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Reflective materials and management practices on the physicochemical and biochemical quality of Merlot grapes

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Abstract: The aim of this study was to evaluate the use of reflective materials on the soil surface and management practices on the physicochemical and biochemical quality of the Merlot grapes (*Vitis vinifera* L.). The experimental design was of randomized blocks, in factorial 3 x 2 ("material type" x "management practice"), with 4 replications, using 4 plants by plot. The "management practice" factor was divided into two levels, with and without its realization. For "material type", two reflective films were tested in the soil surface, it being white raffia plastics of polypropylene (reflective film 1), metallic raffia plastic (reflective film 2) and without the use of any reflective material. When they reach the harvesting point in the 2009/2010 and 2010/2011 production cycles, the physicochemical and biochemical evaluations of fruit quality were submitted; physiological characteristics of the plant and microbiological properties of soil were also evaluated. The use of reflective material on the soil surface improved the quality of the grape in some aspects, especially determining the reduction of the berry dropping and, consequently, an increase in the productivity. Furthermore, it provided greater microbial activity in the soil, which may be important for grapevine. The cultural practices had no influence on the physicochemical and biochemical quality of the vine fruits, providing only a greater number of berries per bunch.

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1. Introduction

Grape is one of the most economically important fruits in the world, with Brazil in 2014 occupying 78,765 hectares, while production was 1,454,183 tons (FAO, 2014; Camargo *et al.*, 2011). Approximately 57% of this production was used for winemaking (Mello, 2011), with the rest consumed *in natura* or as dried fruits (Conde *et al.,* 2007).

Viticulture for winemaking is mainly concentrated between the 30th and 50th parallel of North latitude and between 30th and 45th of South latitude. The main climates that allow the cultive of vines are those of temperate, Mediterranean and arid areas, in different levels (Tonietto and Mandelli, 2003).

However, the state of Paraná, Brazil, presents potential for the cultivation of grapes destined for the *in natura* consumption and for the elaboration of juices or wines. In particular, in the Southwest region of Paraná there are numerous vine orchards in small rural properties even though the grapes produced in this region had sporadically shown inferior quality to what is considered as good for wine and/or juice, especially when related to soluble solids content.

Fruit quality is linked directly to genetic characteristics, edaphoclimatic factors and cultural practices. The management adopted in the vine orchard usually aims to promote the penetration of solar rays inside the canopy, allowing the leaves located in the lower part of the plant to increase the photosynthetic rate and increase the availability of the photo assimilates for the fruits (Mota *et al*., 2009). The solar radiation is one of the main factors to obtain fruits with high quality, with regard to size, firmness, sugar content, coloration, anthocyanins, starch content and acidity (Procton and Lougheed, 1976; Erez and Flore, 1986; Jackson, 1989). Thus, the increase in the efficiency of its use is fundamental for obtaining more attractive fruits.

Among the management techniques performed in the pre-harvesting of the grape, which can improve the penetration of light and aeration inside the canopy, favouring the obtaining of quality fruits, are green pruning, defoliation, thinning, removal extra shoots (suckering) in the grape tree leaf (Mendonça *et al*., 2016).

However, many winegrowers are resistant to these practices, preferring the adoption of management techniques that allow them to obtain fruits with quality, without the need to increase the demand for labour and the costs in the property.

One of the alternatives that can be adopted is the use of reflective materials in the soil, since they allow to increase the total light absorbed and the distribution of the same inside the canopy, improving the quality of the fruits (Chavarria and Santos, 2009). In 'Fuji' apple the use of reflective materials in the soil was able to increase fruit quality as the red intensity of the epidermis and increase the size of fruits from the interior of the canopy (Andris and Crisosto, 1996).

The use of reflective plastics, under the canopy of plants, is a very used management technique in some countries of America, Europe and Asia. The main objective is to reflect the sunlight to the inside of the crown, to intensify the coloration of the fruit epidermis, to improve the flavour, as well as to antecipate maturation (Trevisan *et al.,* 2006; Meinhold *et al.,* 2011). This additional light is beneficial for photosynthesis and anthocyanin production (Layne *et al.,* 2002).

The principle of the use of these materials is the ability to reflect the solar radiation to the interior of the canopy and it can provide a 40% increase in the photosynthetically active radiation reflected when the soil is completely covered and, around 24%, when partially covered (Green *et al*., 1995).

The present study aimed to evaluate the use of reflective materials and management practices on plant physiology and physicochemical and biochemical quality of Merlot grape (*Vitis vinifera* L.).

