



# Development and production of curly and iceberg lettuce under the influence of different types of mulch

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## Abstract

Lettuce is a plant that develops and is produced under the influence of climatic conditions, competition with weeds, pests, and diseases. One way of minimizing these effects on the crop is to use mulch, which can be of plastic or vegetable origin. This study aimed to evaluate the development and production of lettuce subjected to different types of mulch. The experimental design used was randomized blocks, with a factorial of 2×4 and four replications, with two cultivars—“Vera” for curly lettuce and “Delícia Americana” for iceberg lettuce—and four treatments—mulch with coffee husks, grass straw, black plastic and the control (no mulch)—, totaling 32 plots. Each experimental plot consisted of 20 plants, and only the six central plants were evaluated. The highest temperatures were recorded when using black plastic for covering, which also resulted in better weed suppression and higher means for plant height, number of healthy leaves, stem fresh mass, stem diameter, and commercial fresh mass. It was concluded that the Delícia Americana cultivar and the black plastic mulch provided the best growing conditions for the crop, with the best means for the variables studied.

**Keywords:** *Lactuca sativa* L. Mulching. Mulch. Cropping Systems. Plastic Cover.

## Introduction

Lettuce (*Lactuca sativa* L.) is an herbaceous plant belonging to the Asteraceae family, grown in temperate and tropical climates. Considered the most produced and consumed leafy vegetable in Brazil, lettuce is of great social importance in family farming and human nutrition (SANTOS et al., 2009).

According to data from the Brazilian Institute of Geography and Statistics (IBGE, 2017), lettuce production in 2017 was 671,500 tons, generating a financial return of more than R\$1.2 billion. In Brazil, lettuce production mainly takes place on small farms, most of which are family farms with little infrastructure and unskilled labor.

Since lettuce has a short cycle and annual production, it does not have a high marketing value. Added to this, characteristics such as sensitivity to climatic conditions, attacks by pests and diseases, nutritional management,

competition with weeds, low size, and a shallow, poorly branched root system require a lot of techniques for cultivation and management that make production more expensive and reduce the producer's profitability.

According to Rodrigues, Nomura, and Garcia (2009), mulching is a technique that alleviates these problems, as it brings advantages to the soil, reducing the occurrence of weeds and protecting the soil against sudden changes in temperature and humidity.

Thus, techniques such as mulching enable producers to obtain higher-quality products and, at the same time, reduce the labor required to manage the crop. Proper weed management is a determining factor in obtaining better yields when growing lettuce, since competition between plants results in significant losses (FERREIRA et al., 2013). Farias et al. (2017) reported that the mulch used in vegetable production can be

natural, such as straw, sawdust, fodder, among others, or synthetic, such as polyethylene plastic in different colors.

The use of plastic covers results in a much higher cost when compared to the use of organic mulch because producers can often find crop remains and straw on their own property and use these materials to cover the soil. For the use of mulch to be viable, new mulch alternatives available in the region of cultivation need to be evaluated (MACHADO et al., 2008). Therefore, based on this context, this study aimed to evaluate the development and production of the Vera and Delícia Americana lettuce cultivars, grown under different types of mulching.

## Material and methods

The experiment was carried out in the olericulture sector of the School Farm of the Federal Institute of Education, Science and Technology of the South of Minas Gerais (IFSULDEMINAS), Inconfidentes Campus. The municipality is located in the southern region of Minas Gerais, 869 m above sea level, latitude 22°19'02" South and longitude 46°19'42" West.

According to the Köppen classification, the climate of the region is subtropical highland, with rainy, mild summers and dry winters, and annual

means of 18 °C (PÁDUA et al., 2015). According to Fernandes et al. (2010), the Inconfidentes region has an average annual precipitation index of 1,420 mm.

The experiment was set up using a randomized block design with a 2 × 4 factorial scheme and four replications, totaling 32 experimental plots. The first factor refers to the cultivars: Vera – SAKATA SEED® (curly lettuce) and Delícia Americana – ISLA Sementes® (iceberg lettuce). The second factor refers to the types of mulch (Table 1).

