ISSN 0100-2945 DOI: http://dx.doi.org /10.1590/0100-29452022100

Revista Brasileira de Fruticultura

Crop Production

Alternatives for trellis systems and pruning of Blackberry: yield and fruit quality in the Southwest region of Mato Grosso do Sul

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Abstract - The cultivation of blackberry trees has been increasing in Brazil, making it necessary to establish management and crop treatments in order to enhance its production. The aim of this study is to evaluate the production and quality of blackberry fruits cv. 'Tupy' regarding pruning seasons and trellis systems in the Southwest region of Mato Grosso do Sul. The experiment was developed with evaluations in two production cycles (2013 and 2014). Three trellis systems were studied: C1 – Double-wire trellis, C2 – single-wire trellis, and C3 – 'T' trellis; and the following three winter pruning times in both production cycles: P1: 07/12; P2: 07/27; and P3: 08/11. Production performances were similar within each year. In 2013, the harvest period ranged from 10/22/2013 to 01/07/2014, while in 2014 the period ranged from 09/24/2014 to 12/12/2014. In 2014, the highest fruit production per plant occurred when P3 was performed. Cultivation using the Double-wire trellis system (C1) produced 11,669.43 and 3,465.98 kg, while the single-wire trellis system (C2) produced 11,965.53 and 3,373.87 kg in 2013 and 2014, respectively. The highest pH of fruits was observed when pruning was conducted in P1 using the 'T' trellis system. Double-wire trellis contributes in higher results of production blackberry in the Southwest region of Mato Grosso do Sul.

Index terms: Double-wire trellis; early harvest; small fruit.

Alternativas para sistemas de condução e poda em Amoreira-preta: produtividade e qualidade de frutos na região Sudoeste do Mato Grosso do Sul

Resumo - O cultivo da amoreira-preta vem aumentando no Brasil, tornando-se necessário estabelecer manejo e tratos culturais visando a potencializar sua produção. Diante disto, objetivou-se avaliar a produção e a qualidade de frutos de amora-preta cv. "Tupy", em função de épocas de podas e sistemas de condução na região Sudoeste do Mato Grosso do Sul. O experimento foi desenvolvido com avaliações em dois ciclos de produção (2013 e 2014). Foram estudados três tipos de condução: C1 – espaldeira duplo fio; C2 – espaldeira simples; e C3 – espaldeira em "T", e três épocas de poda de inverno nos dois ciclos de produção (P1: 12/07; P2: 27/07; e P3: 11/08). Os desempenhos de produção foram próximos dentro de cada ano. Em 2013, o período de colheita variou de 22-10-2013 a 07-01-2014, enquanto em 2014 foi de 24-09-2014 a 12-12-2014. Em 2014, a maior produção de frutos por planta ocorreu ao realizar a P3. O cultivo sob espaldeira duplo fio (C1) apresentou produção de 11.669,43 e 3.465,98 kg, e sob sistema de espaldeira simples (C2) foi de 11.965,53 e 3.373,87 kg, em 2013 e 2014, respectivamente. O maior pH dos frutos foi ao realizar a P1 (12/07) sob sistema de condução em espaldeira em "T". A condução em espaldeira duplo fio contribuiu em maiores resultados de produção de amora-preta na região sudoeste do Mato Grosso do Sul.

Termos para indexação: Espaldeira duplo fio; antecipação de colheita; pequenas frutas.

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Received: October 26, 2021
Accepted: April 19, 2022

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Introducion

The consumption of small fruits such as blackberry (*Rubus* spp.) has been increasing in several countries. The blackberry harvested area in the world ranges from 1,325 to 28,400 ha with production between 21,468 and 140,000 tons. The main producing countries are Russia, Poland, Serbia, United States, Ukraine, and Mexico (ANTUNES et al., 2014; SEGANTINI et al., 2014).

In 2017, in the US, blackberry production was valued at US$31.1 million (NASS, 2021), and in 2021, they imported 130 million pounds of fresh blackberries valued at US$ 318 million (USDA, 2021). In this sense, the cultivation of blackberry is a promising and rewarding opportunity in Brazil.

In Brazil, the blackberry demand has also been increasing, but with scarce productivity information in recent years. The largest producing orchards are located in the states of Rio Grande do Sul, São Paulo, Minas Gerais, Paraná, Santa Catarina and Espírito Santo, with Rio Grande do Sul being the largest national producer, being responsible for almost 50% of the country's planted area (239 ha) and having an estimated production of 9.24 t ha^{-1} (ANTUNES et al., 2014; PEREIRA et al., 2015).

