

Performance of crispy lettuce cultivars in different soil covers

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Abstract

The lettuce cropping is an important segment of the national agriculture, with strong economic expression. However, climatic factors such as high temperature and humidity can affect this vegetable cultivation. These environmental conditions are common in various Brazilian regions, so the growers should adopt crop management systems, as soil covers, to minimize the environmental effect and obtain higher returns. Thus, the aim of this study was to evaluate the influence of different soil covers on the agronomic performance of crispy lettuce cultivars. The study was conducted at UNESP, Registro Campus, Brazil, from August to October, 2013. The experiment was carried out in a randomized blocks design, arranged in a 4x4 factorial, with three repetitions. The treatments consisted of the factors soil covers (black mulching, silver mulching, white mulching and control) and cultivars (Inaiá, Milena, Vanda and Vera). The experimental unit consisted of fifteen plants, with the useful area composed of nine central plants. At harvest, the following characteristics were evaluated: plant height, head diameter, fresh mass, number of leaves, leaf width, leaf height, stem diameter, heart diameter, heart height, dry mass, yield and nitrate content. Among the studied covers, white mulching showed the best results for the main productive characteristics and can be used as soil cover in the cultivation of Vera, Vanda and Inaiá cultivars.

Keywords: *Lactuca sativa*, mulching, yield

Introduction

Lettuce (*Lactuca sativa* L.) is the leafy vegetable with high expression in the national economic scenario, being grown and consumed throughout the country (Tosta et al., 2010; Carvalho & Sabbag, 2015). In 2014, the lettuce commercialization moved an amount of R\$ 8 billion only in retail, and its production represented 1.5 million tons (FAEMG, 2015). In São Paulo, the largest national lettuce producer, the sales volume in 2014 was 49,648 tons, being the crispy lettuce responsible for the production of 22,123 tons, representing 44% of the total volume produced in the state (AGRIANUAL, 2016).

In the Ribeira Valley, the cropping of

this vegetable is incipient when compared to other locations in the São Paulo State. The high temperature and humidity of this region alter the physiology of development and increase the diseases incidence in the crop; therefore, the full expression of the genetic potential of cultivars is not achieved. Thus, growers should adopt farming systems that can minimize the effect of temperature, aiming higher returns.

In lettuce production, there are several techniques used to increase yield and improve the product quality, as well as reducing the environmental effects on cropping. Among these techniques, the use of soil covers is highlighted (Oliveira et al., 2008; Tosta et al., 2010).

Received: 06 April 2016
Accepted: 22 March 2017

The soil covering, mulch or mulching, has the objective to form a soil surface protection, ie to develop a physical barrier, providing a more suitable environment for the crop. Mulching materials can be permeable or impermeable, and organic-originated (crop residues, bark, bagasse, etc.) (Rodrigues et al., 2009) or from synthetic and industrial products (polyester and plastics) (Ferreira et al., 2009).

The soil cover with plastic practice provides several advantages to the crop and the environment, such as the decreases in soil compaction and erosion, improve leaves quality and weed control (Silva et al., 2009; Olinik et al., 2011).

In regions with high temperatures, the soil cover provides the reduction of thermal soil amplitude, factor that limits the cultivation of the main leafy vegetables (Castoldi et al., 2008) and promotes the decrease of water consumption and evaporation (Mulumba & Lal, 2008; Mota et al., 2010).

In the cropping of different lettuce cultivars, some research indicates that the use of soil cover with plastic mulching promotes higher income, when compared to other soil cover techniques (Mógor & Câmara, 2007, Branco et al., 2010; Ferreira et al., 2014).

Verdial et al., (2001) reports that in addition to the productive factors, the use of plastic coverage in high temperature regions provides greater accumulation of nutrients in soil due to reduced leaching. According to the cited authors, the use of the plastic cover can help the nitrification process, so the nitrogen can be more available, occurring largest nitrate accumulation by the plant.

The identification of cultivars that best fits in different growing conditions, combined with an efficient soil cover, may be an alternative for sustainably cropping of crispy lettuce. Thus, the aim of this study was to evaluate the influence of soil covering on the agronomic performance of crispy lettuce cultivars.

Material and Methods

The experiment was conducted under field conditions in the Vegetables Sector of the São Paulo State University, Registro Campus, from

August to October, 2013. The climate is classified as Af, according to Köppen classification. The average temperature during the experiment was 26.5°C.