2. Materials and Methods

The experiment was conducted in a commercial vineyard in the Dois Vizinhos city - PR, Brazil, in Santa Lucia community (25° 51' 08" S, 53° 06' 15" W, 594 m of altitude), for two productive cycles (2009/2010 and 2010/2011), indicated as cycles 1 and cycles 2 in the following text.

The studied vineyard was planted in 2004 with Merlot (*Vitis vinifera* L.) grafted 1103 rootstock Paulsen (*V. berlandieri* x *V. rupestris*). The spacings between rows are 3.0 m and between plants are 2.0 m in an espalier system, totalling 1.666 plants per hectare.

The experimental design was of randomized blocks, in multifactorial 3 x 2 ("material type" x "management practice"), with 4 replications, considering each 4 plants as a plot, the two central ones being useful, disregarding those near the border.

The "management practice" factor was divided into two levels, with and without its realization. The treatments with the management practices consisted of the adoption of the shoot topping, withdrawal of tertiary branches, disbudding and defoliation. In the treatments without the management practices, only the disbudding was done.

For "material type", two reflective films were tested in the soil: polypropylene white raffia plastic (reflective film 1) and metallic raffia plastic (reflective film 2), both placed below the projection of the crown of the plants, in the lines and between the lines. The films were placed in the vineyard 30 days after plants broke their dormancy; as third level, none film was used.

Upon reaching the harvesting point, in both cycles, the fruits were harvested and taken to the Laboratory of Plant Physiology, (Universidade Tecnológica Federal do Paraná - Campus Dois Vizinhos) for physicochemical and biochemical evaluations.

The evaluated variables were rot incidence (bunch and berry), bunch and berries weight, number of berries and bunches, berry drop, total soluble solids content (°Brix) (SS) titratable total acidity (TTA) (g tartaric acid 100 mL^{-1}), SS/TTA *ratio*, pH and production per plant (kg).

The incidence of rot was determined visually, considering fruits with damage when they presented lesions and typical characteristics of pathogen attack. The berry drop was determined by the percentage of berries detached from the general total of the bunch. The SS contents were determined by refractometry. The titratable acidity was determined by titrating 10 mL of juice in 90 mL of water diluted with 0.1 N NaOH solution to pH 8.1; the results being expressed in g of tartaric acid 100 mL^{-1}.

Analysis of biochemical variables of productive cycle 1 fruits included total proteins, total phenols, total and reducers sugars, phenylalanine ammonia-lyase enzyme (PAL), flavonoids and anthocyanins, constituting a total of four samples per treatment.

For total protein dosage, the pulp samples from the fruits of each treatment were macerated in a mortar with 10 mL of 0.2 M phosphate buffer (pH 7.5). Then the material was centrifuged (14.000 *g* for 10 min at 4°C) and the supernatant collected. For the quantification of the total protein content in the samples, the Bradford test (1976) was used and the spectrophotometer, model UV-SP2000-Spectrum at 630 nm, with bovine serum albumin as standard.

The quantification of the total phenolic compounds of the pulp of the fruits of each treatment was carried out in two stages; the first one, following the method adapted from Bieleski and Turner (1966) and the second one according to Jennings (1991). The total soluble sugar concentrations of fruit pulp from each treatment were determined by the phenol-sulfuric method as described by Dubois *et al.* (1956). The activity of PAL was evaluated based on the difference in absorbance resulting from the conversion of phenylalanine to trans-cinnamic acid (Hyodo *et al*., 1978).

Were evaluated the efficiency of water use (%), CO_2 assimilation rate (µmol CO_2 m^{-2} s^{-1}), water conductance (mol H_2O m^{-2} s^{-1}), intracellular CO_2 concentration (µmol CO_2 mol^{-1}), transpiration rate (mmol H_2O m^{-2} s^{-1}) and foliar temperature (°C) in the productive cycle 1 and productive cycle 2. These physiological analyses of the plants were performed on three different dates (8th, 15th and 21st of January, 2010) for the productive cycle 1 and a date (14th of December, 2010) during the productive cycle 2. The gas exchange readings always started at 9:30 A.M. using an open gas measurement system equipped with a LI-6400XT infrared gas analyser (IRGA - LI-COR, Lincoln, Nebraska - USA) and an artificial source of red and blue light, performed on the fully developed and healthy middle third leaves of two plants per plot. The microclimatic conditions in the sample chamber were maintained constant during the readings, being 1100 µmol m^{-2} s^{-1} PAR (photosynthetically active radiation) and ambient CO_2 concentration (average of 383 µmol CO_2 mol^{-1}).