The blackberry crop presents good adaptation to edaphoclimatic conditions and its yield can reach up to 10,000 kg ha^{-1} in traditional regions of cultivation (ANTUNES et al., 2002; BRUGNARA, 2016). Campagnolo and Pio (2012a) verified yields of 6,430 kg ha^{-1} in the municipality of Santa Helena/PR for cv. 'Tupy' and yields of 18,602.5 kg ha^{-1}, 15,129.8 kg ha^{-1}, and 11,395.9 kg ha^{-1} in the municipality of Marechal Cândido Rondon/PR for the cultivars 'Brazos', 'Guarani' and 'Choctaw', respectively. Brugnara (2016) described an average yield of 13,300.0 t ha^{-1} for the 2013/2014 and 2014/2015 crops.

However, there is little technical information describing the agronomic responses of the species in other regions, including the Southwest of the state of Mato Grosso do Sul. Thus, it is necessary to establish management and cultural treatments that can enhance the production of the crop in commercial orchards of family farming, as well as in large rural properties, in order to meet the demands of the consumer market.

Among the recommended agronomic practices for the crop, pruning is essential, which can be carried out both in summer and winter. When pruning is practiced in the summer, it aims to eliminate the stems that produced in the previous year and reduce the size of those that emerged from the ground. On the other hand, pruning practiced in winter aims to reduce the length of lateral branches and clean the branches that emerged from the ground and 15.0 cm above the ground in the main stems (PAGOT et al., 2007; CAMPAGNOLO; PIO, 2012a). In this sense, this information can support practices aimed at anticipating fruit harvest and income scaling.

In addition, in order to avoid contact of the fruit with the soil and due to its growth habit, contributing to the fruit quality, the use of a trellis system is essential for the blackberry, especially for the cv. 'Tupy' (FERREIRA et al., 2016). Generally, the most used type of trellis for the culture is the "T" trellis. However, information on trellis systems is limited in the literature, especially considering the possible variations in growing conditions and regions.

Based on the above, the aim of this study is to evaluate the production and quality of fruits of blackberry cv. 'Tupy' cultivated under different pruning times and trellis systems, in the Southwest region of Mato Grosso do Sul.

Material and Methods

The experiment was carried out during the production cycles of 2013 and 2014 at the Experimental Farm (22º14'S and 4º49W, altitude of 458 meters) of the Faculty of Agricultural Sciences of the Federal University of Grande Dourados/UFGD, in the municipality of Dourados, state of Mato Grosso do Sul/MS, Brazil. The soil in the area was classified as a Dystroferric Red Latosol (SANTOS et al., 2018), with clayey texture and natural fertility, presenting the following chemical attributes at a depth of 0-20 cm: pH $CaCl_2$= 5.5; Al = 0.0 $cmol_c$ dm^{-3}; Ca = 7.1 $cmol_c$ dm^{-3}; Mg = 2.7 $cmol_c$ dm^{-3}; (H+AL) = 3.7 $cmol_c$ dm^{-3}; K = 0.53 $cmol_c$ dm^{-3}; P (Mehlich) = 8.8 mg dm^{-3}; sum of the bases = 10.3 $cmol_c$ dm^{-3}; CEC = 14.1 $cmol_c$ dm^{-3}; effective CEC = 10.3 $cmol_c$ dm^{-3}; V (%) = 73.0; O.M. = 36.41 g kg^{-1}; Cu = 10.8 mg dm^{-3}; Fe = 24.4 mg dm^{-3}; Mn = 54.1 mg dm^{-3}; and Zn = 2.1 mg dm^{-3}; and at a depth of 20-40 cm with pH $CaCl_2$= 5.0; Al = 0.1 $cmol_c$ dm^{-3}; Ca = 3.3 $cmol_c$ dm^{-3}; Mg = 1.3 $cmol_c$ dm^{-3}; (H+AL) = 4.7 $cmol_c$ dm^{-3}; K = 0.08 $cmol_c$ dm^{-3}; P (Mehlich) = 1.6 $cmol_c$ dm^{-3}; sum of the bases = 4.7 $cmol_c$ dm^{-3}; CEC = 9.4 $cmol_c$ dm^{-3}; effective CEC = 4.8 $cmol_c$ dm^{-3}; V (%) = 50.0; O.M. = 20.57 g kg^{-1}; Cu = 9.2 mg dm^{-3}; Fe = 42.0 mg dm^{-3}; Mn = 15.1 mg dm^{-3}; and Zn = 1.1 mg dm^{-3}.

The climate of the region of Dourados/MS, according to the Köppen climate classification, is Cwa (humid mesothermal climate, with hot summers and dry winters) (ALVARES et al., 2013), with the temperatures of the coldest month (June and July) being below 18 ºC and of the warmest month (January) being above 22 °C (Figure 1).

