface water and groundwater abstractions, mainly for irrigation (FAO, 2021). However, the use of irrigation makes it possible to reduce risks of losses associated with the water balance and expand the production of quality food in regions with limitation of seasonal water availability.

Knowledge on the water requirement of crops is fundamental for irrigation projects and management in regions with production potential and enables sustainable food production with higher water use efficiency (Rallo et al., 2021; Salman et al., 2021). Fruit crops are among those with the highest requirement of available water (Abdolahipour et al., 2018; Sokolow et al. 2019; Bwambale et al., 2022); however, cultural practices such as soil management associated with the use of mulching have been considered as good strategies to minimize the effects of soil water evaporation, improve water retention, nutrient cycling, spontaneous vegetation control, among others (Souza et al., 2014; Martim et al., 2018; Rallo et al., 2021; Tadayon & Hosseini, 2022).

Fig (*Ficus carica* L.), despite being considered a rustic plant and with easy adaptation to different environments (Ammar et al., 2020), is sensitive to the effects caused by water stress (Ammar et al., 2022). Native to Asia, it is one of the oldest crops on record (Langgut & Garfinkel, 2022), and its expansion is associated with high nutritional potential and added value of fruit and derivatives (Ayuso et al., 2022). In Brazil, fig is cultivated in the South and Southeast regions, but cultivated areas have expanded in tropical climate regions due to its hadiness (Silva et al., 2017)

The Middle-North region of Mato Grosso in

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Cerrado-Amazon transition biome stands out due to its commodity production (IMEA, 2017), however the supply of vegetables is dependent on other regions of the country. The main factor that hinders the cultivation of fruit in the region is the type of climate defined by Köppen’s classification as Aw (tropical hot and humid), with two well-defined seasons, rainy (October to April) and dry (May to September) (Souza et al. 2013), and the production of perennial fruits is a challenge that requires studies to enable the cultivation of crops with high consumption potential.

In this context, the objective of this study was to determine the crop coefficients (Kc), crop evapotranspiration (ETc) and water use efficiency of fig plants cultivated with different mulches in the Cerrado-Amazon transition.

Material and Methods

‘Roxo de Valinhos’ fig (*Ficus carica* L.) was cultivated between 09/2019 and 11/2021, in a Latossolo Vermelho-Amarelo distrófico (Oxisol) (EMBRAPA, 2013), in Sinop, northern region of the State of Mato Grosso (11.85° S and 55.38° W and altitude of 371 m).

According to Köppen’s classification, the climate of the region is type Aw (hot and humid tropical), with two well-defined seasons: rainy (October to April) and dry (May to September). Annual average precipitation and potential evapotranspiration are 1974.77 and 1327.29 mm, respectively, with average monthly temperatures ranging from 23.2 to 25.8 °C (Souza et al., 2013). During the experimental period, meteorological data were collected by a HOBO OnSet RX3000 complete automatic weather station with telemetry system, installed next to the experimental area.

‘Roxo de Valinhos’ fig plants were transplanted in September 2019, with spacing of 2.0 x 2.5 m (between rows and plants) (Leonel & Sampaio 2011). Soil corrections and fertilization were performed according to the recommendations for the crop, with chemical fertilization (NPK) and organic compost (Leonel & Sampaio, 2011), considering the soil analysis performed previously in the 0-20 cm layer: pH in H_2O: 5.8; Al: 0.00 cmol dm^{-3}; P and K contents: 3.5 and 61.60 mg dm^{-3}; Ca^{2+} and Mg^{2+}: 1.97 and 0.73 cmol$_c$ dm^{-3} and Organic Matter: 2.67 dg kg^{-1}.

For the formation of the crown, pruning was carried out in May/2020 (two branches), December/2020 (four branches) and July/2021 (eight branches). After the shoots began to grow, weekly applications of Bordeaux mixture (2%) were performed to prevent rust (*Cerotelium fici*). In addition, lateral shoots were removed and weeding was carried out when necessary.