The experiment was carried out in a randomized blocks design, arranged in a 4x4 factorial with three repetitions. The treatments were composed by the factors soil covers (black mulching, silver mulching, white mulching and control) and cultivars (Inaiá, Milena, Vanda and Vera). The experimental plot consisted of an area with 1.5 m in length and 1.0 m in width, totaling 1.5 m². The experimental unit consisted of fifteen plants, with a useful area with nine central plants, not considering the first and last three plants.

The soil chemical analysis of the 0-20cm layer presented the following characteristics: pH = 5.4; Q = 4.0 mg dm⁻³; K = 0.40 mmol dm⁻³; Ca = 14.0 mmol dm⁻³; Mg = 10 mmol dm⁻³; Al = 0 mmol dm⁻³; H + Al = 18.0 mmol dm⁻³; SB = 25 mmol dm⁻³; T = 43 mmol dm⁻³; V = 58% and O.M. = 15.0 g kg⁻¹. The soil liming was performed three months before the seedlings transplant to increase the bases saturation to 80% (Trani et al., 1997).

The seedlings were grown in a protected environment, in polypropylene trays with 200 cells with trapezoidal root guide, filled with Plantmax HT® commercial substrate, placing a pelleted seed per cell.

The transplant was carried out 30 days after sowing, when the seedlings presented three to four leaves and root system sufficiently developed, in plant spacing of 0.30 x 0.30 m.

The beds were prepared using a rotary hoe of 1 m wide, coupled to a tractor. The fertilizers used in the experiment were incorporated during beds preparation, following the crop recommendation (Trani et al., 1997). Drip tapes were used, being distributed three lines of tape per bed. The mulch was setted up according to the treatments arrangement.

The irrigation was daily performed, increasing the water content in the soil to field capacity throughout the crop cycle.

For the control treatment, weed management was performed manually during the production cycle. For the covered soil, no weed control was necessary. During the cycle, there was no incidence of pests and diseases, not

making necessary the use of methods of control.

At 29 days after transplantation, when the plants reached their maximum vegetative development, plants were harvested and the following agronomic characteristics were evaluated:

- Plant height: data obtained in the field before harvest, with a graduated ruler (cm);
- Head diameter: data obtained in the field before harvest, with a graduated ruler (cm);
- Fresh mass: obtained on a digital scale (g);
- Number of leaves: obtained by counting the leaves with a minimum of 3 cm high;
- Width of the diagnostic leaf: the eighth leaf was set as diagnostic leaf and the width was measured with a ruler (cm);
- Height of the diagnostic leaf: the eighth leaf was set as diagnostic leaf and the height was measured with a ruler (cm);
- Stem diameter: obtained using a digital pachymeter (mm), after cutting the plant;
- Heart diameter: obtained using a pachymeter (mm) after total defoliation of the plant;
- Heart height: obtained after total defoliation of the plant, using a ruler (cm);
- Dry mass: obtained by the arithmetic mean of three plants (plant 1, plant 5 and plant 9) placed in an oven at 65°C until constant weight, and weighed using a digital scale (g);
- Yield (kg ha⁻¹), calculated by multiplying the fresh mass by the number of plants per hectare. It was considered one hectare the production of 70% of the area, due to the spacing between beds and lines.
- Nitrate content in the plant leaves (mg kg⁻¹ of N-NO³⁻), measured using a portable ion meter, Cardy Nitrate (Horiba). The nitrate evaluations were performed using expanded leaves of the plant.

The average data for each measured characteristic were submitted to analysis of variance by the F test and means were compared by Tukey test at 5% of probability, using the SISVAR Software (Ferreira, 2011).

Results and Discussion

From the obtained results, significant effects were shown ($p < 0.01$) for the interaction between the factors type of soil coverage x cultivar, for the characteristics number of leaves, diameter and height of the head, fresh mass, yield and nitrate content (Table 2). For other characteristics, as there was no interaction between factors, the results will be individually presented and discussed (Table 1).

For the heart height and stem diameter, it was not observed differences among lettuce cultivars, averaging 3.99 and 9.42 mm, respectively. Regarding the soil cover factor, white mulching was superior to black mulching, not differing from silver mulching and control. Thus, it was observed heart height 45% higher in white mulching, when compared to the black mulching, which showed the least effect on the evaluated characteristics.

