

## Full Length Research Paper

## Performance of American lettuce under different plant covers for no-tillage system

Jose Antonio maior Bono Bono\*, Denise Renata Pedrinho Pedrinho, Francisco de Assis Rolim Pereira Pereira, Silvana Lima Rosa Rosa and Marlos Ferreira Dornas Dornas

University Anhanguera-Uniderp Brazil.

Received 8 July, 2015; Accepted 12 August, 2015

This study aimed to evaluate the agronomic performance of American lettuce "Lucy Brown" in different types of straw from dried cover crops, for a no-tillage system, under the climatic conditions of Campo Grande (Mato Grosso do Sul state, Brazil). The experiment was set up in a randomized block design with five treatments and six replications, totalizing 30 plots. The treatments were: T1 (control) - planting lettuce in bare soil; T2 - planting lettuce on millet straw; T3 - planting lettuce on white oat straw; T4 - planting lettuce on forage radish straw; and T5 - planting lettuce on sunn hemp straw. After 37 days from sprouting the plants were assessed for fresh weight. They were dried at 38 days after planting, and at 11 days after drying they were evaluated for dry weight. The transplantation of the lettuce seedlings was carried out 12 days after the cover crop was dried, leaving a space of 25 x 25 cm for cultivation of a total of 24 plants. The plots were evaluated for weed control 20 days after transplanting lettuce. At 35 days after transplantation six central plants were evaluated in each plot, assessing the following variables: Above-ground fresh mass from shoot and root, dry weight of shoot and root and head diameter. Under the conditions in Campo Grande, for no-tillage cultivation of "Lucy Brown" lettuce, hemp is the most suitable cover, followed by millet.

**Key words:** *Lactuca sativa*, *Avena sativa* L., *Pennisetum glaucum* L., *Crotalaria spectabilis* Roth, *Raphanus sativus* L., yield.

### INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a herbaceous plant belonging to the Asteraceae family. It is the leafy vegetable that is most consumed in the Brazilian diet, which ensures that this crop has significant economic importance (Henz and Suinaga, 2009).

In Brazil, since the 1990s, there have been significant changes in the productive chain for vegetables, giving prominence to American lettuce. This is mainly due to demand from fast-food networks and because this variety

presents a longer period of conservation after being harvested than do other types of lettuce (Sala and Costa, 2012).

The demand by consumers for leafy vegetables in the right quantity and quality has led to the use of high-technology cultivation systems, such as planting on straw (direct planting) (Furlani and Purqueiro, 2010). The direct planting technique is very well known in Brazil for use with grain crops, but it has been little studied for leafy

\*Corresponding author. E-mail: bono@uniderp.edu.br

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](http://creativecommons.org/licenses/by/4.0/)

vegetables (Purqueiro and Tivelli, 2007). Based on minimum soil turning, crop rotation and soil dressing with plant residue, it presents the advantages of improved soil structure, increased infiltration and retention of water in the soil, improved development of the plant root system, control of invasive plants, and the fact that the soil temperature remains more temperate (Henz and Suinaga, 2009; Marouelli et al., 2008). For the lettuce crop, a dead cover crop or straw is commonly used, providing a microclimate that is more favorable to crop development (Henz and Suinaga, 2009). High temperature is a factor that directly interferes in the development of lettuce plants, leading to losses of up to 60%, as well as early bolting (Sala and Costa, 2012). According to Setúbal and Silva (1992), even using hybrid cultivars, high temperatures modify the texture of lettuce leaves, making them more fibrous. As lettuce is from temperate zones, this is an important factor in the Brazilian summer, because the crop may present low yield and low quality (Filgueira, 2008).

In the state of Mato Grosso do Sul, producers face the problem of high temperatures, and so they often collect lettuce plants before these have reached their maximum vegetative development, leading to losses with low-weight plants. Crop dressing aims to reduce the oscillations in soil temperature, decrease the excessive loss of water and, as a result, improve the performance of crops (Souza and Resende, 2003).

In recent years, some researchers have carried out successful experiments with vegetables cultivated among dead plant cover (Purqueiro et al., 2009; Tivelli et al., 2010). The use of soil cover in lettuce growing has proved to be a determining factor in increasing product yields and quality (Andrade Júnior et al., 2005), and according to Carvalho et al. (2005) it has become an essential practice in hot regions. However, to optimize the use of plant cover on the soil, the most suitable species and varieties need to be identified for different regions, and they should be matched with the best management system (Ceretta et al., 1994).

It is a challenge to make planting feasible and to increase the yield of lettuce in hot regions, especially for American lettuce. This work aimed to evaluate the agronomic performance of the American lettuce "Lucy Brown", cultivated from October to November under different dried plant covers, for the direct planting system in the soil and climate conditions of Campo Grande, Mato Grosso do Sul state (MS).

## MATERIALS and METHODS

The experiment was carried out in Campo Grande, MS, in the period from August to November 2012, in soil classified as Orthic Quartzarenic Neosol (Quartzite sand) at the geographic coordinates of latitude 20°26'21" S and longitude 54°32'27" W, at an altitude of 531.2 m above sea level. According to the Köppen classification, the climate in the region is considered tropical humid, with a rainy season in summer and a dry season in winter.