For the determination of the water requirements of the fig crop, two production cycles were considered in two consecutive dry seasons, namely: 2020 season (from May 21 to November 1, 2020 - 165 days after pruning (DAP)) and 2021 season (from July 15 to November 1, 2021 - 110 DAP). In both cases, harvests were finished with regularization of the rains and stabilization of soil moisture in the different treatments.

Fig cultivation was evaluated in five treatments (mulches): without mulch (bare soil) and with residues of velvet bean (*Mucuna pruriens* L.), pigeon pea (*Cajanus cajan* L.), Congo grass (*Brachiaria ruziziensis*) and zoysia grass (*Zoysia japonica*), referred to as BS, MP, CC, BR and ZJ, respectively. These straws were distributed in 1.0 m^2 surrounding plants with a density of 25 t ha^{-1} (Souza et al., 2014; Martim et al., 2018), being considered as two legumes and two grasses, with distinct chemical compositions (**Table 1**). For each production cycle, the layers of plant residues were reconstituted, maintaining the above-mentioned conditions. To form the layers of plant residues, the crops were sown in surrounding areas, and the cuts were performed according to the growth of each species, in the flowering stage. The biomass produced was crushed and dried in the shade; grass was collected from local gardening management.

Table 1. Chemical composition of plant residues (mulches) used in ‘Roxo de Valinhos’ fig cultivation, in Sinop, MT

Nutrients		Treatments			
		Zoysia japonica	Brachiaria ruziziensis	Mucuna pruriens	Pigeon pea
g kg^{-1}	N	15.41	14.43	25.07	26.89
	P	1.19	3.01	2.01	2.24
	K	13.58	51.45	31.98	18.81
	Ca	3.7	6.51	10.07	6.87
	Mg	1.34	5.44	2.77	2.03
	S	3.19	3.05	1.95	1.98
mg kg^{-1}	B	11.3	11.14	28.28	18.44
	Cu	9.26	74.1	35.67	23.17
	Fe	2,288.96	1,845.84	944.18	225.81
	Mn	46.9	28.9	21.34	20.13
	Zn	26.41	45.96	25.5	22.49

To obtain crop evapotranspiration (ETc) by soil water balance, prior to planting the crop, undisturbed soil samples were collected to determine the soil water retention curves, by fitting the model of Van Genuchten (1980). The coefficients were fitted by the Solver optimization tool, with maximization of R^2 (Reichardt & Timm, 2004) (**Figure 1**).

The ETc was monitored daily by tensiometry, using digital tensimeters and three sets of tensiometers at depths of 0.10, 0.20, 0.40 and 0.60 m (control), per

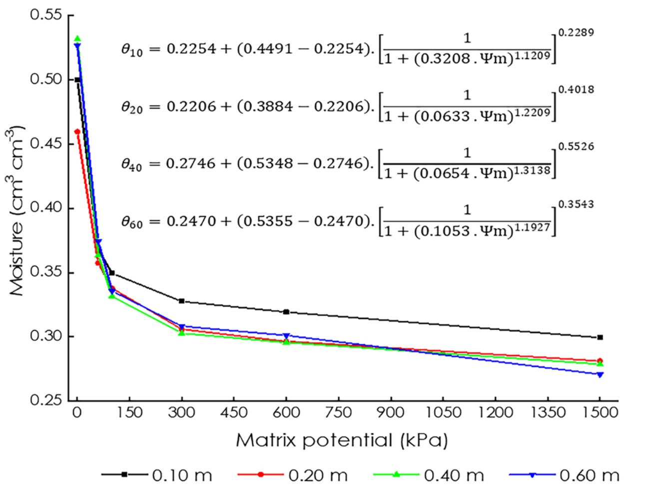

Figure 1 - Water retention curves in a Latossolo Vermelho-Amarelo distrófico (Oxisol) at depths of 0.10, 0.20, 0.40 and 0.60 cm, Universidade Federal de Mato Grosso, Campus de Sinop (MT), 2019.

cultivation condition. Daily irrigation was applied through drip hoses (arranged in strips) made of polyethylene, 250 micron thickness, with a flat labyrinth-type dripper, with nominal flow rate of 1.5 L h^{-1} at 100 kPa pressure and spacing of 0.5 m between drippers.