The experiment was set up in four beds, each 0.30 m high, forming a ridge, 1.2 m wide and 20 m long. The soil was sampled and analyzed, then limed and fertilized as required to plant the crop, according to the soil analysis (Table 2).

The experimental plot consisted of four rows with five plants each, totaling 20 plants per plot, with only the six central plants considered useful for the evaluation criteria and the rest considered experimental borders. The experimental plots measured 1.2 m in width and 1.5 m in length, totaling 1.8 m<sup>2</sup>. When planting, the spacing used was 0.30 m between rows and 0.30 m between plants, in line with Radin et al. (2004).

The seeds were sown on June 18, 2022, in polystyrene trays with 200 cells. The trays were filled with the commercial substrate Carolina Soil®.

**Table 1.** Description of the treatments used: two lettuce cultivars (Delícia Americana and Vera) and four types of mulch (black plastic; coffee husks; grass straw, and no cover). IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Cultivar	Type of mulch	Acronym
Delícia Americana	Black plastic	DABP
Delícia Americana	Coffee husks	DACH
Delícia Americana	Grass straw ( <i>Brachiaria decumbens</i> )	DAGS
Delícia Americana	No cover	DANC
Vera	Black plastic	VBP
Vera	Coffee husks	VCH
Vera	Grass straw ( <i>Brachiaria decumbens</i> )	VGS
Vera	No cover	VNC

Source: Prepared by the author (2023).

**Table 2.** Results of the analysis of soil collected from the experimental area. IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

pH H <sub>2</sub> O	P K mg dm <sup>-3</sup>		V %	MO dag dm <sup>-3</sup>	m %	Ca/Mg
5,40	36,6	153,2	53,18	3,71	0,00	6,55
Mg/K	Al	Ca	Mg	H+Al	SB	CTC
	Cmol <sub>c</sub> dm <sup>-3</sup>					
1,10	0,00	2,8	0,43	3,22	3,65	6,78
Zn	Fe	Mn	Cu	B	S	P-rem mg L <sup>-1</sup>
	mg dm <sup>-3</sup>					
2,8	59,8	21,6	1,0	0,2	-	38,16

**Source:** Soil analysis laboratory at IFSULDEMINAS – Inconfidentes Campus, Inconfidentes - MG, Brazil, (2022); adapted by the author (2023).

The treatments studied (different types of mulch) were implemented in the ready-made beds 24 days after sowing (DAS). For the plots with mulch, either coffee husks or grass straw, a layer approximately 5 cm thick of each material was added.

Transplanting took place 25 DAS, as recommended by Resende et al. (2003), who stipulated that the preferred transplanting age for lettuce seedlings ranges from 22 to 30 days, the best range for plant development.

After the seedlings were transplanted from the trays to the beds, all the cultural treatments that the crop normally requires were carried out. Manual weeding began 25 days after transplanting (DAT), and top dressing was applied according to the needs of the crop, following recommendations based on soil analysis. Irrigation was carried out using a micro-sprinkler, three to four times per week, for around 15 to 20 minutes, depending on the visual soil moisture.

During plant growth, the soil temperature was assessed weekly (16, 23, 30, 37, and 44 DAT) for each experimental plot, in order to check the influence of mulch on temperature. The measurement was carried out using an IncoTerm® digital long-stem soil thermometer. The thermometer was inserted at a mean depth of 7 cm to measure temperature.

In order to characterize the climatic conditions, such as the temperature in the environment during the experiment, data were collected from the weather station at the School Farm of IFSULDEMINAS – Inconfidentes Campus.

A phytosociological survey of the weeds was carried out for each treatment 25 DAT to verify the suppression of weeds by the mulch in each plot.