Microbiological analyses of the soil were also performed according to the type of coverage adopted, by means of the quantification of the respiratory activity of the same, according to method proposed by Öhlinger (1993). The analyses were carried out in the laboratory after the collection of the same, in the period of seven days after the harvest of each productive cycle to the depth of 10 cm.

Maximum, average and minimum temperatures of the plant body were obtained after reflection of the solar radiation for the productive cycle 1, captured by infrared images (thermographic) by a Therma CAM SC500 camera, always installed in the direction of the region of the plant, at 1 m of distance from the projection of the plant, discarding those of the border of each treatment. The temperature was obtained using the Therma CAM 200 Professional software based on the readings of 15th and 22nd of January, 2010 starting at 9:00 A.M.

The results of all variables were submitted to analysis of variance and the means were compared by the Tukey's test (α = 0.05), except for the soil microbiological analyses where the Duncan's test (α = 0.05) was applied. The data expressed in percentage was transformed by *sine arc* $\sqrt{x/100}$ and when expressed in numbers by $\sqrt{x+1}$, according to the Lilliefors' normality test. All analyses were performed by the statistical software SANEST (Zonta and Machado, 1984).

3. Results and Discussion

In the course of the experiment, excessive rainfall occurred during the two productive cycles (Figs. 1A and 1B). In addition to the occurrence of hail in productive cycle 1, which impaired the performance of phytosanitary treatments, creating a favourable environment for disease incidence, it being observed among these, a greater incidence of mildew (*Plasmopara viticola*), close to 25% of bunches or berries.

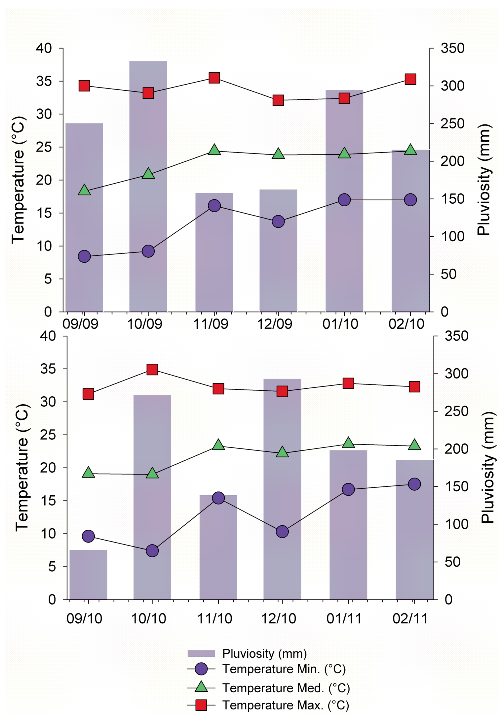

Fig. 1 - Data obtained from INMET's meteorological station, from productive cycle 1 (2009/2010) (A) and productive cycle 2 (2010/2011), located at Universidade Tecnológica Federal do Paraná - campus Dois Vizinhos - PR.

There were no statistically significant differences for the multifactorial interactions between the type of material and the management practices in the physicochemical variables (Table 1) during productive cycles 1 and 2 and biochemical (Table 2) of productive cycle 1, except for the SS/ATT *ratio* of the productive cycle 2. When factors were analyzed separately, significant results were observed, except for the total weight of berries and bunch, berry drop, yield per plant and total sugars concentration for the factor "material type" of production cycle 1 (Table 3) and number of berries per bunch for the factor "management practice" of cycle 1 (Table 4).

For berry drop of the grapes, in the productive cycle 1, it was verified that the use of the reflective film 2 (metallized raffia plastic) presented the lowest values in comparison to the reflective film 1 (white raffia plastic) and without film (Table 1). However, in production cycle 2 these values were lower in relation to cycle 1. The highest values of berry drop productive cycle 1 obtained in the reflective film 1 and without film, may be related to the greater attack of fungal diseases in the berries, because the cycle had an average temperature around 25°C and a high incidence of rainfall (280 mm) near the harvest season

Table 1 - Berry drop (%), bunch weight (g), weight of total and individual berries (g), SS (°Brix), ATT (g of tartaric acid 100 mL-1), pH, SS/TTA ratio, number of berries per bunch, number of bunches, rot berries and bunches (%), production per plant (Kg) of Merlot grapes submitted or not to management practices with or without the use of reflexive films on the soil, in productive cycle 1 of (2009/2010) and productive cycle 2 of (2010/2011)