ETc measurements started with the appearance of shoots in the plants; however, between pruning and the beginning of sprouting, irrigation was based on the daily replacement of reference evapotranspiration (ETo). ETc, and consequently the water depth to be applied daily, were determined based on the actual tension (readings performed in the tensimeters) and field capacity (considered as -30 kPa), considering the differences in soil water content up to 0.40 m depth.

The method of Penman Monteith Fao 56 was used to obtain the daily reference evapotranspiration (ET_0), according to the recommendations of Tanaka et al. (2016) for the region. After the definition of ETc, the crop coefficients (Kc) were defined by the ratio between ETc and ETo. The relationships between the crop coefficients (Kc) and accumulated thermal sum were also established, considering in this case minimum basal temperature (Tb) and maximum basal temperature (TB) of 8.0 and 36.0 °C, respectively, according to propositions by Souza et al. (2009) for the fig crop.

Water use efficiency (WUE) in the different cultivation systems was established by the relationship between the mass of fruits produced and unit volume of applied water (m³), considering the irrigated depth and precipitations.

At the end of the harvest period (stabilization of the rainy season in the region), the development of the crop under the different mulching conditions was evaluated by means of destructive sampling (pruning), with determination of the following morphometric variables: stem diameter (mm), branch diameter (mm), branch length (cm), number of leaves, number of fruits, average fruit weight (g) and leaf area (cm²). Leaf area measurements were performed with the LI-3000 LICOR photoelectric leaf area integrator.

The experiment (two production cycles) was conducted in a randomized block design, considering three replicates of six plants each. The data were subjected to normality analysis and, when significant, the differences between the measurements of morphometric variables of the plant and water use efficiency were compared by Tukey test at 0.05 probability level.

Results and Discussion

During the two experimental periods of ETc evaluation, there were cumulative rainfalls of 91.80 and 71.84 mm in the 2020 and 2021 seasons, respectively. Although the first rainfall records occurred on 09/19/2020 (4.8 mm) and 09/13/2021 (4.85 mm), the homogenization of soil moisture from rainfall in the different treatments was observed from 10/22/2020 and 11/02/2021, that is, 155 and 119 days after pruning (DAP), respectively (**Figure 2**), and these periods are still considered to have the effects of treatments for the harvest of fresh fruits.

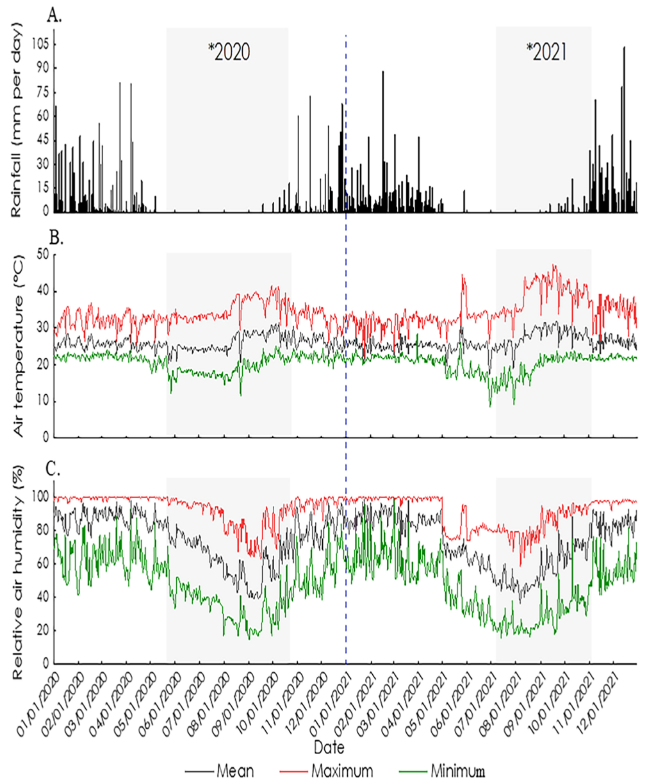

Figure 2 - Rainfall (A), temperature (B) and relative humidity (C) between 12/01/2020 and 12/31/2021, in Sinop-MT (highlight for experimental periods in the *2020 and *2021 seasons)