According to Yuri et al. (2004), the heart height is an important variable to lettuce, due to its direct relation to the fresh material yield. However, high heart height can characterize bolting in locations with excessive heat, being an important characteristic that should be taken into consideration in the cultivar choice (Ferreira et al., 2009).

For the variables heart diameter and leaves height, no significant differences were observed (Table 1).

The plant dry mass was not influenced by the cultivar, with an average of 9.41 g. Regarding soil cover, plants grown under white mulching presented the best performance, 61.04% higher than silver mulching.

Regarding the characteristic leaves width, the cultivar 'Milena' presented the best performance, with an average of 17.96 cm, not differing significantly from Vanda and Inaiá cultivars. This can be explained by the intrinsic characteristics of the genotypes, having Milena and Vanda varieties wider leaves compared to other cultivars. With respect to soil cover, no influence was observed for the leaves width, with an average of 15.51 cm.

For the average number of leaves per plant (Table 2), it was found that coverage with white mulching resulted in highest values for the

Table 1. Average values of heart height (mm), heart diameter (mm), stem diameter (mm), leaves dry mass (g), leaves width (cm) and leaves height (cm) according to lettuce cultivars and soil cover.

Factors Cultivar (C)	Heart height	Heart diameter	Stem diameter	Leaves dry mass	Leaves width	Leaves height
Milena	3.110 a	18.158 a	15.625 a	7.209 a	17.96 a	14.50 a
Vera	3.908 a	17.600 a	13.507 a	9.733 a	13.22 c	13.16 a
Inaiá	4.040 a	18.206 a	14.790 a	10.272 a	14.48 bc	14.40 a
Vanda	4.723 a	22.040 a	12.833 a	10.505 a	16.77 ab	15.72 a
Fc:	2.338 ^{ns}	2.237 ^{ns}	2.887 ^{ns}	2.358 ^{ns}	7.240**	2.085 ^{ns}
Soil cover (CS)						
Black mulch	3.415 b	17.645 a	12.873 b	8.066 b	15.34 a	14.18 a
White mulch	4.952 a	20.875 a	15.889 a	12.99 a	15.69 a	14.71 a
Silver mulch	4.000 ab	18.806 a	13.910 ab	8.018 b	15.80 a	14.31 a
Control	3.615 ab	18.678 a	14.083 ab	8.845 b	15.61 a	14.57 a
Fc:	3.241*	0.981 ^{ns}	2.878 ^{ns}	5.407**	0.060 ^{ns}	0.112 ^{ns}
C x CS						
Fc:	1.102 ^{ns}	0.965 ^{ns}	0.763 ^{ns}	1.035 ^{ns}	0.925 ^{ns}	0.792 ^{ns}
CV (%):	32.85	24.92	18.03	37.25	17.71	17.34

**Significant at 1% by F test; *Significant at 5% by F test; ^{ns} not significant; Means followed by the same letter in the column, within each factor, do not differ statistically by Tukey's test at 5% of probability.

cultivar Inaiá, not differing from silver mulching and control. There was a difference of 35.65% between the highest and lowest value. Unlike other types of coverage, white mulching did not significantly influenced the cultivars performance.

Blind & Silva Filho (2015) reported that plants with larger leaves amounts provide greater biomass accumulation, being the largest and most desirable for sale. This statement corresponds to the results of the present study. The cultivars Inaiá, Vanda and Vera obtained the highest number of leaves, also showing superiority for fresh mass and yield, when grown in white mulching.

The cultivar Milena presented the best average for the number of leaves, despite the soil cover, with steady performance. Thus, it can be inferred that this cultivar is more adaptable to changes in soil temperature.

It was found that the silver mulching showed no significant difference for plant diameter and height, with 28.29 and 15.20 cm, respectively (Table 2). The Milena and Inaiá cultivars presented the lowest performance for plant height in black mulching. Monteiro Neto et al. (2014) also obtained lower results for plant height evaluating cultivar Veronica crispy lettuce grown in black mulching.

In white mulching, 'Milena' presented the lowest plant diameter (19.45 cm). However, the treatments black mulching, silver mulching

and control, showed no significant differences between the cultivar for the evaluated variable. The Vera and Inaiá cultivars were not influenced by the types of soil cover, with steady performance.