Accumulated precipitation in the experimental period was 350 mm, with a mean maximum temperature of 29.2°C and a mean minimum temperature of 18.9°C.

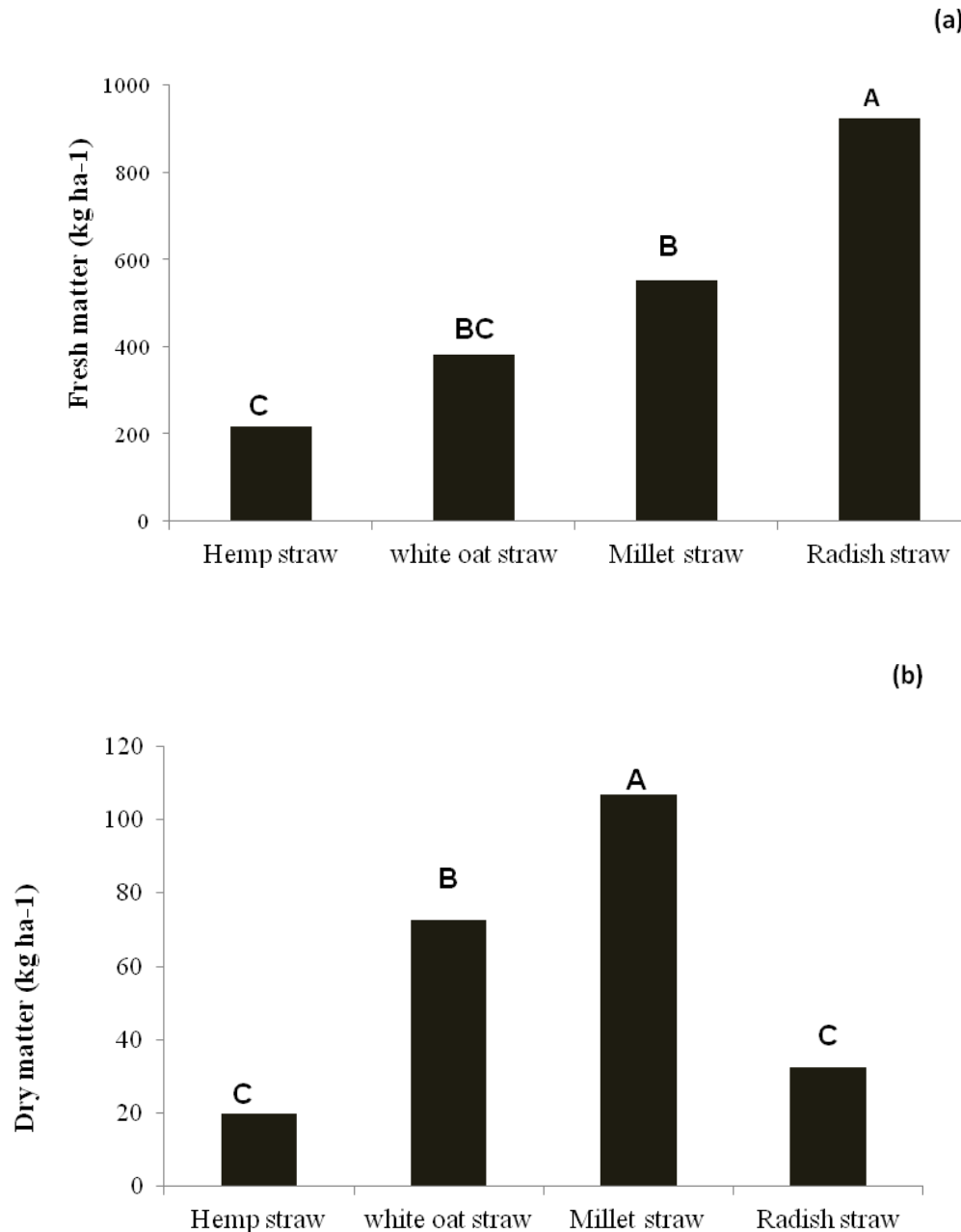
The experimental area was used for vegetables in the year 2010 and until September 2011. In October 2011 maize was planted and collected at the beginning of February 2012, and fertilization was applied in accordance with soil analysis and the crop being planted. After the maize had been harvested the area remained fallow for a period of four months, covered with spontaneous plant growth. The chemical and physical characteristics of the soil before the experiment was set up were determined in accordance with Embrapa (2006), and they are described as follows: pH in water 6.82, pH in CaCl<sub>2</sub> (0.01 M) 6.22; Phosphorus in Melich-1 (P) 47 mg dm<sup>-3</sup>; Potassium (K<sup>+</sup>) 136 mg dm<sup>-3</sup>; Calcium (Ca<sup>+2</sup>) 3.40 cmol<sub>c</sub> dm<sup>-3</sup>; (Mg<sup>+2</sup>) 1.30 cmol<sub>c</sub> dm<sup>-3</sup>; (H<sup>+</sup>) 2.0 cmol<sub>c</sub> dm<sup>-3</sup>; organic matter (OM) 19.5 g kg<sup>-1</sup>; cation exchange capacity (CEC) 6.7 cmol<sub>c</sub> dm<sup>-3</sup>; base saturation (V) 71%; clay 115 g kg<sup>-1</sup>; silt 30 g kg<sup>-1</sup> and total sand 855 g kg<sup>-1</sup>, by the pipette method.