The maximum and minimum temperatures recorded were 41.62 and 11. 42 °C in 2020 and 47.0 and 9.22 °C in 2021; it is also worth pointing out that the maximum temperatures were higher than the TB (36 °C) of the fig crop for 38 and 42 days, in the 2020 and 2021 seasons, respectively. In general, lower thermal amplitudes were observed in the rainy season and higher water vapor pressure deficits were observed in the dry season (Figure 2), which together with high temperatures, incident global radiation and winds, tend to increase evapotranspiration in the region (Tanaka et al., 2016).

In the 2020 crop cycle, the accumulated ETc of the fig plants was 356.95 mm under the bare soil condition, and 355.27, 324.96, 328.44 and 315.02 mm for the mulches with ZJ, BR, CC and MP plant residues, respectively. In turn, the accumulated ETo in the same period was 508.93 mm, equivalent to 3.49 mm per day (**Figure 3**A). In the 2021 crop cycle, the accumulated ETc values were 335.36, 321.96, 314.53, 308.91 and 298.36 mm for the mulches CC, BR, ZJ, BS and MP, respectively; and the ETo accumulated in the period was equal to 455.21 mm, with an average of 4.18 mm per day (Figure 3B). It is emphasized that the two production cycles had different durations, 155 and 119 days after pruning (DAP), in 2020 and 2021, respectively.

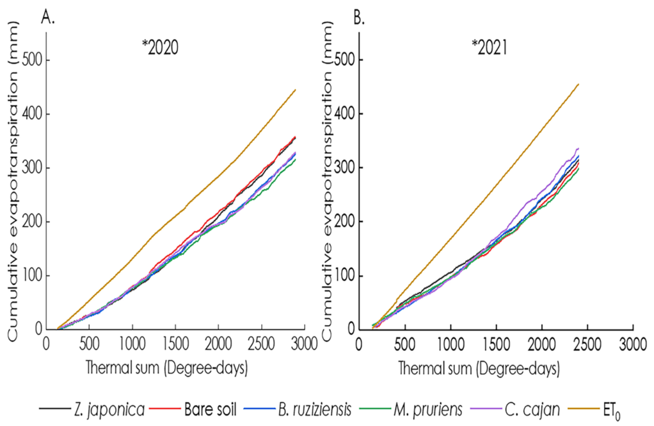

Figure 3. Accumulated evapotranspiration of ‘Roxo de Valinhos’ fig crop under the different mulches and reference evapotranspiration in the *2020 (A) and *2021 (B) seasons as a function of the accumulated thermal sum, Sinop, MT, Brazil.

The small difference in the accumulated ETc between the different mulches in the same production cycle indicates that the kinetics of decomposition of plant residues was not significantly influenced by the experimental periods evaluated. This behavior may be due to the homogenization of the size of fragments of the straws (mulches) between grass and legume residues.

However, when comparing with BS, there are also small differences between the accumulated ETc in the cultivation with mulches, and this condition, in turn, can be explained by the daily wetting and drying (evaporation) of the layer of plant residues, since the drip hoses were positioned on the straw layer. In this case, this dynamics of water use in the straw itself (interaction between plant residue and atmosphere) reduced the volume of water available in the surface layers of the soil and increased tension, generating higher ETc. Moreover, as the movement of water in straw is also dependent on the density and arrangement of the fragments of plant residues (Souza et al., 2014), plant residues that form denser layers (such as ZJ) tend to have higher water losses and ETc, corroborating the observations in the 2020 production cycle.