Treatment (z)	Berry drop	Bunch weight	Total weight of berries	Berry weight (g)	SS	ATT	pH	SS/ATT	Berries No. per bunch	Bunches No.	Berries with mildew	Bunch with mildew	Production (Kg)
						Productive cycle 1 (2009/2010)							
T1	12.71 NS	132.4 NS	125.70 NS	1.73 NS	16.64 NS	5.57 NS	3.44 NS	2.99 NS	72.76 NS	25.67 NS	25.24 NS	24.02 NS	3539.04 NS
T2	15.29	162.65	155.17	2.43	15.74	4.71	3.47	3.34	63.62	27.69	20.44	25.57	4222.51
T3	4.59	155.96	148.5	1.98	15.89	4.84	3.53	3.28	74.87	26.71	21.96	24.92	4535.66
T4	16.76	117.29	111	1.98	16.64	5.34	3.42	3.12	56.06	23.91	25.24	22.5	2831.5
T5	11.36	148.45	139.96	2.22	15.74	4.77	3.43	3.3	62.95	30.06	20.45	27.48	4503.96
T6	4.68	157.17	150.16	2.48	15.89	4.51	3.45	3.52	60.65	29.12	21.96	25.66	4554.81
CV (%)	18.77	14.06	14.29	18.33	7.98	8.29	2.21	16.52	8.12	8.79	4.54	5.1	24.37
						Productive cycle 2 (2010/2011)							
T1	1.59 NS	250.58 NS	237.82 NS	1.75 NS	60.25 NS	4.04 NS	3.67 NS	4.14**	137.2 NS	60.25 NS	4.47 NS	15.61 NS	15321.1 NS
T2	4.8	259.4	241.74	1.76	62.63	3.77	3.36	4.44	139.75	62.62	6.25	15.98	16389.38
T3	5.42	283.37	268.07	1.74	70.25	4.58	3.06	3.72	152.97	70.25	4.13	14.13	19997.24
T4	3.72	245.29	233.95	1.78	59.63	4.4	3.37	3.86	131.97	59.62	6.04	11.26	14907.88
T5	3.63	265.81	253.84	1.75	60.88	4.08	3.2	3.93	145.06	60.88	4.85	17.11	16278.66
T6	3.78	246.34	238.1	1.62	70.3	4.43	3.35	4.48	147.22	69.38	8.06	18.99	17504.40
CV (%)	27.72	18.25	17.92	6.6	25.57	10.93	2.99	11.79	16.16	25.57	49.36	26.24	30.64

NS= non-significant by the F test. ** Significant at 5% of probability.T1= with management practices and no reflexive film; T2= with management practices with reflexive polypropylene white raffia plastic (film 1); T3= with management practices with reflexive metallic raffia plastic (film 2); T4= without management practices and no reflexive film; T5= without management practices with reflexive polypropylene white raffia plastic (film 1) and (T6) without management practices with reflexive f metallic raffia plastic (film 2).

(Fig. 1), favouring the development of pathogens. Although they did not present statistically significant difference in both cycles, it is assumed that the use of metallized raffia plastic as a reflective film beneath the Merlot vines had provided greater heat in the area of the crown projection as compared to the use of white raffia plastic without film creating an environment with low levels of moisture, unfavourable to the attack of diseases. The same was visualized in productive cycle 2 whose incidence of fungal diseases attack was reduced, resulting in lower values of berry drop.

This hypothesis can be verified by the analysis of plant surface temperatures (minimum, average and maximum) after reflection of the solar radiation, captured by infrared (thermographic). In fact, we found divergent results for the type of cover and management practice, and the use of reflective film allowed an increase of up to 3°C in the average and maximum temperatures, in relation to the non-use of reflective film (Tables 3 and 4, respectively).

The same significant effect was not obtained for the maximum, average and minimum temperatures of the plants during the second evaluation (Table 2).