To calculate the Importance Value Index (IVI%), the equations described by Brandão, Brandão and Laca-Buendia (1998) were used, considering that:

$$Frequency (F) = \frac{\text{no. of plots with a given species}}{\text{total no. of plots used}}$$

$$Density (D) = \frac{\text{total individuals per species}}{\text{total area of collection}}$$

$$Abundance (A) = \frac{\text{total individuals per species}}{\text{total number of plots with the given species}}$$

$$Relative Frequency (Fr) = \frac{\text{Frequency of a given species} \times 100}{\text{Combined frequency of all species}}$$

$$Relative Density (Dr) = \frac{\text{Density of a given species} \times 100}{\text{Combined density of all species}}$$

$$Relative Abundance (Ar) = \frac{\text{Quantity of a given species} \times 100}{\text{Combined quantity of all species}}$$

$$Important Value Index (IVI \%) = \frac{Fr + Dr + Ar}{3}$$

Plants were harvested 75 DAS. Harvest evaluations were carried out following Brzezinski et al. (2017), measuring plant height (PH, cm), head diameter (HD, cm), stem diameter (SD, cm), stem fresh mass (SFM, g), total number of commercial leaves (NCL), and plant fresh mass (PFM, kg). The dry mass (DM, g) of the commercial plants was assessed by drying them in a microprocessor oven with forced air circulation.

The healthy leaves of each useful plant were placed in paper bags for moisture absorption. The samples were kept at a temperature of 60 °C for around 48 hours, when they reached a constant mass, after being weighed several times.

All data were recorded on evaluation forms and then entered into Excel spreadsheets. Analysis of variance (ANOVA) was carried out on the experimental data. The means of the treatments were compared using the Tukey's test at 5 % probability using SISVAR software (FERREIRA, 2011).

## Results and discussion

For weed suppression, the phytosociological survey of the treatments identified that the seed bank in the experimental area was made up of plants from three different species and families (Table 3).

The weed with the highest incidence in the experiment area was broadleaf woodsorrel (Table 3), which accounted for 46.54 % of the total number of weeds found.

Table 4 shows that no weeds grew in the treatments using plastic mulch, which means that the plastic inhibited the luminosity under the soil, which is a determining factor in breaking the dormancy of weeds.

Reghin et al. (2002), when evaluating lettuce production using mulch and plant protection, found that black plastic mulch was the most efficient in controlling weeds, allowing for a mean increase of 22.12 % in fresh mass. The biggest infestations of broadleaf woodsorrel occurred in the treatments that used coffee husk mulch for both lettuce cultivars and in the control treatment for the Vera cultivar, in which the soil was completely exposed (Table 4).

Among the treatments, the Vera cultivar with no cover had the highest levels of infestation for the three weed species found in the experimental area (Table 4), a fact that may have been caused by the physical characteristics of this cultivar, which has more upright plants in its early stages of development, leaving most of the soil uncovered.

For the Delícia Americana cultivar, the lowest importance value was found for gallant soldier (*Galisonga parviflora*) in the treatment with grass straw (Table 4), similar to the Vera cultivar, for which the two lowest importance values were also observed in the treatments with grass straw, with 1.47 % for nutsedge (*Cyperus esculentus*) and 2.68 % for gallant soldier (*Galisonga parviflora*). Reghin et al. (2002) reported that competition with weeds interfere in lettuce crops and can lead to a reduction of 30 to 45 % in

**Table 3.** Identification of weed species in the experimental area using a phytosociological survey. IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Family	Species		Infestation Level (%)
	Scientific name	Common name	
Oxalidaceae	<i>Oxalis latifolia</i>	Broadleaf woodsorrel	46.54
Asteraceae	<i>Galisonga parviflora</i>	Gallant soldier	27.86
Cyperaceae	<i>Cyperus</i> spp.	Nutsedge	25.58