Regarding the fresh mass, in white mulching 'Milena' had the lowest average with 137.70 g, unlike the other cultivars that obtained average of 225.09 g. The values obtained in this experiment ranged from 129.02 to 240.34 g, these data are corroborated by Ferreira et al. (2009), which harvested lettuce plants with fresh mass ranging from 137.94 to 177.53 g in different types of soil cover. Mógor & Câmara (2007) observed higher values, averaging 256.87 g for the cultivar Veronica.

For yield, white mulching obtained the highest values for the cultivars Vera, Vanda and Inaiá. Ferreira et al. (2014) presented data on which 'Vera' in soil cover with double face polyethylene film white/black, increased the shoot fresh mass and marketable yield.

Regarding the black mulching, 'Inaiá' showed the lowest yield, 10.03 t ha⁻¹, however, when it was grown in silver mulching, this cultivar obtained a better result with an average of 18.69 t ha⁻¹, ie there was a variation of 86.34% according to soil cover.

The difference in yield due to the type of plastic cover may be related to soil and air temperature. Soils covered with black mulching

shows higher temperatures when compared to silver and white mulching. According to Ferreira et al. (2014), in lettuce cropping under high temperature condition, the photosystem efficiency is reduced, causing photoinhibition and yield reduction.

For the variable nitrate content, there was a significant interaction between the factors soil cover and cultivars, where the control obtained

the highest nitrate concentration values for Inaiá and Milena cultivars, 2100.00 mg kg⁻¹. While silver mulching silver, obtained the lowest average values, 1333.33 mg kg⁻¹, between the soil cover factors, except for the cultivar Inaiá. Cavarianni et al. (2000), also evaluating lettuce cultivars, observed values (mg kg⁻¹ of N-NO³⁻ of dry mass) of 1545 to 1963 to iceberg lettuce, 1242 to 1536 for crispy and 1030 to 1965 for iceberg lettuce.

Table 2. Interaction between the soil cover and lettuce cultivars for the average number of leaves, average head diameter (cm), average plant height (cm), fresh mass (g), estimated yield (t ha⁻¹) and average nitrate content (mg kg⁻¹).

Cultivar	Soil cover			
	Black mulching	White mulching	Silver mulching	Control
Average number of leaves				
Inaiá	18.66 bB	32.44 aA	29.48 aA	27.03 aA
Milena	24.66 aA	28.00 aA	25.66 abA	28.63 aA
Vanda	24.18 abB	31.00 aA	26.96 aAB	25.52 abAB
Vera	20.92 abB	28.48 aA	20.40 bB	20.22 bB
CV (%) = 10.05 F = 3.202**				
Average head diameter				
Inaiá	25.61 aA	26.76 aA	28.36 aA	27.18 aA
Milena	24.23 aA	19.45 bB	27.97 aA	27.87 aA
Vanda	27.02 aAB	28.58 aAB	30.20 aA	25.99 aB
Vera	25.92 aA	29.24 aA	26.64 aA	25.81 aA
CV (%) = 6.88 F _c = 5.337**				
Average plant height				
Inaiá	10.91 bB	14.07 abAB	14.41 aA	14.56 aA
Milena	9.78 bB	11.88 bB	15.15 aA	15.58 aA
Vanda	14.21 aA	15.14 aA	16.11 aA	15.78 aA
Vera	15.28 aA	16.40 aA	15.15 aA	13.74 aA
CV (%) = 10.22 F _c = 3.2**				
Fresh mass				
Inaiá	129.02 bB	219.30 aA	240.34 aA	185.40 aAB
Milena	148.90 abB	137.70 bB	218.40 aA	172.00 aAB
Vanda	169.59 abAB	223.93 aA	193.55 abAB	145.95 aB
Vera	204.43 aAB	232.06 aA	143.73 bB	164.53 aB
CV (%) = 15.20 F _c = 5.884**				
Estimated yield				
Inaiá	10.03 bB	17.05 aA	18.69 aA	14.42 aAB
Milena	11.58 abB	10.71 bB	16.98 aA	13.37 aAB
Vanda	13.19 abAB	17.41 aA	15.05 abAB	11.35 aB
Vera	15.90 aAB	18.04 aA	11.17 bB	12.79 aB
CV (%) = 15.20 F _c = 5.884**				
Average nitrate content				
Inaiá	2000.00 aAB	1666.66 bC	1700.00 aBC	2100.00 aA
Milena	1533.33 bB	2000.00 aA	1333.33 bB	2100.00 aA
Vanda	1466.66 bAB	1500.00 bAB	1333.33 bB	1700.00 bA
Vera	1966.66 aA	2000.00 aA	1700.00 aA	1866.66 abA
CV (%) = 7.79 F _c = 5.355**				

**Significant at 1% by F test; Means followed by the same letter in the column and uppercase letter in lines are not statistically different according to Tukey's test at 5% of probability.

