Research, Society and Development, v. 9, n. 11, e1869119729, 2020
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v9i11.9729

Soil mulch in control of soil temperature and incidence of weeds in the production of crisphead lettuce

Cobertura morta no controle da temperatura do solo e na incidência de plantas daninhas na produção de alface americana

Mantillo para controlar la temperatura del suelo y la incidencia de malezas en la producción de lechuga

Received: 10/28/2020 | Reviewed: 11/02/2020 | Accept: 11/06/2020 | Published: 11/11/2020

Deisy Lúcia Cardoso
ORCID: https://orcid.org/0000-0003-1982-3413
Universidade Estadual de Mato Grosso do Sul, Brasil
E-mail: deisycardoso@uems.br
Denise Renata Pedrinho
ORCID: https://orcid.org/0000-0002-8522-6126
Universidade Anhanguera, Brasil
E-mail: denise.pedrinho@uniderp.com.br
Giselle Feliciani Barbosa
ORCID: https://orcid.org/0000-0001-5456-1039
Universidade Estadual de Mato Grosso do Sul, Brasil
E-mail: giselle.barbosa@uems.br
Wolff Camargo Marques Filho
ORCID: https://orcid.org/0000-0001-6407-1375
Instituto Federal de Educação, Ciência e Tecnologia Goianos, Brasil
E-mail: wolff.filho@ifgoiano.edu.br
José Antônio Maior Bono
ORCID: https://orcid.org/0000-0002-9573-9494
Universidade Anhanguera, Brasil
E-mail: bono@anhanguera.com
José Francisco Assis Rolim[1]
ORCID: https://orcid.org/0000-0002-8306-176X
Universidade Anhanguera, Brasil
E-mail: assisrolimp@gmail.com

[1] †In Memoriam

Abstract

It was evaluated the effects of different types of mulching of soil in the cultivation of crisphead lettuce (*Lactuca sativa* L.), cultivar "Lucy Brown", in the spring period, on weed control, soil temperature and productivity. The experiment was arranged in a randomized block design with four treatments and five replications in plots of 14.0m^2. The following coverages were studied: *Pennisetum glaucum* L., *Avena strigosa*, *Brachiaria ruziziensis*, plus the control treatment (soil without mulching). The use of mulching of soil, *P. glaucum* and *B. ruziziensis*, proved to be a beneficial practice, reducing the soil temperature by up to 5ºC. There was a lower incidence of weeds with the use of the *P. glaucum* and *A. strigosa* coverages. The use of mulch did not provide a significant gain in productivity, however, there was a gain regarding the quality of the product, since the coverage with *P. glaucum* provided an increase in the size of the head (fresh mass of the commercial head).

Keywords: *Lactuca sativa* L.; Straw; Productivity.

Resumo

Avaliaram-se os efeitos de diferentes tipos de cobertura morta de solo no cultivo da alface (*Lactuca sativa* L.) americana, cultivar "Lucy Brown", sobre o controle de plantas daninhas, a temperatura do solo e a produtividade. O delineamento experimental utilizado foi o de blocos casualizados, com quatro tratamentos e cinco repetições em parcelas de 14,0m^2. Estudaram-se as seguintes coberturas: milheto (*Pennisetum glaucum* L.), aveia preta (*Avena strigosa*), ruziziensis (*Brachiaria ruziziensis*), mais o tratamento controle (solo sem cobertura morta). A utilização da cobertura morta de solo, milheto e ruziziensis, mostrou-se como uma prática vantajosa, reduzindo a temperatura em até 5ºC. Houve menor incidência de plantas daninhas com o uso das coberturas milheto e aveia. O uso de cobertura morta não proporcionou um ganho significativo na produtividade, no entanto, houve ganho quanto a qualidade do produto, visto que a cobertura com milheto proporcionou um aumento no tamanho da cabeça (massa fresca da cabeça comercial).

Palavras-chave: *Lactuca sativa* L.; Palhada; Produtividade.