Table 2 - Flavonoids (mg/100 g), phenols (mg/g), total and reducing sugar (mg/g), anthocyanins (mg/100 g), PAL (UAbs/min/mg prot) and proteins (mg/g), minimum, average and maximum surface temperatures of the second evaluation, intracellular CO_2 concentration (µmol CO_2 mol^{-1}) of the first and third evaluation, of Merlot vine submitted or not to management practices and the use or not of reflexive films on the soil, in productive cycle 1 (2009/2010)

Treatment (z)	Flavonoids (mg/100 g)	Phenols (mg/g)	Total sugar (mg/g)	Antho-cyanins (mg/100 g)	PAL (UAbs/min/ mg prot)	Proteins (mg/g)	Surface temperature in 2nd evaluation			Intracellular CO_2 concentration	
							Min (°C)	Med (°C)	Max (°C)	1st evaluation	3rd evaluation
T1	159.12 NS	1.78 NS	26.92 NS	128.08 NS	0.09 NS	0.92 NS	26.33 NS	30.23 NS	37.90 NS	255.55 NS	242.07 NS
T2	153.31	1.01	28.02	119.43	0.02	1.02	25.2	29.98	38.77	251.23	250.12
T3	110.41	1.32	30.76	86.01	0.04	0.79	24.85	31.38	41.65	246.61	241.07
T4	121.79	1.56	26.82	94.87	0.04	0.45	25.92	29.6	35.75	253.19	235.12
T5	151.74	1.63	27.76	118.22	0.03	0.74	26.83	31.13	39.73	255.55	244.82
T6	137.52	1.27	28.16	107.13	0.39	0.54	23.05	31.1	38.6	246.94	242.71
CV (%)	31.83	33.38	5.67	30.82	282.43	71.27	8.13	4.76	7.99	3.1	3.99

NS= non-significant by the F test. ** Significant at 5% of probability. (z) T1= with management practices and no reflexive film; T2= with management practices with reflexive polypropylene white raffia plastic (film 1); T3= with management practices with reflexive metallic raffia plastic (film 2); T4= without management practices and no reflexive film; T5= without management practices with reflexive polypropylene white raffia plastic (film 1) and (T6) without management practices with reflexive f metallic raffia plastic (film 2).

Table 3 - Berry drop (%), total weight of bunches and berries (g), production per plant (Kg) and total sugar (mg/g), minimal, medium and maximum surface temperatures during the first evaluation, of Merlot vines submitted or not to management practices with the use or not of reflexive films on the soil, in productive cycle 1 (2009/2010)

Type of material (z)	Berry drop	Total weight of berries	Bunch weight	Production per plant	Total sugar	Surface temperatures in first evaluation		
						Min (°C)	Med (°C)	Max (°C)
Reflexive film 1	13.26 a*	147.57 a	155.55 a	4519.81 a	27.92 ab	20.43 ns	29.84 ab	39.98 ab
Reflexive film 2	4.63 b	149.33 a	156.57 a	4388.66 ab	29.46 a	18.81	30.45 a	41.55 a
No film	14.68 a	118.35 b	124.84 b	3185.27 b	26.87 b	18.26	29.09 b	38.20 b
CV (%)	24.62	14.29	14.06	24.37	5.67	14.35	2.75	5.83

NS= non-significant by the F test. *Means followed by the same lowercase letter in the column don't differ significantly by the level of 5% by Tukey's test. (z) reflexive polypropylene white raffia plastic (Reflexive film 1); reflexive metallic raffia plastic (Reflexive film 2).

Table 4 - Minimum, medium and maximum surface temperatures during the first evaluation, number of berries per bunch in Merlot vines submitted or not to management practices, in productive cycle 1 (2009/2010)

Management practice	Surface temperature in first evaluation			N° of berries per bunch
	Min (°C)	Med (°C)	Max (°C)	
With management	20.75 a *	29.79 a	38.63 b	70.33 a
Without management	17.58 b	29.79 a	41.8 a	59.86 b
CV (%)	14.35	2.75	5.83	5.67

* Means followed by the same lowercase letter in the column do not differ significantly at 5% level of significance by Tukey's test.

Regarding the bunch weight, total berries weight, and production per plant, the highest values were obtained when the reflective films 1 and 2 (white raffia plastic and metallized raffia plastic, respectively) were used, and when observed in the productive cycle 2 these values were even more expressive, but without statistical difference for the effect of the treatments (Table 1). Observing the productive cycles 1 and 2, we noticed the alternation of productivity, which may be related to the lower pluviosity in the final period of development of the fruits (Fig. 1) and lower incidence of fungal diseases, providing best sanitary conditions of the vines resulting in increased production.

It is believed that the use of reflective films in productive cycle 1 may have provided an increase in the use of the photosynthetically active radiation by the plant, since when it reaches the films, it is reflected, mainly in the regions below the canopy, usually more shaded, increasing the production of photo assimilates, which allowed a greater weight of bunch and berries and, consequently, greater production. This fact can also be observed for productive cycle 2, however, with no statistical difference.