'Vanda' showed the lowest average compared to other cultivars in different plastic covers and control. This fact may be related to the capacity of plants to accumulate nitrate, as well as the influence of the genetic character of the cultivar. Blom-Zandstra (1986) state that with highest incidence of solar radiation there is less nitrate accumulation in the leaves. Thus, in cultivars with more open leaves and head (as Vanda), due to its architecture, the leaves can absorb higher amounts of solar radiation.

The high nitrate content in lettuce leaves can cause serious damage to health and may be potentially carcinogenic (Turazi et al., 2006; Silva et al., 2011). Due to the risks, there are standards regulating the nitrate concentration in leafy species (Ohse et al., 2009). The European Community states that the nitrate content should be below 3000 mg of N-NO₃ kg⁻¹ of dry mass (McCall & Willumsen, 1998). In general, the average levels of nitrate found in this study for cultivars Inaiá (1866.50 mg of N-NO₃ kg⁻¹), Milena (1741.66 mg of N-NO₃ kg⁻¹), Vanda (1499.99 mg of N-NO₃ kg⁻¹) and Vera (1883.33 mg of N-NO₃ kg⁻¹) are below the limit.

Conclusions

Considering the soil and climate conditions in which the study was conducted, it is concluded that to maximize the production of lettuce, the cultivars Vera, Vanda or Inaiá over white mulching should be used.

References

- AGRIANUAL 2016. Anuário Estatístico da Agricultura Brasileira. FNP Consultoria e Comércio, São Paulo, Brasil. 472 p.
- Blind, A.D., Silva Filho, D.F. 2015. Desempenho de cultivares de alface americana cultivadas com e sem mulching em período chuvoso da Amazônia. *Revista Agroambiente Online* 9:143-151.
- Blom-Zandstra, M., Eenink, A.H. 1986. Nitrate concentration and reduction in different genotypes of lettuce. *Journal of the American Society for Horticultural Science* 111: 908-911.
- Branco, R.B.F., Santos, L.G.C., Goto, R., ISHIMURA, I., Schlickmann, S., Chiarati, C.S. 2010. Cultivo orgânico sequencial de hortaliças com dois sistemas de irrigação e duas coberturas de solo. *Horticultura Brasileira* 28: 75-80.
- Carvalho, J.B., Sabbag, O.J. 2015. Análise de eficiência da produção de alface no noroeste de São Paulo. *Revista Agroambiente Online* 9: 152-160.
- Castoldi, R., Charlo, H.C.O., Ito, L.A., BRAZ, L.T. 2008. Effect of plastic film mulch on the production of butterhead lettuce cultivars under protected cultivation. *Acta Horticulturae* 767: 125-128.
- Cavarianni, R.L., Cazetta, J.O., May, A., Barbosa, J.C., Cecilio Filho, A.B. 2000. Acúmulo de nitrato em cultivares de alface, cultivadas na primavera, em função do ambiente de cultivo. *Horticultura Brasileira* 18: 324-325.
- FAEMG - Federação da Agricultura e Pecuária do Estado de Minas Gerais. 2016. Alface é a folhosa mais consumida no Brasil. Disponível em: <<http://www.faemg.org.br/Noticia.aspx?Code=8021&ParentCode=139&ParentPath=None&ContentVersion=R>>. Access in: 26 Jan. 2016
- Ferreira, R.L.F., Araújo Neto, S.E., Silva, S.S., Abud, E.A., Rezende, M.I.F.L., Kusdra, J.F. 2009. Combinações entre cultivares, ambientes, preparo e cobertura do solo em características agrônômicas de alface. *Horticultura Brasileira* 27: 383-388.
- Ferreira, D.F. 2011. Sisvar: a computer statistical analysis sistem. *Ciência e Agrotecnologia* 35: 1039-1042.
- Ferreira, R.L.F., Alves, A.S.S., Araújo Neto, S.E., Kusdra, J.F., Rezende, M.I.F.L. 2014. Produção orgânica de alface em diferentes épocas de cultivo e sistemas de preparo e cobertura de solo. *Bioscience Journal* 30: 1017-1023.
- McCall, D., Willumsen, J. 1998. Effects of nitrate, ammonium and chloride application on the yield and nitrate content of soil-grown lettuce. *Journal of Horticultural Science & Biotechnology* 37: 698-703.
- Mógor, A.F., Câmara, F.L.A. 2007. Produção de alface no sistema orgânico em sucessão a aveia preta, sobre palha e diferentes tipos de cobertura do solo. *Scientia Agraria* 8: 239-245.
- Monteiro Neto, J.L.L., Silva, A.C.D., Sakazaki, R.T., Trassato, L.B., Araújo, W.F. 2014. Tipos de coberturas de solo no cultivo de alface (*Lactuca sativa* L.) sob as condições climáticas de Boa Vista, Roraima. *Boletim do Museu Integrado de Roraima* 8: 47-52.
- Mota, J.C.A., Libardi, P.L., Brito, A.S., Assis Júnior, R.N., Amaro Filho, J. 2010. Armazenagem de água e produtividade de meloeiro irrigado por gotejamento, com a superfície do solo coberta e desnuda. *Revista Brasileira de Ciência do Solo* 34: 1721-1731.