On the other hand, in the 2021 production cycle, the values of accumulated ETc showed variations of up to 37.0 mm (at 119 DAP) between the different treatments, indicating that the relationships between evaporation (soil/straw) and transpiration (plant crown structure/architecture) were similar to each other, even with significant increase of ETo. Evapotranspiration is not an isolated factor, and the differences for the same crop may result from plant growth (according to environmental and management conditions) and soil physical-hydraulic conditions (Martim et al., 2018; Rallo et al., 2021).

Among the production cycles (seasons), the average daily values of ETc and Kc increased with the increase in the accumulated thermal sum and showed small variations between the evaluated mulches (**Table 2**). Under this same soil condition and period of the year, Martim et al. (2018) observed no influence of mulches with millet (*Pratylenchus brachyurus*) and brown hemp (*Crotalaria juncea*) residues on the ETc and Kc of summer squash (*Cucurbita pepo*).

In the 2021 season, the daily means of ETc were higher than in 2020, for similar values of accumulated growing degree-days – “thermal sum” (AGDD). This difference results from the crown formation management and development of the crop, with eight productive branches. Evapotranspiration is influenced by climatic conditions, plant development stage, in addition to crop management and edaphic factors (Borella et al., 2021).

The crop coefficients (Kc) varied between the two crop cycles (seasons), regardless of mulching, being higher in 2021. The values obtained in this study for the 2020 season corroborate those obtained by Souza et al. (2014), who evaluated the first cultivation of ‘Roxo de Valinhos’ fig and obtained mean values of Kc from 0.16 to 0.49 in the absence of mulch and from 0.18 to 0.50 in the presence of mulch. Andrade et al.

Table 2. Reference evapotranspiration (ETo), crop evapotranspiration (ETc) and crop coefficients (Kc) of 'Roxo de Valinhos' fig under different mulches as a function of the accumulated thermal sum, fortnightly in the 2020 and 2021 seasons, Sinop-MT

Thermal Sum – AGDD (DAP)		Bare Soil	*Zoysia japonica*	*Brachiaria ruziziensis*	*Mucuna pruriens*	*Pigeon pea*
	ETo (mm per day)	ETc (mm per day)				
		2020				
375 (22)	2.97 ± 0.14	1.18 ± 0.40	1.16 ± 0.53	1.09 ± 0.77	1.13 ± 0.63	1.18 ± 0.49
893 (52)	3.00 ± 0.03	1.82 ± 0.99	1.70 ± 0.69	1.78 ± 0.98	1.79 ± 0.78	1.76 ± 0.64
1410 (82)	3.31 ± 0.06	2.71 ± 1.14	2.27 ± 0.89	2.39 ± 1.38	2.02 ± 1.09	2.36 ± 0.75
2013 (112)	3.76 ± 0.07	2.91 ± 1.23	3.11 ± 1.08	2.20 ± 0.81	2.52 ± 1.42	1.96 ± 0.76
2667 (142)	4.17 ± 0.05	3.51 ± 0.81	3.70 ± 1.62	3.54 ± 1.22	3.04 ± 1.74	3.52 ± 1.27
2892 (153)	4.30 ± 0.03	3.48 ± 1.23	3.37 ± 1.10	3.10 ± 1.07	3.20 ± 1.10	3.36 ± 1.24
		Kc				
375		0.40 ± 0.14	0.39 ± 0.18	0.31 ± 0.11	0.38 ± 0.22	0.37 ± 0.15
893		0.49 ± 0.12	0.50 ± 0.15	0.44 ± 0.18	0.60 ± 0.26	0.53 ± 0.14
1410		0.69 ± 0.12	0.63 ± 0.19	0.51 ± 0.15	0.61 ± 0.34	0.62 ± 0.15
2013		0.74 ± 0.31	0.77 ± 0.26	0.61 ± 0.21	0.67 ± 0.39	0.68 ± 0.16
2667		0.84 ± 0.19	0.83 ± 0.33	0.85 ± 0.29	0.82 ± 0.31	0.75 ± 0.18
2892		0.81 ± 0.29	0.78 ± 0.26	0.72 ± 0.25	0.72 ± 0.21	0.78 ± 0.29
		2021				
382 (23)	3.12 ± 0.26	2.00 ± 1.02	2.08 ± 0.86	1.83 ± 0.75	1.8 ± 0.46	1.9 ± 0.46
951 (53)	4.04 ± 0.23	2.19 ± 0.80	2.36 ± 0.81	2.41 ± 0.64	2.07 ± 0.59	2.23 ± 0.85
1614 (82)	4.63 ± 0.30	2.89 ± 1.04	2.79 ± 0.92	3.25 ± 0.97	2.96 ± 0.89	3.77 ± 1.49
2333 (114)	4.66 ± 0.15	3.97 ± 1.27	3.86 ± 1.28	4.33 ± 1.85	3.63 ± 1.44	4.31 ± 1.72
		Kc				
382		0.45 ± 0.20	0.68 ± 0.32	0.43 ± 0.13	0.49 ± 0.09	0.53 ± 0.14
951		0.53 ± 0.19	0.58 ± 0.20	0.56 ± 0.09	0.51 ± 0.13	0.54 ± 0.18
1614		0.62 ± 0.23	0.60 ± 0.19	0.67 ± 0.17	0.64 ± 0.18	0.76 ± 0.27
2333		0.85 ± 0.27	0.77 ± 0.18	0.75 ± 0.26	0.77 ± 0.30	0.86 ± 0.28