The influence of the radiation on the weight of the berries was also verified by Cargnello (1992), Kliewer and Lider (1968), and Todic *et al.* (2007), who verified that the weight of berries in plants exposed directly to the radiation was superior to those kept under shading conditions. This fact was also verified by Morrison (1988), reporting that shading of the leaves undermined the weight of the berries. During fruit development, shading affects the photosynthetic rate, which consequently limits carbohydrate sources for their development (Garriz *et al*., 1998).

In part, this hypothesis can be verified by the results obtained regarding the intracellular CO_2 concentration during the second evaluation in productive cycle 1, since there was a significant effect for the interaction between the factors tested (Table 5), demonstrating that when the management practice was performed, there was a lower value with the use of reflective film 2 (metallized raffia plastic), followed by the use of reflective film 1 (white raffia plastic) and during productive cycle 2, the results remained favourable for the use of some kind of material, however, with no statistical difference.

It is assumed that these lower values in the intracellular CO_2 concentration with the use of the reflective films are due to the greater photosynthetic activity by the plant, quickly converting all CO_2 absorbed into photo assimilates, as previously attributed to the results regarding bunch weight, total of berries weight and production per plant. The same effect of the films was obtained for the contents of total sugars, with a higher mean obtained in fruits, where the plants had reflective films 1 and 2, which is also related to the greater use of the photosynthetically active radiation.

Table 5 - Intracellular CO_2 concentration (μmol CO_2 mol^{-1}) during the second evaluation in Merlot vines submitted or not to management practices with or without reflexive films on the soil, in productive cycle 1 (2009/2010)

Material type [(z)]	Intracellular CO_2	
	With management	Without management
Reflexive film 1	266.35 abA*	259.50 aA
Reflexive film 2	261.19 bA	261.53 aA
No film	274.13 aA	254.73 aB
CV (%)	2.03	

* Means followed by the same lowercase letter in the column don't differ significantly by the level of 5% by Tukey's test.

[(z)] Reflexive polypropylene white raffia plastic (Reflexive film 1); reflexive metallic raffia plastic (Reflexive film 2).

In grapevine, Kliewer (1980) described that the fruits located inside the canopy, therefore, with lower illumination, presented less accumulation of sugar. This fact also occurred in the fruits of those plants that did not have reflective films below the canopy, which demonstrates that the use of these is important for the greater use of photosynthetically active radiation.

When submitted to the management practices the SS/ATT ratio of the fruits obtained higher results significantly using the reflective film 1 and without the use of reflective films. However, when they observed the non-use of management practices, the use of reflective material did not present statistical difference (Table 6).

The same phenomenon can be also observed concerning, the management practice. With its realiza-

Table 6 - SS/ATT ratio in Merlot vines submitted or not to management practices with or without reflexive films on the soil, in productive cycle 2 (2010/2011)

Material type [(z)]	SS/ATT ratio	
	With management	Without managment
Reflexive film 1	4.44 aA	3.93 aA
Reflexive film 2	3.72 bA	4.48 aA
No film	4.14 aA	3.86 aA
CV (%)	11.8	

* Means followed by the same lowercase letter in the column don't differ significantly by the level of 5% by Tukey's test.

[(z)] Reflexive polypropylene white raffia plastic (Reflexive film 1); reflexive metallic raffia plastic (Reflexive film 2).

tion, it is believed that there was increase in the photosynthetic rate of the plant, as results in the intracellular CO_2 concentration (Tables 5, 7, and 8), since practices like disbudding and defoliation allow higher incidence of light to enter the plants. In part, the greater light penetration can be proven by obtaining the increase in the minimum temperature of the plants during the first evaluation, when the management practice is carried out (Table 4), which is advantageous for greater metabolic activity of the plant, consequently providing increase in energy production and photo assimilates.

However, when there was no management practice the plants showed a higher maximum temperature in comparison with those in which it was carried out (Table 4). This demonstrates that the accomplishment of the management practice besides increasing the minimum temperature of the plant, provides lower maximum temperature, favouring the photosynthetic activity, since very high temperatures can provide stomatic closure, reducing the entrance of CO_2, which diminishes the photosynthetic activity in addition to reducing the absorption of water and nutrients. On the other hand, the average surface temperature of the plant presented equal means with or without the management practice (Table 4).