Resumen

Se evaluaron los efectos de diferentes tipos de mantillo de suelo sobre el cultivo de lechuga americana (*Lactuca sativa* L.), cultivar "Lucy Brown", sobre el control de malezas, temperatura del suelo y productividad. El diseño experimental utilizado fue de bloques al azar, con cuatro tratamientos y cinco repeticiones en parcelas de 14.0 m^2. Se estudiaron las

siguientes coberturas: mijo (*Pennisetum glaucum* L.), avena negra (*Avena strigosa*), ruziziensis (*Brachiaria ruziziensis*), más el tratamiento testigo (suelo sin mantillo). El uso de mantillo de tierra, mijo y ruziziensis, resultó ser una práctica ventajosa, reduciendo la temperatura hasta en 5ºC. Hubo una menor incidencia de malezas con el uso de cobertura de mijo y avena. El uso de mantillo no proporcionó una ganancia significativa en la productividad, sin embargo, hubo una ganancia en términos de calidad del producto, ya que la cobertura de mijo proporcionó un aumento en el tamaño de la cabeza (masa fresca de la cabeza comercial).

Palabras clave: *Lactuca sativa* L.; Paja; Productividad.

1. Introduction

The lettuce (*Lactuca sativa* L.) is a leafy vegetable of mild climate that belongs to the family Asteracea. It is one of the most important vegetables grown in the world and in Brazil, certainly one of the most popular and consumed, being an important source of minerals, mainly calcium and vitamins (Filgueira, 2013).

It is estimated that the area planted of vegetables in Brazil is 5,1 million hectares, having as production the value of R$ 36 billion, and the volume, more than 53 million of tons (Anuário, 2019).

Brazil has an area of approximately 39,000 hectares for intensive production of lettuce, through cultivation in small areas and by small producers with family farming (up to 10 hectares) concentrated close to major centers and contributing to the generation of employment and income (Heredia Zárate et al., 2010; Vilela & Luengo, 2017)

In Brazil, the lettuce marketed can be classified into six groups according to the type of leaf lettuce: butterhead lettuce; crisphead lettuce (American); loose-leaf lettuce; green-leaf lettuce; mimosa lettuce and romaine lettuce (Filgueira, 2013). Among the types of lettuce grown today, the type iceberb has been highlighted, aiming at fulfilling mainly the fast foods chains.

The temperature and photoperiod are the main factors that interfere with the cultivation of lettuce, directly affecting their development. High temperatures affect the texture of the lettuce leaves, making them more fibrous, cause the burning of edges of the outer leaves, affecting the proper formation of head (Filgueira, 2013). High temperatures also stimulate the tasseling, which is intensified to the extent that the same increases (Luz et al., 2009).

To mitigate the effect of high temperatures on cultivations, in recent decades, new cultivation techniques have been used, such as the use of soil cover. The mulching induces less loss of water through evaporation and reduction of the oscillations of temperature, soil, it is used commonly for the lettuce cultivation, providing a microclimate that is more favorable to the development of the cultivation, so it has the capacity to express better their genetic potential (Kosterna et al., 2014).

The advantages presented by this system are: Improvement of the soil structure, increase of the infiltration and soil water retention, improvement on the root system of the invasive plants control, keeping the soil temperature milder (Gilley et al., 1990; Derpsch et al., 1991; Marouelli et al., 2008).

However, the high temperatures are still one of the main problems faced by producers of lettuce in the State of Mato Grosso do Sul. High temperatures during most of the year are marked characteristics of the climate of the region and interfere and affect the production of the cultivation. Considering that use of stubble straw can soften the soil temperature, the objective of this work was to evaluate the effects of the use of plants mulching on the incidence of weeds and soil temperature in the cultivation of crisphead lettuce, cultivar "Lucy Brown", in Campo Grande - MS during the spring, as well as the effects of this system of cultivation on the productivity and the quality of the lettuce.

2. Material and Methods

The study was carried out between May and November of 2014 in the experimental area at the Anhanguera Uniderp University in Campo Grande – MS (20°26'16.62"S, 54°32'16.07"W). The climate of the region, according to the Köppen (1948) classification system, is Aw, humid tropical climate with the rainy season in the summer and dry in winter. Average annual climatic variables are: rainfall 1500mm and temperature 26°C (Brasil, 1992).