**Source:** Prepared by the author (2023).

**Table 4.** Frequency (F), population density (D), abundance (A), relative frequency (Fr), relative density (Dr), relative abundance (Ar) and importance value index (IVI) values for each weed species and treatment. IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Treatment	Species	F	D pl/1.8 m <sup>2</sup>	A	Fr (%)	Dr (%)	Ar (%)	IVI (%)
DABP	0	0	0	0	0	0	0	0
DACH	<i>O. latifolia</i>	1.00	31.67	14.25	6.35	8.46	7.78	7.53
DACH	<i>G. parviflora</i>	0.75	13.33	8.00	4.76	3.56	4.36	4.23
DACH	<i>C. spp.</i>	1.00	20.00	9.00	6.35	5.34	4.91	5.53
DAGS	<i>O. latifolia</i>	1.00	27.78	12.50	6.35	7.43	6.82	6.87
DAGS	<i>G. parviflora</i>	0.50	9.44	8.50	3.17	2.52	4.64	3.44
DAGS	<i>C. spp.</i>	0.75	17.22	10.33	4.76	4.60	5.64	5.00
DANC	<i>O. latifolia</i>	0.75	24.44	14.66	4.76	6.53	8.00	6.43
DANC	<i>G. parviflora</i>	1.00	17.22	7.75	6.35	4.60	4.23	5.06
DANC	<i>C. spp.</i>	1.00	22.78	10.25	6.35	6.08	5.60	6.01
VBP	0	0	0	0	0	0	0	0
VCH	<i>O. latifolia</i>	1.00	41.11	18.50	6.35	10.98	10.09	9.14
VCH	<i>G. parviflora</i>	1.00	15.56	7.00	6.35	4.15	3.83	4.78
VCH	<i>C. spp.</i>	0.75	6.11	3.66	4.76	1.63	1.99	2.79
VGS	<i>O. latifolia</i>	1.00	27.22	12.25	6.35	7.28	6.69	6.77
VGS	<i>G. parviflora</i>	0.75	5.56	3.33	4.76	1.48	1.81	2.68
VGS	<i>C. spp.</i>	0.50	1.67	1.50	3.17	0.44	0.81	1.47
VNC	<i>O. latifolia</i>	1.00	45.00	20.25	6.35	12.01	11.05	9.80
VNC	<i>G. parviflora</i>	1.00	32.78	14.50	6.35	8.75	7.92	7.67
VNC	<i>C. spp.</i>	1.00	15.56	7.00	6.35	4.15	3.82	7.77
Total	-	15.75	374.44	183.23	100	100	100	100

\*Delícia Americana (DA); Vera (V); black plastic (BP); coffee husks (CH); grass straw (GS); no cover (NC).  
**Source:** Prepared by the author (2023).

productivity when it occurs in the early stages of crop development.

Another important characteristic observed was the variation in soil temperature in each treatment. According to the ANOVA, there was no interaction between cultivars and type of mulch at a 5 % significance level (Table 5).

Table 6 shows the means for each type of mulch. The black plastic mulch resulted in the highest average temperature, with the soil being around 1.45 °C warmer than that of the control treatment.

Our outcome corroborates that found by Meneses et al. (2016), who, in a study

assessing different types of mulch for lettuce, found that covering the soil with black plastic increased the soil temperature in relation to the air temperature by a mean of 2.31 °C, but did not have a negative effect on the variables assessed in the produce.

The grass straw mulch provided the lowest mean soil temperature among the types of mulch studied (Table 6), a result that is similar to that found in the work by Meneses et al. (2016), who, when analyzing soil temperature in different types of mulch for lettuce, obtained lower temperatures—3.4 °C to 6.4 °C—when using organic mulch compared to the treatments with no cover and with polyethylene plastic.

**Table 5.** Mean soil temperatures at a depth of 7 cm for the Delícia Americana (DA) and Vera (V) cultivars, measured using a long-stem soil thermometer. IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Cultivar	Temperature (°C)
DA	21.19 a
V	21.11 a
CV (%)	1.83

\*Means followed by the same letter do not differ from each other by the Tukey's test at 5 % probability, CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

Temperature and plant development are directly related, and the type of mulch used can have a positive or negative influence on this parameter. According to Favarato et al. (2017), soil temperature influences plant temperature more than air temperature does, since lettuce plants are small and grow close to the ground.