As for the other physiological variables (water use efficiency, CO_2 assimilation rate, water conductance, transpiration rate and leaf temperature), there was no significant interaction or for the factors individually during the production cycle 1 in the three evaluations carried out (Table 7), also verified for intracellular CO_2 concentration in the first and third evaluation (Table 2), and in the water use efficiency, CO_2 assimi-

Table 7 - Water use efficiency (%), CO_2 assimilation rate (μmol CO_2 m^{-2} s^{-1}), water conductance (mol H_2O m^{-2} s^{-1}), transpiration rate (mmol H_2O m^{-2} s^{-1}), leaf temperature (°C), intracellular CO_2 concentration (μmol CO_2 mol^{-1}) of Merlot vines submitted or not to management practices with or without reflexive films on the soil, during the first, second and third evaluations, in productive cycle 1 (2009/2010)

Treatment [(z)]	Water use efficiency (%)			CO_2 assimilation rate (μmol CO_2 m^{-2} s^{-1})			Water conductance (mol H_2O m^{-2} s^{-1})			Transpiration rate (mmol H_2O m^{-2} s^{-1})			Leaf temperature (°C)		
	1ª Ev.	2ª Ev.	3ª Ev.	1ª Ev.	2ª Ev.	3ª Ev.	1ª Ev.	2ª Ev.	3ª Ev.	1ª Ev.	2ª Ev.	3ª Ev.	1ª Ev.	2ª Ev.	3ª Ev.
T1	0.26 NS	0.25 NS	0.38 NS	12.12 NS	10.55 NS	10.9 NS	0.23 NS	0.24 NS	0.18 NS	4.76 NS	4.76 NS	2.94 NS	32.59 NS	31.58 NS	28.3 NS
T2	0.27	0.27	0.38	12.57	11.93	11.8	0.26	0.25	0.23	4.69	4.69	3.41	31.82	31.16	28.38
T3	0.31	0.3	0.37	11.92	12.53	10.69	0.22	0.23	0.2	4.57	4.57	3.27	32.45	31.13	28.58
T4	0.28	0.3	0.39	12.44	11.52	10.98	0.23	0.22	0.18	4.5	4.5	2.96	31.84	31.21	28.6
T5	0.24	0.27	0.39	12.96	11.05	11.5	0.26	0.21	0.2	5.34	5.34	3.23	32.94	31.82	28.49
T6	0.26	0.3	0.37	12.9	12.62	11.78	0.23	0.25	0.17	4.34	4.34	2.8	31.78	30.93	28.02
CV (%)	15.03	9.78	10.72	7.22	9.69	10.72	10.85	15.89	20.67	11.69	13.37	13.43	2.99	2.07	1.41

NS= non-significant by the F test. [(z)] (T1) with management practices and no reflexive film; (T2) with management practices with reflexive polypropylene white raffia plastic (film 1); (T3) with management practices with reflexive metallic raffia plastic (film 2); (T4) without management practices and no reflexive film; (T5) without management practices with reflexive polypropylene white raffia plastic (film 1) and (T6) without management practices with reflexive f metallic raffia plastic (film 2).

Table 8 - Intracellular CO_2 concentration (μmol CO_2 mol^{-1}), water use efficiency (%), CO_2 assimilation rate (μmol CO_2 m^{-2} s^{-1}), water conductance (mol H_2O m^{-2} s^{-1}), transpiration rate (mmol H_2O m^{-2} s^{-1}), leaf temperature (°C) of Merlot vines submitted or not to management practices with or without reflexive films on the soil, in productive cycle 2 (2010/2011)

Treatment [(z)]	Intracellular CO_2 concentration	Water efficiency (%)	CO_2 assimilation rate (μmol CO_2 m^{-2} s^{-1})	Water conductance (mol H_2O m^{-2} s^{-1})	Transpiration rate (mmol H_2O m^{-2} s^{-1})	Leaf temperature (°C)
T1	261.31 NS	1.43 NS	14.67 NS	0.23 NS	3.29 **	24.44 NS
T2	263.7	1.46	14.36	0.23	3.2	24.51
T3	263.09	1.46	14.09	0.22	3.36	24.32
T4	260.05	1.41	15.02	0.23	3.23	24.37
T5	263.43	1.44	14.71	0.23	3.67	24.5
T6	261.82	1.44	14.44	0.22	3.04	24.26
CV (%)	2.78	7.84	7.85	8.74	7.48	2.85

NS= non-significant by the F test. [(z)] (T1) with management practices and no reflexive film; (T2) with management practices with reflexive polypropylene white raffia plastic (film 1); (T3) with management practices with reflexive metallic raffia plastic (film 2); (T4) without management practices and no reflexive film; (T5) without management practices with reflexive polypropylene white raffia plastic (film 1) and (T6) without management practices with reflexive f metallic raffia plastic (film 2).

lation rate, water conductance for productive cycle 2. The transpiration rate of productive cycle 2 showed significant interaction indicating that the use of reflective film 2 in conjunction with the management practice were superior to the other treatments, which possibly may have contributed to the quantity and quality of the fruits in the cycle productive 2 (Table 9).