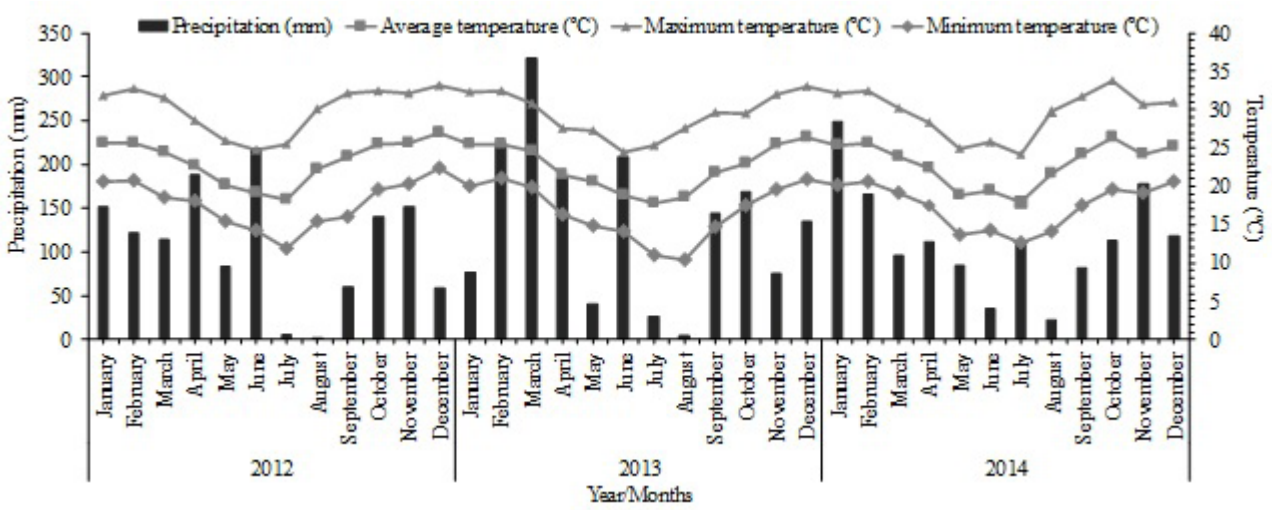

Figure 1. Precipitation and maximum, average, and minimum temperatures recorded during the experiment period (2012, 2013, and 2014) in the cultivation of blackberry, in Dourados/MS. Source: EMBRAPA – CPAO.

The seedlings used in the experiment were obtained by rooting woody cuttings of blackberry cv. 'Tupy' from matrices planted in April 2012, with spacing of 1.0 m between plants and 3.0 m between rows, and planting density of 3,333.33 plant/ha^{-1}, from the Universidade Estadual Paulista/UNESP in Ilha Solteira/SP. The experimental area was prepared with harrowing and soil correction and planting fertilization were carried out according to chemical analysis.

The randomized blocks experimental design was used in a split-plot scheme, with the following three types trellis systems: C1 – double-wire trellis, C2 – single-wire trellis, and C3 – 'T' trellis; and the following three winter pruning times: P1: 07/12; P2: 07/27; and P3: 08/11, both in 2013 and 2014, that is, in Double production cycles.

The crop water supply was carried out using a drip irrigation system, with a PETRODRIP® drip hose (Manari model) for each plant row, with a spacing of 20 cm between emitters, flow rate of 7.5 L h^{-1} m^{-1}, flow rate of 1.5 L h^{-1}, and pressure of 97.8 kPa. Irrigation management was carried out based on the monitoring of the soil water status, using the volumetric soil moisture sensor 'Hidrofarm 2010'.

In each production cycle, the following two pruning were carried out: a) cleaning pruning in summer, consisting in the elimination of branches, leaving four main branches (current-year stems), which were pruned at a height from 1.0 m to 1.2 m from the ground; b) in winter, the secondary branches inserted up to 30 cm from the soil were removed and the lateral branches were pruned (PAGOT et al., 2007), being carried out in three pruning times, as described above. Maintenance fertilization with 28, 10, and 24 g plant^{-1} simple superphosphate, potassium chloride, and ammonium sulfate, respectively, were carried out before budding and flowering. Crop treatments such as pest and disease control were carried out according to recommendations (PAGOT et al., 2007).

The quantitative characteristics evaluated in the two production cycles (2013/2014) were fruit production per hectare, production per plant (g plant^{-1}) and average fruit mass (g fruit^{-1}). The characterization of the production period (harvest), in days, was obtained by counting the number of days of production in each plot. The harvest index was based on the moment when berries were completely black, considering the characteristics described by Figueiredo et al. (2013).