Mulumba, L.N., Lal, R. 2008. Mulching effects on selected soil physical properties. *Soil & Tillage Research* 98: 106-111. 28: 284-288.

Olinik, J.R., Oliveira Júnior, A., Kepp, M.A., Reghin, M.Y. 2011. Produtividade de híbridos de abobrinha italiana cultivados sob diferentes coberturas de solo. *Horticultura Brasileira* 29: 130-134.

Oliveira, F.F., Guerra, J.G.M., Almeida, D.L., Ribeiro, R.L.D., Espindola, J.A.A., Ricci, M.S.F., Ceddía, M.B. 2008. Avaliação de coberturas mortas em cultura de alface sob manejo orgânico. *Horticultura Brasileira* 26: 216-220.

Ohse, S., Ramos, D.M.R., Carvalho, S.M., Fett, R., Oliveira, J.L.B. 2009. Composição centesimal e teor de nitrato em cinco cultivares de alface produzidas sob cultivo hidropônico. *Bragantia* 68: 407-414.

Rodrigues, D.S., Nomura, E.S., Garcia, V.A. 2009. Coberturas de solo afetando a produção de alface em sistema orgânico. *Revista Ceres* 56: 332-335.

Silva, A.C., Hirata, E.K., Monquero, P.A. 2009. Produção de palha e supressão de plantas daninhas por plantas de cobertura, no plantio direto do tomateiro. *Pesquisa Agropecuária Brasileira* 44: 22-28.

Silva, E.M.N.C.P., Ferreira, R.L.F., Araújo Neto, S.E., Tavella, L.B., Solino, A.J.S. 2011. Qualidade de alface crespa cultivada em sistema orgânico, convencional e hidropônico. *Horticultura Brasileira* 29: 242-245.

Tosta, P.A.F., Mendonça, V., Tosta, M.S., Machado, J.R., Tosta, J.S., Medeiros, L.F. 2010. Utilização de coberturas de solo no cultivo de alface 'Babá de Verão' em Cassilândia (MS). *Revista Brasileira de Ciências Agrárias* 5: 85-89.

Trani, P. E., Raij, B. 1997. Hortaliças. In: Recomendações de adubação e calagem para o Estado de São Paulo. 2.ed.rev.atual. Instituto Agrônomo/Fundação IA, Campinas, Brasil. p.157-185.

Turazi, C.M.V., Junqueira, A.M.R., Oliveira, S.A., Borgo, L.A. 2006. Acúmulo de nitrato em alface em função da adubação, horário de colheita e tempo de armazenamento. *Horticultura Brasileira* 24: 65-70.

Verdial, M.F., Lima, M.S., Morgor, A.F., Goto, R. 2001. Production of iceberg lettuce using mulches. *Scientia Agricola* 58: 737-740.

Yuri, J.E., Mota, J.H., Resende, G.M., Souza, R.J., Júnior, J.C.R. 2004. Desempenho de cultivares de alface tipo americana em cultivo de outono no sul de Minas Gerais. *Ciência e Agrotecnologia*