The coverages were through solid seeding, being used the following cultivation densities: 80kg.ha^{-1} of *A. strigosa*, 20 seeds.m^{-1} of *P. glaucum* and 16kg.ha^{-1} *B. ruziziensis*, as recommended by Embrapa (2006).

At 91 days after seeding (DAS), evaluations were conducted on the fresh mass of the coverages, using a square frame of iron of 50cm/side placed in the center of each experimental plot, where it was cut the fresh mass in the area bounded by the square, weighed on precision scale, and, after drying in oven to 60 - 70°C until constant mass, it was measured the dry mass; and the values were extrapolated to kg.ha^{-1}.

The evaluation of weeds infestation was performed immediately before the chemical desiccation of the experimental area, which was performed at 92 DAS, with application of glyphosate in the dose of 1.44kg of a.i..ha^{-1}. It was used the method of visual evaluation according to methodology of Research Method in Weed Science (1997): 100 (full control), 90 - 99 (excellent control), 80 - 89 (acceptable control), 50 - 79 (not acceptable control), 0 - 49 (insufficient control to no effect).

The seedlings of lettuce cultivar "Lucy Brown", were produced in a greenhouse, transplanting was done manually 30 DAS, on the desiccated plants, with a spacing of 0.30 m between rows and between plants. The corrective and coverage fertilizations were performed based on the soil analysis of the area and following the recommendations of Ribeiro et al. (1999). The water supply was performed daily by means of a system of sprinkler irrigation.

It was evaluated the soil temperature by means of daily measurements, before the beginning of the irrigation, always at 14 hours to a depth of five centimeters below the surface of the soil.

At 42 days after transplanting the lettuce plants were harvested, washed and separated into the aerial part and the root. Subsequently, the following ratings were performed: fresh weight of the head (FW), fresh weight of the commercial head (FWC), dry weight of the commercial head (DWC), losses (L), head diameter (HD), diameter of compact head (DCH), number of leaves (NL), fresh weight of the root (FWR), dry weight of the root (DWR), root diameter (RD), root length (RL), commercial productivity (PROD).

This is an experimental research qualitative and quantitative, with visual assessments of weed infestation and collection and statistical analysis of the data measured in lettuce plants (Pereira et al., 2018).

The experimental design adopted was in randomized blocks with four treatments (mulching) and five replications, totaling 20 experimental units. The experimental units had the dimensions of 7.0m long and 2.0m wide, where 116 seedlings of lettuce were planted. As useful plot 10 plants were harvested.

The treatments were characterized by the soil coverage: planting of lettuce on *P. glaucum*, *A. strigosa* and *B. ruziziensis* mulching, plus the control treatment with planting of lettuce in soil without plant coverage (spontaneous vegetation).

The data were interpreted statistically through analysis of variance, and the averages were compared among themselves through Tukey test at 5% probability; using the statistical program Genes (Cruz, 2013). The statistical model adopted was the following:

$$Y_{ijk} = \mu + t_i + b_j + e_{ij}$$

Where: μ = general average of treatments t_i = fixed effect of the i-th treatment (i = 1, 2, 3, 4) b_j = end of the j-th block (j = 1, 2, 3, 4); e_{ij} = experimental error associated with the observation Y_{ij}.

3. Results and Discussion

The materials, millet and oats, used as mulching on the lettuce cultivation were equally effective and with significantly different results from the lack of coverage on maintenance for the soil temperature (Table 1). On average, these covers kept the soil with a temperature gradient of approximately 5°C below the control (without coverage). The use of mulching in other vegetables show similar results. According to Resende et al. (2005), in the culture of carrots the use of mulching has reduced the gradient temperature gradient at 3.5°C. In the garlic cultivation, the mulching provides greater insulating effect on the soil surface and contributes to milder temperatures (Costa et al, 1997).

Table 1. Averages of soil temperature during the lettuce cycle, cultivar "Lucy Brown", cultivated on different soil mulching. Campo Grande, Mato Grosso do Sul, Brazil.