(2014) also reported that the pattern of Kc values found throughout the fig crop cycle is strongly related to the evapotranspiration components (soil water evaporation and plant transpiration). However, Kc values for tree crops and vines vary with the fraction of soil cover and plant height (Pereira et al., 2020).

The use of mulches did not significantly influence the vegetative development of fig plants, since no significant differences were observed for most morphometric variables at the end of the two production cycles, in both seasons (except for branch diameter in the 2021 season) (**Table 3**).

Regarding the variables related to production, there was influence of mulching, especially in the 2021 production cycle, when fruits with higher average weight and higher number of fruits per plant were observed under mulching (**Table 4**).

According to Tadayon & Hosseini (2022), high air temperatures and low relative humidity cause plant dehydration and fruit fall as a mechanism of survival of plants under stress conditions. Fig plants grown in BS possibly spent a greater amount photoassimilates to maintain their development during the dry period, leading to a reduction in fruit production. On the other hand, the production increment observed in plants cultivated under CC residues in the 2021 season results from the fact that legume plant residues have rapid decomposition and release of nutrients to the soil, when compared with grass plant residues (Souza et al., 2010). Silva et al. (2017), when evaluating the phenology and production of 'Roxo de Valinhos' fig in Mossoró-RN, obtained under adequate irrigation conditions fruits with an average weight of 38.93 g in plants with six productive branches, and these values were close to those obtained in 2021, under BR mulch.

In the case of fig crop, yield is related to the number of branches per plant, which affects the average number of fruits per plant and the average weight of the fruits as a function of the source-sink relationships (Silva et al., 2011). This relationship can be evidenced under the conditions of cultivation in BS, since there was an increase in the average weight of the fruits; however, even with a larger number of branches, there was no increase in the number of fruits per plant. Yield increments of 67, 108, 42 and 269% were obtained for cultivation under mulches of ZJ, BR, MP and CC, respectively.