Subsequently, using the fruits of each plot, the following physicochemical components were determined: soluble solids (SS - ºBrix), using a Shimadzu® tabletop refractometer; titratable acidity (TA), evaluated by neutralization titrimetric method, diluting 10 mL of pure juice in 90 mL of distilled water and performing titration with a 0.1 N NaOH solution (LIMA et al., 2013). We also determined the pH of the fruit juice using a pH meter and calculated the SS/TA ratio.

Statistical analyzes of data from each production cycle were performed separately. Data were subjected to analysis of variance (ANOVA) and when significant by F test (P<0.05), means were compared by the Tukey test (P<0.05) using the SISVAR software (FERREIRA, 2011).

Results and Discussion

Production performances of blackberry were similar within each year, with no discrepant variation occurring regarding the trellis systems studied. In 2013, the harvest period ranged from 10/22/2013 to 01/07/2014 (Figure 2), while in 2014 it ranged from 09/24/2014 to 12/12/2014 (Figure 3).

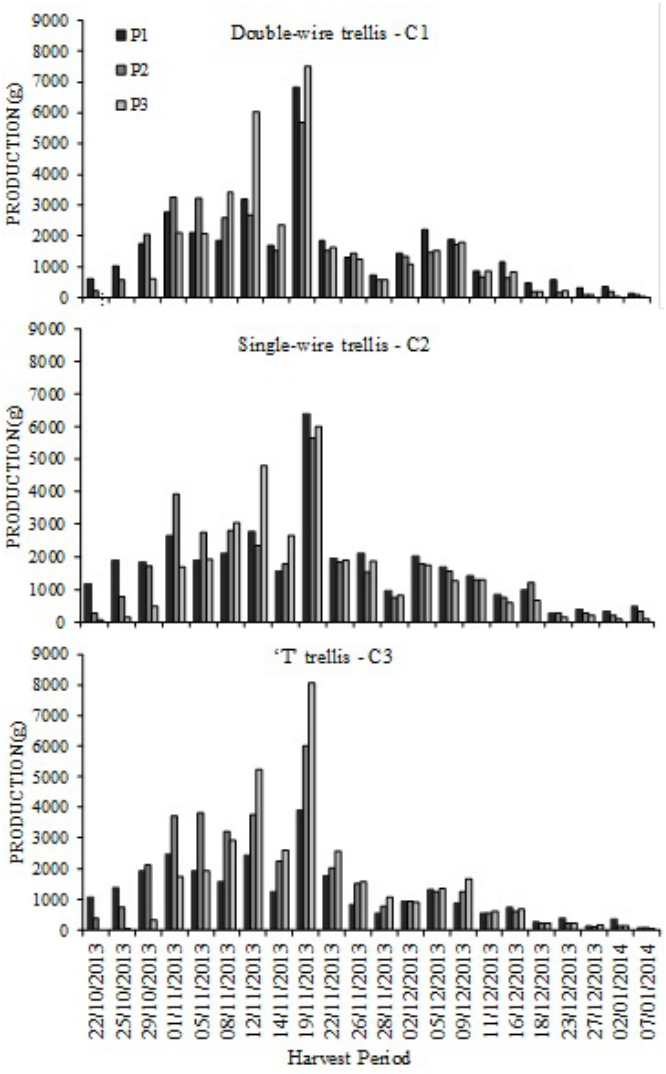

Figure 2. Blackberry production period by trellis system as a function of pruning times in 2013. Dourados/MS. Pruning (P1: 07/12; P2: 07/27; and P3: 08/11).