Soil coverage	**Temperature (ºC)**
Control treatment	33.25[a]
Pennisetum glaucum L.	26.25c
Avena strigosa	30.50ab
Brachiaria ruziziensis	28.75bc

Means followed by the same letters in columns do not differ (Tukey test, $p \leq 0.05$). Source: Authors.

The temperature range between the control and treatment coverage more efficient in reducing the gradient was 7, *Penninsetum glaucum* was the most efficient coverage in reducing soil temperature.

In Table 2 are the weed species identified in the experiment, as well as their respective densities. The highest densities of weeds were the species of *Gamochaeta coarctata* and *Cenchrus echinatus.*

Table 2. Averages of density of weeds on different soil mulching. Campo Grande, Mato Grosso do Sul, Brazil.

Soil coverage	**Average density (plants.m^{-2})**			
	Gamochaeta coarctata	*Cenchrus echinatus*	*Emilia fosbergii*	*Eleusine indica*
Control treatment	72.90 a	9.90 a	6.30 a	7.20 a
P. glaucum	8.10 b	1.10 b	0.70 b	0.80 b
A. strigosa	4.05 b	0.55 b	0.35 b	0.40 b
B.ruziziensis	62.90 a	2.20 b	5.60 a	1.60 b
Soil coverage	*Amaranthus viridis*	*Richardia brasiliensis*	*Solanum sisymbrifolium*	*Coronopus didymus*
Control treatment	5.40 a	5.40 a	2.70 a	4.50 a
P. glaucum	0.60 b	0.60 b	2.40 b	0.50 b
A. strigosa	0.30 b	0.30 b	1.80 c	0.25 b
B.ruziziensis	1.20 b	1.20 b	0.60 d	1.00 b
Soil coverage	*Solanum americanum*	*Sida cordifolialium*	*Commelina benghalensis*	Total
Control treatment	3.70 a	3.60 a	3.60 a	125.20 a
P. glaucum	0.45 b	0.40 b	0.45 b	16.10 c
A. strigosa	0.15 b	0.20 b	0.25 b	8.60 c
B.ruziziensis	0.80 b	0.80 b	0.70 b	78.60 b

Means followed by the same letters in columns and for each weed do not differ (Tukey test, $p \leq 0.05$).
Source: Authors.

The soil cover provided by the *P. glaucum*, *A. strigosa* and *B.ruziziensis* coverings reduced weed infestation by 93, 87 and 37%, respectively. The coverings *P. glaucum* and *A. strigosa* are the most efficient in controlling weeds.

The millet and oats mulching and oats have significantly reduced the total number of *Gamochaeta coarctata* plants in relation to bare soil and to ruziziensis mulching (Table 3). The weed control through vegetation coverage can occur both through physical effect, preventing the luminous incidence, as through allelopathy effects (Theisen et al., 2000; Favero et al., 2001; Monquero et al, 2009; Favarato et al, 2017).

Table 3. Efficiency of *Gamochaeta coarctata* control on different soil mulching. Campo Grande, Mato Grosso do Sul, Brazil.

Soil coverage	**Notes of visual evaluation**
Control treatment	0 b
P. glaucum	100 a
A. strigosa	100 a
B. ruziziensis	15 b

Means followed by the same letters in columns do not differ (Tukey test, $p \leq 0.05$). Source: Authors.