There was no interaction between the lettuce cultivar and type of mulch for the response variables plant height (PH), head diameter (HD), number of healthy leaves (NHL), and fresh stem mass (FSM) in the F test at a 5 % significance level. This means that the mulch did not interfere with the lettuce varieties in relation to the variables evaluated. Thus, the factors can be evaluated independently (Table 7).

Table 7 shows that the Vera cultivar achieved higher mean plant height values compared to

**Table 7.** Plant height (PH), head diameter (HD), number of healthy leaves (NHL) and stem fresh mass (SFM) for the Delícia Americana (DA) and Vera (V) cultivars. IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

CULTIVAR	PH (cm)	HD (cm)	NHL (n°)	SFM (g)
DA	21.90 b	25.23 b	26.97 a	82.82 a
V	26.09 a	36.18 a	21.36 b	45.07 b
CV (%)	7.69	10.85	13.23	14.34

\*Means followed by the same letter do not differ from each other by the Tukey's test at 5 % probability, CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

**Table 6.** Means of soil temperature at a depth of 7 cm, for the black plastic (BP), coffee husk (CH) and grass straw (GS) mulches and the soil with no cover (NC), measured with a long-stem soil thermometer. IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Type of mulch	Temperature (°C)
BP	22.70 a
NC	21.25 b
CH	20.80 b
GS	19.85 c
CV (%)	1.83

\*Means followed by the same letter do not differ from each other by the Tukey's test at 5 % probability, CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

the Delícia Americana cultivar. A different result was found by Silva (2014), who, when working with different groups of lettuce and at different planting times, found that the curly lettuce group achieved the lowest mean height values at all four planting times (summer, fall, winter, and spring).

However, the author found that the curly lettuce group produced taller plants in winter (15.85 cm) than in the other seasons studied, a value well below that found in this study, in which the mean plant height for the curly lettuce group was 26.09 cm, also grown in winter (Table 7). Lima et al. (2016), when working with different cultivars of curly lettuce, found a mean plant height of 27.25 cm for the Verônica cultivar, a value similar to that found in this study.

As observed for plant height, the Vera cultivar had the highest mean for HD: 36.18 cm, compared to 25.23 cm for the Delícia Americana cultivar (Table 7). This value is close to that found by Medeiros (2015) when evaluating the production and quality of iceberg lettuce cultivars, found a mean HD of 25.86 cm.

Regarding the number of healthy leaves (NHL), the Delícia Americana cultivar performed 26.3 % better than the Vera cultivar. The result obtained in this study was different to that found by Oliveira et al. (2016), who, when evaluating the performance of different cultivars of iceberg lettuce, found that the Delícia Americana cultivar had the lowest mean number of healthy leaves (22.57) among all cultivars, a value lower than that obtained in this study (Table 7).

The Delícia Americana cultivar was also superior to the Vera cultivar regarding stem fresh mass (SFM), with a mean mass 37.75 grams higher (Table 7).

Lima et al. (2016), when evaluating the performance of curly lettuce cultivars for the conditions of Jataí - Goiás, found that the Verônica cultivar produced the highest mean fresh stem mass, with 42.70 g plant<sup>-1</sup>, a value similar to that found in this study (Table 7). However, the authors highlighted that, in the market for “natural” products, plants with a lower stem mass

are desirable, since the stem is discarded and only the leaves are used in the preparation of meals.

Table 8 shows that the mean obtained for the black plastic mulch was not statistically different from the means obtained for the coffee husk and grass straw mulches.

According to Sala and Costa (2012), characteristics such as the height and diameter of lettuce plants are important metrics, as they provide the information needed to correctly pack these plants in transport boxes. Larger plants can be damaged in packaging and transportation processes, which reduces their commercial quality (SUINAGA et al., 2013).

For the head diameter (HD) variable, the mulch types were not significant, resulting in statistically equal means.