Souza et al. (2014) obtained lower yield of 'Roxo de Valinhos' green figs cultivated without mulching, and the management of irrigation and mulching (sugarcane

Table 3. Stem diameter, branch diameter, branch length, number of leaves and leaf area of ‘Roxo de Valinhos’ fig under different mulches, in the experimental periods of 2020 and 2021, Sinop-MT

Treatment	Stem diameter (mm)	Branch diameter (mm)	Branch length (cm)	Number of leaves	Leaf area (m²)
			2020		
Bare soil	49.28 ns	38.57 ns	131.83 ns	60.13 ns	2.90 ns
Zoysia japonica	41.00	29.96	109.83	52.40	2.46
Brachiaria ruziziensis	50.43	37.02	146.93	58.60	3.00
Mucuna pruriens	46.51	32.38	122.33	54.93	2.60
Pigeon pea	38.60	28.67	102.80	53.20	2.26
CV (%)	10.54	14.98	14.72	6.66	12.34
			2021		
Bare soil	61.76 ns	21.14 ab	55.44 ns	173.66 ns	3.68 ns
Zoysia japonica	57.02	16.97 b	54.46	159.38	3.26
Brachiaria ruziziensis	60.49	24.91 a	71.68	189.20	5.00
Mucuna pruriens	60.88	22.74 a	66.14	186.73	5.12
Pigeon pea	56.28	24.54 a	71.16	184.73	4.21
CV (%)	9.87	7.32	19.82	9.79	22.06

ns - Not significant. Means followed by the same letter in the column do not differ from each other by Tukey test at 0.05 probability level.

Table 4. Production variables and water use efficiency (WUE) of ‘Roxo de Valinhos’ fig under different mulches, in the 2020 and 2021 production cycles, in Sinop-MT

Treatment	Fruit weight(g)	Number of fruits plant^{-1}	Yield(kg ha^{-1})	Effective depth applied(m³ ha^{-1})	WUE
			*2020		
Bare soil	27.78b	38.93 ab	2170.97 ab	2141.67	1.01 ab
Zoysia japonica	32.05 a	35.86 ab	2303.98 ab	2131.59	1.08 ab
Brachiaria ruziziensis	32.18 a	45.73 a	2943.53 a	1949.75	1.51 a
Mucuna pruriens	26.74 bc	33.13 ab	1776.54 b	1890.13	0.94 b
Pigeon pea	23.98 c	25.53 b	1249.15 b	1970.64	0.63 b
CV (%)	4.58	17.03	17.97		18.32
			*2021		
Bare soil	29.11 c	31.21 c	1818.89 c	2289.1	0.79 b
Zoysia japonica	34.02 abc	51.86 abc	3858.28 abc	2322.8	1.66 ab
Brachiaria ruziziensis	38.53 a	72.60 a	6134.47 a	2367.4	2.59 a
Mucuna pruriens	31.69 ab	47.31 ab	2539.83 ab	2228.8	1.13b
Pigeon pea	35.74 ab	64.46 ab	4619.53 ab	2447.8	1.88 ab
CV (%)	6.92	15.70	25.23		25.17

Means followed by the same letter in the column do not differ from each other by Tukey test at 0.05 probability level.

bagasse) allowed the obtaining of 3.32 kg of green figs per m^3 of irrigation water applied. Tadayon & Hosseini (2022) verified that the use of mulching with rice husk associated with shade net increased yield by 144.6% for dried fruits compared to traditional production (without use of mulch) in ‘Sabz’ fig plants, under severe drought condition.

The influence of the use of mulching on water use efficiency was evident in the 2021 production cycle (plants with eight productive branches) (Table 4). Cultivation with BR mulch allowed the obtaining of 2.59 kg of ripe figs per m^3 of effective depth, while under BS, only 0.79 kg per m^3 was obtained. Jafari et al. (2012) also reported similar behavior with the use of wheat straw as a mulch in rainfed cultivation of fig, with increased yield and better quality of fruits for fresh consumption (ripe figs).

Conclusions

Mulching with plant residues does not reduce evapotranspiration and crop coefficients of ‘Roxo de Valinhos’ fig but improves the production responses and water use efficiency of the crop over successive production cycles.

Under the dry season conditions of the Cerrado-Amazon transition, the use of mulches formed from plant residues of grasses allows better efficiency in the use of irrigation water in fruit crops under drip irrigation.

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