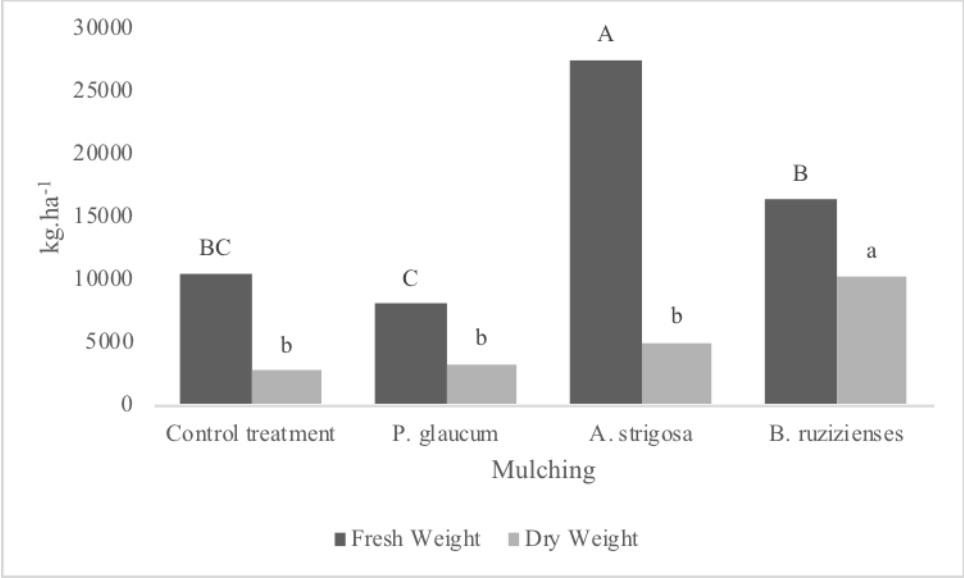
The coverage provided by *B. ruziziensis* was not efficient for the control of *Gamochaeta coarctata*, the other coverages were effective in suppressing the weed.

Trezzi; Vidal (2004), emphasize the ability to weed suppression through millet cultivation. The authors found average reductions of 91, 96 and 59% of the infestation of *Brachiaria plantaginea*, *Sida rhombifolia* and *Bidens pilosa*, respectively, in areas covered millet stubble. The literature reports that the straw in decomposition can release allelochemicals, which, in turn, can be associated to reduce the emergence of plants seeds (Trezzi; Vidal, 2004; Souza et al., 2006; Carvalho et al, 2016).

Jacobi; Fleck (2000), claim that the allelopathic action of some oat genotypes is attributed to its ability to exude scopoletin. Scopoletin. is a secondary product from the class of coumarins and has an inhibitory effect on root growth of plants. Hagemann (2010) reports allelopathic potential of oats on the germination and the weeds development.

The allelopathic effect of mulching is so much more intense as the greater the amount of dry matter produced, thus ensuring a sufficient concentration of toxins to lethal action on the seeds or weeds seedlings (Almeida; Rodrigues, 2018). In Figure 1, it is possible to see the data of fresh and dry mass produced by mulches. It is observed that the coverage oats provide the greatest amount of fresh matter, whereas at *B. ruzizienses* the largest dry mass. In organic cultivation, under direct seeding, it is recommended that the pre-cultivation of species that have large amount of straw, allowing the soil cover, reducing then the undesirable or invasive plants (Vaz de Melo et al., 2007).

Figure 1. Averages of fresh and dry weight of different plants used as soil mulching. Campo Grande, Mato Grosso do Sul, Brazil



Bars followed by the same letter - capital letter to fresh weight and small letters for dry weight - do not differ (Tukey test, $p \leq 0.05$). Source: Authors.

B. ruzizienses was the covering with the best mass production, the largest amount of dry mass provided a greater reduction in the temperature gradient in the soil, however, it was not efficient for the suppression of weeds.

For most of the characteristics related to productivity, showed no difference between treatments, i.e., there was no significant effect of different coverage on the productivity of the lettuce, a fact that can be attributed to the high degree of adaptability to high temperature conditions of this cultivar (Sala; Costa, 2012). There were significant differences only for two variables: dry mass of the commercial head and the fresh mass of the root of lettuce (Table 4). The mass of commercial head, however, is an important feature for the *producer*, because the remuneration, in this case, occurs according to the mass of the head. It is also important, as it affects yield during processing.

Table 4. Averages of dry weight of the commercial head (DWC) and of fresh weight of roots (FWR) in lettuce, cultivar "Lucy Brown", cultivated on different soil mulching. Campo Grande, Mato Grosso do Sul, Brazil.

Treatments	DWC	FWR
Control treatment	10.15ab	8.75b
P. glaucum	21.65[a]	19.55a
A. stigosa	13.55ab	8.72ab
B. ruziziensis	10.00b	6.25b

Means followed by the same letters in columns do not differ (Tukey test, $p \leq 0.05$). Source: Authors.