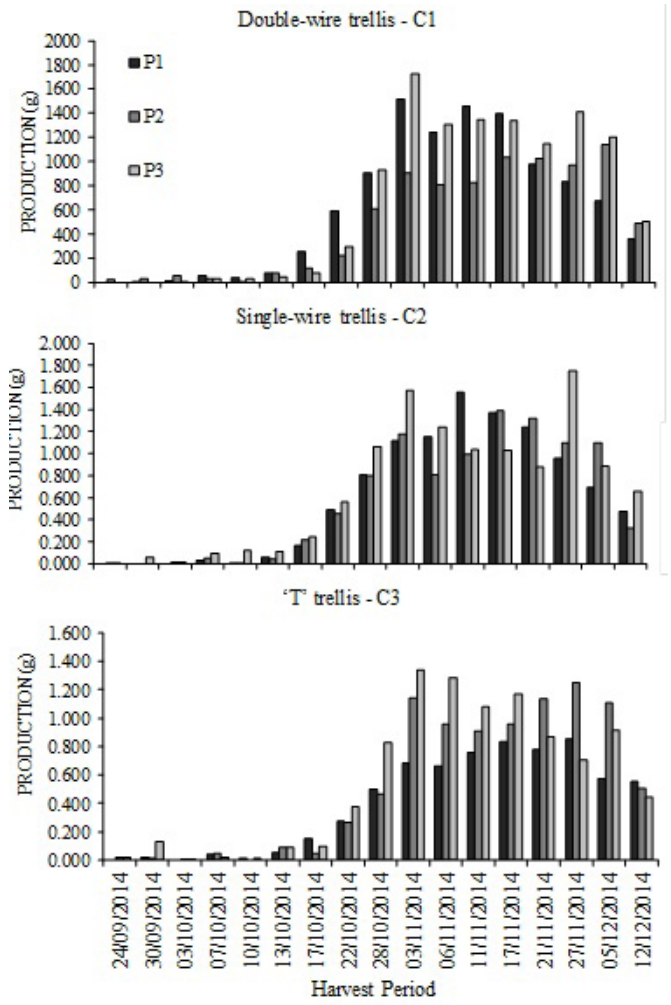

Figure 3. Blackberry production period by trellis system as a function of pruning times in 2014. Dourados/MS. Pruning (P1: 07/12; P2: 07/27; and P3: 08/11).

However, it is noteworthy that the period of highest production occurred at the end of October until the first half of December in both production cycles, with the highest production peaks occurring in 11/19/2013 and 11/03/2014. It is noted that regardless of weather conditions, there is a tendency of anticipation of the harvest peak in the region where this study was developed. The harvest period in traditional regions of production begins in the second week of November (PAGOT et al., 2007). Thus, the producer can commercialize the fruits at a higher price due to the early production.

The estimated fruit production was not influenced by any of the factors under study in the year 2013 (P<0.05). Regarding the trellis systems, it is noteworthy that production ranged between 10,691.59 and 11,231.30 kg ha^{-1} for the year 2013; regarding the pruning times in the same cycle, the production ranged between 10,842.93 and 11,241.82 kg ha^{-1}. In 2014, we only observed influence from pruning times, with the highest production (3,551.10 kg) occurring in P3 (Table 1). Jara (2017) described an average production of 5,000.00 kg ha^{-1} in the 2015/2016 crop in the Southwest region of MS, values higher than those of the second crop in our study, suggesting that changes in the bioclimatic conditions of the crop year can influence yields. We reinforce that considering the productivity values, the cultivation in the MS region is promising, even though it is an atypical condition, since it is a fruit tree in a temperate climate.

Table 1. Production (kg ha^{-1}), average fruit mass (AFM – g/fruit), and production per plant (PPP - g/plant) of blackberry (*Rubus* spp.) cv. 'Tupy' in 2013 and 2014 in Dourados/MS.

Treatments	2013			2014		
	Production	AMF	PPP	Production	AMF	PPP
Trellis system						
Double-wire trellis	11,220.71^{ns}	6.71^{ns}	2,662.88^{ns}	3,352.52^{ns}	7.43^{ns}	792.86^{ns}
Single-wire trellis	11,231.30	6.50	2,616.94	3,470.54	7.34	809.62
'T' trellis	10,691.59	6.52	2,620.29	2,772.29	8.76	650.42
DMS	5,725.5	0.54	1,258.93	1,356.06	3.34	304.42
Pruning times						
P1	10,842.93^{ns}	6.53^{ns}	2,488.92^{ns}	3,030.21 b	7.42^{ns}	689.03^{ns}
P2	11,241.82	6.54	2,744.15	3,013.96 b	8.92	716.45
P3	11,058.84	6.65	2,667.05	3,551.10 a	7.19	847.43
DMS	1,542.32	0.40	514.96	424.43	2.54	170.85
C.V. (%)	11.00	4.86	15.54	10.55	25.77	18.08

^{ns} – not significant. Means followed by the same letter in the column do not differ significantly from each other by the Tukey test (P<0.05). Pruning - 2013 (P1: 07/12/13; P2: 07/27/13; P3: 08/11/13) and 2014 (P1: 07/12/14; P2: 07/27/14; P3: 08/11/14).

According to Antunes et al. (2014), off-season pruning, usually carried out from the beginning to mid-July, generally provides a lower production than if carried out later. However, if the production remains in this period, that is, off-season, it can be interesting especially for the rural producer, since it is possible to reach a price up to 700% higher than prices practiced in the harvest period, as the peak production in traditional growing regions occurs from the second half of November to the second half of January.

Still regarding production, there was a significant effect of trellis systems within season 1 (07/12) for both production cycles. Cultivation using a double-wire trellis system (C1) produced 11,669.43 and 3,465.98 kg ha^{-1}, while using a single-wire trellis system (C2) produced 11,965.53 and 3,373.87 kg ha^{-1} in 2013 and 2014, respectively, obtaining superior values than those obtained from cultivation using the 'T' trellis system (C3), demonstrating that C1 and C2 presented a significant interaction with P1 (07/12/13 and 07/12/14) (Table 2).