Regarding NHL, the lettuce plants covered with black plastic and grass straw did not differ, achieving the highest means (Table 8), with 27.40 and 24.92 leaves, respectively, a value much lower than that found by Tosta et al. (2010), who reported 42.31 leaves for lettuce grown using black plastic mulch.

The lowest NHL value was observed for the plants covered with coffee husk mulch and for those with no cover (Table 8). Different data were found by Andrade Junior and Silva (2004),

**Table 8.** Plant height (PH), head diameter (HD), number of healthy leaves (NHL), and stem fresh mass (SFM) of the plants with black plastic (BP), coffee husk (CH) and grass straw (GS) mulch types and for those with no cover (NC). IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

TYPE OF MULCH	PH (cm)	HD (cm)	NHL (n°)	SFM (g)
BP	25.52 a	31.35	27.40 a	78.47 a
CH	23.77 ab	31.66	21.94 b	59.79 b
GS	24.10 ab	29.27	24.92 ab	59.90 b
NC	22.60 b	30.54	22.41 b	57.62 b
CV (%)	7.69	10.85	13.23	14.34

\*Means followed by the same letter do not differ from each other by the Tukey's test at 5 % probability, CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

who, when analyzing the influence of mulch on the development of arugula, found that coffee husk mulch provided the best average numbers of leaves and root size for the crop. Table 8 shows that the use of black plastic mulch resulted in the highest mean stem fresh mass (SFM): 78.47 g. The plants grown with the other types of mulch did not differ from each other in this respect.

For the variables stem diameter (SD), plant fresh mass (PFM), and plant dry mass (PDM), there was an interaction between the cultivar and mulch type at the 5 % probability level. Table 9 shows that, overall, the lettuce from the Delícia Americana cultivar had a mean stem diameter (SD) higher than those from the Vera cultivar for all types of the mulch evaluated, 14.9 % higher on average.

The black plastic mulch generated the highest mean stem diameter values for the two cultivars studied (Table 9). For Delícia Americana, the two types of mulch generated the same results, differing only from the grass straw mulch, which generated the lowest mean stem diameter (SD) for the cultivar.

Regarding the Vera cultivar, Table 9 shows that, excepting the use of coffee husk mulch, the treatments were statistically equally favorable for the stem diameter variable, including the treatment with no cover.

**Table 9.** Stem diameter (SD) means for the Delícia Americana (DA) and Vera (V) cultivars, and for the black plastic (BP), coffee husk (CH) and grass straw (GS) mulches and soil with no cover (NC). IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Type of mulch	Stem diameter (STMD)	
	Delícia Americana (cm)	Vera (cm)
BP	3.42 A a	2.96 B a
CH	3.24 A ab	2.60 B b
GS	3.15 A b	2.95 B a
NC	3.25 A ab	2.88 B a
CV (%)	4.38	

\*Means followed by the same uppercase letter in the rows and lowercase letter in the columns do not differ from each other by the Tukey's test at 5 % probability; CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

For the Vera cultivar, the coffee husk mulch generated the lowest mean, diverging from the result found by Andrade Junior et al. (2005), who reported that the coffee husk mulch generated the highest mean stem diameter (2.64 cm), which was 26.9 and 38.9 % higher than the values found for the black plastic and grass straw mulches, respectively.

Table 10 shows that the plants from the Delícia Americana cultivar had the highest means for commercial fresh mass (CFM), for all the mulch types evaluated. The black plastic mulch provided the highest mean fresh mass for plants from both cultivars, but unlike those from Delícia Americana, the plants from the Vera cultivar showed no statistically significant differences when grown with the distinct mulch types.

Tosta et al. (2010), when analyzing different types of mulch for lettuce cultivation in the soil conditions of Cassilândia – Mato Grosso do Sul, observed that the black plastic mulch provided the highest yield (42.31 t ha<sup>-1</sup>), similar to this study, in which the black plastic mulch provided the highest fresh mass values for both cultivars (Table 10).

Similarly, Verdial et al. (2001), when using different types of mulch on iceberg lettuce, observed significant increases in total fresh mass, especially when using the black plastic mulch, which generated the highest yields.