Table 9 - Transpiration rate (mmol H_2O m^{-2} s^{-1}) of Merlot vines submitted or not to management practices with or without reflexive films on the soil, in productive cycle 2 (2010/2011)

Material type (z)	Transpiration rate (mmol H_2O m^{-2} s^{-1})	
	With practice	Without practice
Reflexive film 1	3.20 b A	3.67 a A
Reflexive film 2	3.36 a A	3.04 a AB
No film	3.29 a A	3.23 a B
CV (%)	7.48	

* Means followed by the same lowercase letter in the column don't differ significantly by the level of 5% by Tukey's test.

(z) Reflexive polypropylene white raffia plastic (Reflexive film 1); reflexive metallic raffia plastic (Reflexive film 2).

It was verified that the adoption of management practices in spite of not influencing most of the variables analysed in the present study, provided a greater number of berries when carried out on the Merlot vines in productive cycle 1 (Table 4), demonstrating the importance of its execution for the winegrower.

It is believed that the lower number of berries in the plants without management practices can be due to the attack of fungal diseases. Champagnol (1984) and Fregoni (1998) reported in their studies that mildew, after effective fruiting, may be one of the causes for the lower number of berries per bunch. Indeed, the practices of shoot topping, suckering, withdrawal of tertiary branches and defoliation may have improved the penetration of light and air in the area of projection of the plants, not allowing the formation of favourable microclimate for fungal diseases.

Regarding the microbiological analysis of the soil, a statistical difference was observed for the type of reflexive film used in productive cycle 1, with the highest microbial activity in the soil when white raffia plastic and metallized raffia plastic were used. The latter did not differ statistically from the treatment without reflexive film on the soil (Table 10). For production cycle 2, although the values obtained were higher, which makes it favourable for productivity, the same did not present statistical differences.

It is assumed that the use of the white or metallic raffia plastic films to reflect the solar radiation allowed lower temperature in the soil, as well as reduced water loss, favouring the full metabolic activity of soil microorganisms, given the maintenance of conditions optimum temperature and humidity, decreasing problems with water stress for the plant. Hungria *et al.* (1997) mentioned that the reduction of soil microbiota impairs the temporary fixation of nutrients, increasing their losses and resulting in soil impoverishment.

Table 10 - Microbiological respiratory activity of the soil according to the material type addopted for Merlot vines, in productive cycle 1 (2009/2010) and productive cycle 2 (2010/2011)

Material type (z)	Microbiological resiratory activity (mg of CO_2 kg of soil^{-1})
Productive cycle of 2009/2010	
Reflexive film 1(z)	45.65 a
Reflexive film 2	43.45 ab
No film	35.75 b
CV (%)	11
Productive cycle of 2010/2011	
Reflexive film 1	100.10 NS
Reflexive film 2	102.3
No film	82.13
CV (%)	30.87

* Means followed by the same lowercase letter in the column don't differ significantly by the level of 5% by Tukey's test.

(z) Reflexive polypropylene white raffia plastic (Reflexive film 1); reflexive metallic raffia plastic (Reflexive film 2).

In general, soils with high microbiological activity indicate low human interference with the environment and are, in principle, desirable for crops, since they contribute to a faster decomposition and re-synthesis of organic matter, to nutrient cycling, to specific biochemical transformations (nitrification, denitrification, oxidation and sulphur reduction) for biological nitrogen fixation (Silveira and Freitas, 2007).

Thus, the use of reflective material on the soil presents additional benefits to the crop and the environment, and according to the peculiarities of the area, the effects of the application of the technology on the soil microbial population can become as important or more than the benefits obtained directly on the quality of the fruits. Attention must be paid to determining the most appropriate moment for the installation of the reflective film in the soil, since the influence of the radiation on the quality of the fruit varies according to the phenological stage of the crop (Weston and Barth, 1997; Kader, 2002; Meinhold *et al.,* 2011).

4. Conclusions

The use of reflective films on the soil improved the quality of Merlot grapes in some aspects as reducing berry drop, consequently increasing productivity.

Management practices here tested didn't have influence on the physicochemical and biochemical characteristics of the fruits, resulting only in more berries per bunch.

The use of reflective films on the soil provided higher microbiological activity in the soil, which may be important for grapevines.

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