Table 2. Effect of pruning time on trellis using a double-wire trellis and on trellis at pruning time 1 (P1 - 07/12) for yield (kg ha^{-1}), average fruit mass (AFM - g/fruit), and yield per plant (PPP – g/plant) of blackberry (*Rubus* spp.) cv. 'Tupy' for the years 2013 and 2014 in Dourados/MS.

Tratamentos	2013			2014		
	Production	AMF	PPP	Production	AMF	PPP
Trellis/Time 1						
Double-wire trellis	11,669.43 a	6.62^{ns}	2,490.47^{ns}	3,465.98 a	7.21^{ns}	730.69^{ns}
Single-wire trellis	11,965.53 a	6.71	2,752.81	3,373.87 a	7.51	799.76
'T' trellis	8,893.83 b	6.26	2,223.46	2,251.03 b	7.55	536.63
DMS	2,671.38	0.70	891.93	735.13	4.41	295.92
Times/Trellis 1						
P1	11,669.43^{ns}	6.62^{ns}	2,490.47^{ns}	3,465.98 ab	7.21^{ns}	730.69^{ns}
P2	10,603.36	6.45	2,650.84	2,793.04 b	7.50	698.26
P3	11,389.33	7.01	2,847.33	3,798.54 a	7.57	948.64
DMS	2,671.38	0.70	891.93	735.13	4.41	295.92

^{ns} – not significant. Means followed by the same letter in the column do not differ significantly from each other by the Tukey test (P<0.05). Pruning - 2013 (P1: 07/12/13; P2: 07/27/13; P3: 08/11/13) and 2014 (P1: 07/12/14; P2: 07/27/14; P3: 08/11/14).

We also observed a significant effect of the pruning times within C1 (double-wire trellis) in the second year of harvest (2014); in addition, it was noted that pruning time 1 (07/12) did not differ statistically from P2 (07/27) and P3 (08/11) (Table 2). In general, these results indicate that trellis using the double-wire trellis (C1) effectively contributed to provide highest results in the pruning times 1 (07/12/14) and 3 (P3: 08/11/14) in the second production cycle (Table 2).

In general, average fruit mass, both as a function of trellis systems and pruning, obtained values between 6.51 and 8.92 g for the two production cycles (Table 1). It is noteworthy that these values were higher than those found by Campagnolo and Pio (2012), who observed fruits of the same cultivar with masses of 4.68 and 5.30 g in the 2008/2009 and 2009/2010 crop seasons.

However, our results were below those found by Leonel and Segantini (2015), who evaluated blackberry in a subtropical region and found masses of 7.51 g and 7.12 g for pruning carried out in July and August, respectively. Ferreira et al. (2016) observed an average weight of 5.1 and 5.4 g fruit of the cv. 'Tupy' in a trellis and "T" trellis system in the 2010/2011 harvest in the region of Pelotas – RS. In general, our results demonstrate that in the southwest region of MS, greater fruit weight is obtained, an important fact for the commercialization of the production.

For blackberry cv. 'Tupy', it is expected that fruits present a mass between 8 and 10 g (ANTUNES et al., 2014); this pattern was observed only in 2014 using the 'T' trellis system – C3 (8.76 g) and when pruning was carried out on 04/27 – P2 (8.92 g). However, the productive responses of blackberry vary depending on the crop treatments, as well as on the growing region. In a study by Figueiredo et al. (2013), a fruit mass of 7.56 g was obtained for the same cultivar when produced in the region of Lavras/MG, being lower than the mass observed in our study.

Fruit production per plant (PPP) was not influenced by the factors separately (P>0.05) (Table 1), with values of 2,488.92 and 2,744.15 g plant^{-1} in 2013, which are higher than the results described by Campagnolo and Pio (2012a; 2012b). In 2014, the PPP ranged between 650.42 and 847.43 g plant^{-1}, being lower than those reported by Tadeu et al. (2015), who performed drastic summer pruning and obtained values between 1578.30 and 1754.30 g for cv. 'Tupy' under subtropical conditions.

The highest yield results observed using the double-wire trellis (Table 2) are possibly associated with larger leaf areas, as it facilitates vegetative development, especially of leaf blades (VILLA et al., 2014), contributing to a greater photosynthetic capacity and photoassimilate production for the fruiting stage of the species under these conditions. In addition, it is suggested that further studies over the years should be carried out, as no statistical difference was observed for the first year of production (2013), whose climatic characteristics were similar to those of traditional regions of production. In a study with the same cultivar trained using a 'T' trellis and the same number of stems in the region of Botucatu/SP, Segantini et al. (2014) observed masses ranging from 9.0 to 9.8 g, which were higher than those observed in our study.