4. Conclusions

The use of soil mulch is a beneficial practice for lettuce cultivation, improving the soil temperature and reducing the incidence of invasive plants. The soil coverage with *P. glaucum* and *B. ruziziensis* stood out in reducing the soil temperature gradient, while with *P. glaucum* and *A. strigosa* reduced the incidence of weeds.

The coverage with *P. glaucum* has also provided an increase in the fresh mass of the commercial head, causing an improvement in product quality.

It is suggested, as a continuation of the studies, new experimental research with other leafy vegetable plants, and other cover crops in order to meet other advantageous possibilities for cropping systems.

Acknowledgments

The authors acknowledge the Fundação Manoel de Barros by their partnership

References

Anuário brasileiro de hortaliças (2019). *Brazilian Vegetable Yearbook*. Editora Gazeta Santa Cruz: Carvalho, C., Kist, B. B. & Beling, R. R.

Almeida, F. S. & Rodrigues, B. N. (2018). *Guia de herbicidas* (7ª ed.). Edição dos Autores.

Ministério da Agricultura, Pecuária e da Reforma Agrária. Departamento Nacional de Meteorologia (1992). *Normais climatológicas: 1961-1990*.

Carvalho, W. P.; Teixeira, L. G. V.; Neto, D. O. A.; Moreira, J. M. S. & Cunha, C.E. (2016). Alelopatia de resíduos de plantas de cobertura no controle de braquiária cv. Marandu. *Revista Brasileira de Biociências*, 14(2), 60-69.

Costa, J. T. A., Silva, L.A. & Melo, F. I. O. (1997). Efeitos do turno de rega e cobertura morta na cultura do alho na serra da Ibiapaba, Ceará: I. umidade e temperatura do solo. *Ciência Agronômica*, 28(1/2), 70-84.

Cruz, C. D. (2013). GENES: software para análise de dados em estatística experimental e em genética quantitativa. *Acta Scientiarum Agronomy*, 35 (3), 271-276.

Derpsch, R.; Roth, C.H.; Sidiras, N.; Kopke, U.; Krause, R. & BLANKEN, J. (1991) *Controle da erosão no Paraná, Brasil: sistemas de cobertura do solo, plantio direto e preparo conservacionista do solo*. Eschborn: Deutsche Gesellschaft für Technische Zusammenarbeit.

Empresa Brasileira de Pesquisa Agropecuária (2006). *Cerrado: adubação verde*. Embrapa Cerrados.

Favarato, L. F.; Souza, J. L. & Guarçoni, R. C. (2017). Efeitos múltiplos da cobertura morta do solo em cultivo orgânico de cenoura. *Revista Brasileira de Agropecuária Sustentável*, 7 (2), 24-30.

Favero, C.; Jucksch I., Alvarenga, R. C. & Costa, L. M. (2001). Modificações na população de plantas espontâneas na presença de adubos verdes. *Pesquisa Agropecuária Brasileira*, 36(11), 1355-1362.

Filgueira, F. A. R. (2013). *Novo manual de olericultura: agrotecnologia moderna na produção e comercialização de hortaliças*. (3ª ed. rev. e ampl.). Viçosa, MG: UFV.

Gilley, J. R., Hackbart, C. A., Stetson, L. E., Feyen, J. (1990). Energy management. In G. J. Hoffman, T. A. Howell & K. H. Solomon, *Management of farm irrigation systems*. American Society of Agricultural Engineers.

Hagemann, T. R.; Benin, G.; Lemes, C.; Marchese, J. A.; Martin, T. N; Pagliosa, E. S. & Beche, E. (2010). Potencial alelopático de extratos aquosos foliares de aveia sobre azevém e amendoim-bravo. *Bragantia*, 69 (39), 509-518.

Heredia Zárate, N. A.; Vieira, M.C.; Helmich, M., Heid, D.M. & Menegati, C.T. (2011). Produção agroeconômica de três variedades de alface: cultivo com e sem amontoa. *Revista Ciência Agronômica*, 41 (4), 646-653.