**Table 10.** Commercial fresh mass (CFM) means for the Delícia Americana (DA) and Vera (V) cultivars, and for the black plastic (BP), coffee husk (CH) and grass straw (GS) mulches and soil with no cover (NC). IFSULDEMINAS - Inconfidentes Campus, Inconfidentes - MG, Brazil, 2023.

Type of mulch	Commercial fresh mass (CFM)	
	Delícia Americana (g)	Vera (g)
BP	1011.07 A a	533.33 B a
CH	782.91 A b	441.86 B a
GS	779.79 A b	499.16 B a
NC	733.54 A b	426.54 B a
CV (%)	10.61	

\*Means followed by the same uppercase letter in the rows and lowercase letter in the columns do not differ from each other by the Tukey's test at 5 % probability; CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

According to Souza and Resende (2003), this is due to the fact that plastic mulch reduces the loss of nitrogen in the soil via leaching and volatilization, thus increasing its availability to plants.

These results differ from those obtained by Silva et al. (2004) with plants from the Vitoria de Verão and Grand Rapids cultivars, for which they found no differences in fresh mass when using coffee husks, grass straw, and sugarcane bagasse mulches and the control. The other types of mulch evaluated generated the same results (Table 10) for the Delícia Americana cultivar.

The variable dry mass (DM) also showed an interaction between the factors cultivar and type of mulch at the 5 % probability level (Table 11).

As can be seen in Table 11, the Delícia Americana cultivar yielded the highest means for all the types of mulch evaluated. However, the black plastic and coffee husk mulches and the uncovered soil did not differ. The lowest dry mass (DM) mean was that found for the grass straw mulch (247.86 grams). The plants from the Vera cultivar, on the other hand, had no statistically significant differences linked to the distinct mulch types used.

Silva (2014), when evaluating the dry mass of lettuce groups grown in the four planting seasons, found that iceberg lettuce had higher mean dry mass values in the fall, spring and winter, similar to what was found in this study, which was also

**Table 11.** Mean dry mass (DM) for the Delícia Americana (DA) and Vera (V) cultivars, and for the black plastic (BP), coffee husk (CH) and grass straw (GS) mulches and soil with no cover (NC). IFSULDEMINAS – Inconfidentes Campus, Inconfidentes – MG, Brazil, 2023.

Type of mulch	Dry mass (DM)	
	Delícia Americana (g)	Vera (g)
BP	337.83 A a	171.08 B a
CH	348.82 A a	133.17 B a
GS	247.86 A b	164.17 B a
NC	265.21 A ab	140.96 B a
CV (%)	19.51	

\*Means followed by the same uppercase letter in the rows and lowercase letter in the columns do not differ from each other by the Tukey's test at 5 % probability; CV%=coefficient of variation.

**Source:** Prepared by the author (2023).

carried out during the winter and found that iceberg lettuce had the highest mean dry mass values.

For the Delícia Americana cultivar, the coffee husk and black plastic mulches had the best responses for the dry mass variable (Table 11). This, in turn, was the highest mean found for the coffee husk mulch, a result confirmed by the work of Andrade Junior et al. (2005), who observed that the coffee husk mulch outperformed the others (those with rice husks, dry tanner-grass, black plastic and the soil with no cover) for all the variables studied, including dry mass.

Farias et al. (2017), when evaluating the performance of lettuce subjected to different colors of polyethylene plastic, found that the black color provided the greatest dry mass. However, for the variables fresh mass of the aerial part and number of healthy leaves, the black polyethylene had the worst performance among the polyethylene colors studied. The black and white plastic mulches contributed to the best performance of the Babá de Verão cultivar.

## Conclusion

It is concluded that the black plastic mulch provided the best weed suppression and the highest soil temperature for both cultivars. The grass straw mulch provided the lowest soil temperature.

The Delícia Americana cultivar and the black plastic mulch provided the best growing conditions for the crop, with the best means for the variables studied.

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