Regarding the qualitative characteristics of the fruits, interaction was observed in 2013, with the highest pH value, 3.17, being observed for the pruning time 1 (P1 - 07/12) using the 'T' trellis system (Table 3). On the other hand, in 2014, we observed that only pH was influenced by the trellis systems, and the highest values (2.74 and 2.76) occurred for C2 and C3, respectively, being similar between them. According to Villa et al. (2014), pH values below 4 are expected and desirable for blackberry cultivars, since the fruits of the species generally have a sour and sour-sweet taste as natural characteristics.

Table 3. Soluble solids (SS – ºBrix), total acidity (TA), SS/TA ratio, and pH of blackberry (*Rubus* spp.) cv. 'Tupy' for the years 2013 and 2014 in Dourados/MS.

Treatments	2013				2014			
	SS	TA	*Ratio*	pH	SS	TA	*Ratio*	pH
Trellis system								
Double-wire trellis	8.38^{ns}	1.23^{ns}	6.84^{ns}	3.03^{ns}	7.98^{ns}	1.27^{ns}	6.31^{ns}	2.67 b
Single-wire trellis	8.24	1.21	6.85	3.08	8.10	1.26	6.43	2.74 a
'T' trellis	8.33	1.21	7.05	3.10	7.95	1.20	6.64	2.76 a
DMS	0.68	0.20	1.67	0.11	1.05	0.13	0.63	0.04
Pruning times								
P1	8.34^{ns}	1.23^{ns}	6.84^{ns}	3.10^{ns}	8.02^{ns}	1.26^{ns}	6.37^{ns}	2.74^{ns}
P2	8.39	1.20	7.09	3.03	8.04	1.23	6.45	2.74
P3	8.22	1.22	6.80	3.07	7.97	1.24	6.56	2.69
DMS	0.22	0.10	0.70	0.07	0.48	0.06	0.53	0.11
C. V. (%)	2.11	6.51	8.01	1.94	4.8	4.09	6.46	3.21

^{ns} – not significant. Means followed by the same letter in the column do not differ significantly from each other by the Tukey test (P<0.05). Pruning - 2013 (P1: 07/12/13; P2: 07/27/13; P3: 08/11/13) and 2014 (P1: 07/12/14; P2: 07/27/14; P3: 08/11/14).

In 2013, the soluble solid (SS) contents ranged from 8.24 and 8.38 ºBrix for trellis and from 8.22 and 8.39 for pruning, with an interaction between the factors under study; in the split-plot scheme, there was effect of pruning in C2, in which fruits produced in the P1 (07/12) and P2 (07/27) were larger than those produced in P3. In 2014, SS contents ranged from 7.95 to 8.10 for trellis and from 7.97 to 8.04 for pruning times (Table 4).

Table 4. Effect of pruning time on single-wire trellis and of trellis on pruning time (P2 - 07/27), soluble solids (SS), titratable acidity (TA), SS/TA ratio and pH of blackberry (*Rubus* spp.) fruits cv. 'Tupy' for the years 2013 and 2014 in Dourados/MS.

Treatments	2013				2014			
	SS	TA	*Ratio*	pH	SS	TA	*Ratio*	pH
Trellis/ Time 2								
Double-wire trellis	8.32^{ns}	1.22^{ns}	6.85^{ns}	2.98^{ns}	7.79^{ns}	1.27^{ns}	6.15^{ns}	2.70^{ns}
Single-wire trellis	8.47	1.25	6.79	3.03	8.35	1.26	6.64	2.72
'T' trellis	8.39	1.14	7.64	3.09	7.98	1.16	6.90	2.80
DMS	0.38	0.17	1.21	0.13	0.84	0.11	0.91	0.19
Times/Trellis 2								
P1	8.34 a	1.21^{ns}	6.97^{ns}	3.10^{ns}	8.12^{ns}	1.30^{ns}	6.21^{ns}	2.76^{ns}
P2	8.47 a	1.25	6.77	3.03	8.35	1.26	6.64	2.72
P3	7.92 b	1.18	6.81	3.11	7.82	1.22	6.45	2.73
DMS	0.38	0.17	1.21	0.13	0.84	0.11	0.91	0.19

^{ns} – not significant. Means followed by the same letter in the column do not differ significantly from each other by the Tukey test (P<0.05). Pruning - 2013 (P1: 07/12/13; P2: 07/27/13; P3: 08/11/13) and 2014 (P1: 07/12/14; P2: 07/27/14; P3: 08/11/14).

Standard SS values range from 8 to 9 ºBrix, demonstrating that the results observed in this experiment are within the desired parameters according to other studies in the literature, including the one by Hirsch et al. (2012), although being below the results found by Segantini et al. (2014) and Tadeu et al. (2015) for the same cultivar when produced in the region of Botucatu/SP and Lavras/MG, respectively.