Jacobi, U. S. & Fleck, N.G. (2000). Avaliação do potencial alelopático de genótipos de aveia no início do ciclo. *Pesquisa Agropecuária Brasileira*, 35 (1), 11-19.

Köppen W. (1948). *Climatologia: con um estúdio de los climas de la tierra.* Fondo de Cultura Económica.

Kosterna E. (2014). Soil mulching with straw in broccoli cultivation for early harvest. *Journal of Ecological Engineering*, 5 (2), 100–107.

Marouelli, W. A.; Abdalla, R. P.; Madeira, N. R. (2008). Irrigação de cebola em sistema de plantio direto. *Revista Plantio Direto*, 105, 07-09.

Monquero, P. A.; Amaral, L. R.; Inácio, E. M.; Brunhara, J.P.; Binha, D. P.; Silva, P. V. & Silva, A. C. (2009). Efeito de adubos verdes na supressão de espécies de plantas daninhas. *Planta daninha*, 27 (1), 85-95.

Luz, A.O.; Seabra Júnior, S.; Souza, S. B. S.; Nascimento, A. S. (2009) Resistência ao pendoamento de genótipos de alface em ambientes de cultivo. *Agrarian*, 2 (3), 71-82.

Pereira, A. S., Shitsuka, D. M., Parreira, F. J. & Shitsuka, R. (2018). *Metodologia da pesquisa científica*. UFSM, NTE.

Research methods in weed science (1997). *Design of field experiments and the measurement and analysis of plant responses* (2ª ed.). Champaing.

Resende, F.V.; Souza, L. S.; Oliveira, P. S. R. & Gualberto, R. (2005). Uso de cobertura morta vegetal no controle da umidade e temperatura do solo, na incidência de plantas invasoras e na produção da cenoura em cultivo de verão. *Ciência e Agrotecnologia,* 29 (1), 100-105.

Ribeiro, A. C., Guimarães, P. T. & Alvarez, V. H. (Ed). (1999). *Recomendação para o uso de corretivo e fertilizantes em Minas Gerais: 5. Aproximação.* Comissão de Fertilidade do Solo do Estado de Minas Gerais.

Sala, F. C. E. & Costa, C. P. (2012). Retrospectiva e tendência da alfacicultura brasileira. *Horticultura Brasileira*, 30 (2), 187-194.

Souza, L.S.; Velini, E.D.; Martins, D. & Rosolem, C. A. (2006). Efeito alelopático de capim-braquiária (*Brachiaria decumbens*) sobre o crescimento inicial de sete espécies de plantas cultivadas. *Planta Daninha*, 24 (4), 657-668.

Theisen, G.; Vidal, R. A. & Fleck, N. G. (2000). Redução da infestação de *Brachiaria plantaginea* em soja pela cobertura do solo com palha de aveia preta. *Pesquisa Agropecuária Brasileira*, 35 (4), 753-756.

Trezzi, M. M. & Vidal, R. A. (2004). Potencial de utilização de cobertura vegetal de sorgo e milheto na supressão de plantas daninhas em condição de campo: II – efeitos da cobertura morta. *Planta Daninha*, 22(1), 1-10.

Vaz de Melo, A.; Galvão, J. C. C.; Ferreira, L. R.; Miranda, G. V.; Tuffi Santos, L. D.; Santos, I.C.; Souza, L. V. (2007). Dinâmica populacional de plantas daninhas em cultivo de milho-verde nos sistemas orgânico e tradicional. *Planta Daninha*, 25, 521-527.

Vilela, N. J. & Luengo, R. F. A. (2017). Produção de Hortaliças Folhosas no Brasil. *Campo & Negócios, Hortifruti*, 146.

Percentage of contribution of each author in the manuscript

Deisy Lúcia Cardoso – 30%

Denise Renata Pedrinho – 20%

Giselle Feliciani Barbosa – 15%

Wolff Camargo Marques Filho – 10%

José Antônio Maior Bono – 10%

José Francisco Assis Rolim – 15%