Titratable acidity and SS/TA ratio were not influenced by the factors under study (P<0.05), with TA ranging from 1.21 and 1.23 for trellis and from 1.20 to 1.23 for pruning times in 2013; in 2014, it ranged from 1.20 to 1.27 for trellis and from 1.23 to 1.26 for pruning times (Table 4). These results are similar to those found by Hirsch et al. (2012), who evaluated the physicochemical characteristics of blackberry cv. 'Tupy' in a temperate climate region. This proximity of TA values to that of the crop when produced under temperate climate is desirable, as it suggests that the species has good adaptability and potential for insertion in production chains in tropical regions, such as in the state of Mato Grosso do Sul.

The SS/TA ratio ranged from 0.15 to 0.07 between the trellis systems and pruning times in 2013 and 2014, respectively, with values between 6.31 and 7.09. The SS/AT ratio refers to fruit quality considering the complete maturation associated with flavor, becoming an indicator of sensory acceptance by the consumer. Curi et al. (2015), who studied blackberry and red mulberry, found a SS/TA ratio of 9.70 and 9.30, respectively, when producing in Lavras/MG, a higher value than those observed in our study with blackberry in MS.

Only the values of total soluble solids were influenced by the interaction between trellis and pruning times, and in the interaction, using the single-trellis system (C2), times 1 (P1 - 07/12) and 2 (P2 - 07/27) stood out, with ºBrix of 8.34 and 8.47, respectively, over time 3 (11/08), with ºBrix of 7.92 in the first production cycle (2013) (Table 5). Variations in the contents of chemical compounds of the fruits may occur depending on the region of cultivation due to differences in the intensity of solar radiation and thermal amplitude, which influence the organoleptic characteristics of blackberry fruits (ALI et al., 2011), such as pruning times and trellis systems.

Table 5. Effect of pruning times in the 'T' trellis system and of trellis in the pruning time 8/11 (pruning 3), soluble solids (SS), titratable acidity (TA), SS/TA ratio and pH of blackberry (*Rubus* spp.) cv. 'Tupy' for the 2013 and 2014 in Dourados/MS.

Treatments	2013				2014			
	SS	TA	*Ratio*	pH	SS	TA	*Ratio*	pH
Trellis/ Time 3								
Double-wire trellis	8.56 a	1.22^{ns}	7.06^{ns}	3.07^{ns}	8.18^{ns}	1.29^{ns}	6.33^{ns}	2.68^{ns}
Single-wire trellis	7.92 b	1.18	6.81	3.11	7.82	1.22	6.45	2.73
'T' trellis	8.17 b	1.27	6.54	3.03	7.90	1.21	6.57	2.67
DMS	0.38	0.17	1.21	0.13	0.84	0.11	0.91	0.19
Times/Trellis 3								
P1	8.42^{ns}	1.21^{ns}	6.97^{ns}	3.17 a	7.99^{ns}	1.24^{ns}	6.45^{ns}	2.82^{ns}
P2	8.39	1.14	7.64	3.09 ab	7.98	1.16	6.90	2.80
P3	8.17	1.27	6.54	3.03 b	7.90	1.21	6.57	2.67
DMS	0.38	0.17	1.21	0.13	0.84	0.11	0.91	0.19

^{ns} – not significant. Means followed by the same letter in the column do not differ significantly from each other by the Tukey test (P<0.05). Pruning - 2013 (P1: 07/12/13; P2: 07/27/13; P3: 08/11/13) and 2014 (P1: 07/12/14; P2: 07/27/14; P3: 08/11/14).

When analyzing the interaction, we observed significance of trellis using the 'T' trellis system (C3) and pruning time 3 (P3 - 08/11). Fruits produced using trellis in a double-wire trellis system (C1) presented higher °Brix (8.56), being statistically superior to C2 and C3, whose °Brix was 7.92 and 8.17, respectively.

Based on the information from this study, it was possible to confirm our hypothesis that the trellis system influences fruit production, especially when grown using the double-wire trellis system, indicating an adequate agronomic practice for the cultivation of blackberry cv. 'Tupy', aiming at its economic exploitation for the family income of farmers in the Southwest region of the state of Mato Grosso do Sul.

Conclusions

In the Southwest region of Mato Grosso do Sul, it is possible to change pruning times, seeking an early harvest;

Double-wire trellis system contributed to good results in the production and quality of blackberry cv. 'Tupy' compared to other trellis systems traditionally used in other regions;

Blackberry cv. 'Tupy', in the conditions in which they were produced, presented qualitative characteristics suitable for commercialization.

Acknowledgments

To CAPES, for granting the postdoctoral scholarship, and CNPq and FUNDECT, for financial support.

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