The experiment was composed of five treatments: T1 (Blank control) – lettuce planted on soil with no plant cover, T2 – lettuce planted on millet straw (*Pennisetum glaucum* L.), T3 – lettuce planted on white oat straw (*Avena sativa* L.), T4 – lettuce planted on forage radish straw (*Raphanus sativus* L.) and T5 – lettuce planted on sunn hemp straw (*Crotalaria spectabilis* Roth.). The experimental plots were 2 m<sup>2</sup> (1 m x 2 m) with six repetitions, totaling 30 plots, and the treatments were distributed according to random block design. The plant covers for the formation of straw were sown on 08/27/2012 by scattering, without any fertilization, at the following as recommended by Embrapa (2006).

At 37 days after sowing, evaluations were carried out for fresh and dry matter of the cover crops, using a square iron frame of 20 cm placed in the center of each experimental plot, discarding the edge. The fresh and dry matter was cut within the area delimited by the square frame and weighed on a precision scale; the values were extrapolated for kg/ha. Next, chemical desiccation of the cover crops was done with glyphosate at 720 g ha<sup>-1</sup> of a.i. The application was carried out with a backpack sprayer pressurized by CO<sub>2</sub> with a fan-type nozzle (80.03), at 8 to 9 a.m., a time of day when the temperature was 26°C, relative humidity was 55% and there was almost no breeze. The lettuce seedlings were produced in a greenhouse, using pelletized seeds of the American lettuce cultivar "Lucy Brown", sown (one seed per cell) in a polystyrene tray with 128 cells, previously filled with commercial substrate (Plantmax®), where they remained for 29 days. For irrigation, 1000 mL of water per tray was used each day, distributed in two irrigations of 500 mL each.

The transplantation of lettuce seedlings to the straw-covered sections took place 12 days after chemical desiccation of the straw, spaced at 25 x 25 cm, totaling 24 plants per straw section. At transplantation, fertilization of the crop took place, as recommended for lettuce, at a dose of 200g of super phosphate (P<sub>2</sub>O<sub>5</sub>)/m<sup>2</sup> (Ribeiro et al., 1999). Cover fertilization with N and K<sub>2</sub>O was applied at 10, 20 and 30 days after transplantation of the seedlings to the beds, using sources of urea and potassium chloride at doses of 15 g/m<sup>2</sup> of N and 10 g/m<sup>2</sup> of K<sub>2</sub>O for each application. At 35 days after transplantation, the lettuce was harvested, taking the whole plant out of the soil (aboveground part and root). The six plants at the center of each plot were evaluated. After harvesting, the plants were washed, and the excess water was dried with a paper towel. Plants were sectioned, separating the aboveground part and the root and checking the following variables: aboveground fresh matter (AFM) and dry matter (ADM) and root fresh matter (RFM) and dry matter (RDM). The drying was done in an oven with forced air circulation at ± 65° C until constant weight was reached. The diameter of the head (HD) was measured individually in two positions, using a ruler graduated in cm, considering only the central compact heart of the lettuce plant.

The treatments were evaluated for infestation of weeds, 20 days



**Figure 1.** Means of fresh matter (a) and dry matter (b) for the plant cover crops. Bars followed by the same letter in the column do not differ among themselves by the Tukey test at 5% of probability, Campo Grande, 2013.

after the lettuce was transplanted, by a method adapted from Research Methods in Weed Science (1997). This method proposes that the efficiency of control should receive scores from 0 to 100, where: 100 (total control – death of all individuals in the population); 90 to 99 (excellent control); 80 to 89 (acceptable control - 80 is the minimum acceptable score from the point of view of agronomic efficiency); 50 to 79 (unacceptable control); 0 to 49 (insufficient control). The data were submitted to analysis of variance and to a means test by the PROC GLM procedure, using the program SAS (SAS, 2001), and the means were compared using the Tukey test at 5% of probability. Contrast was also carried out by the F test for

analysis of variance among the treatments, using sunn hemp (*Fabaceae*), millet and oat (*Poaceae*) and forage radish (*Brassicaceae*).

## RESULTS AND DISCUSSION

The plant covers were evaluated for fresh and dry matter, and the data can be found in Figure 1(a) and (b). Forage radish was the cover that presented the greatest yield of

**Table 1.** Statistical indicators for the variables analyzed in American lettuce “Lucy Brown” cultivated on different dried plant cover crops, Campo Grande, 2013.

Causes of variation	AFM	RFM	RDM	ADM	HD	CFM	CDM	WP
	Value of F							
Block	1.12ns	1.30ns	1.91ns	8.58**	2.00ns	1.47ns	1.39ns	1.62ns
Treatments	3.96**	4.17**	6.79**	3.92**	3.42*	3.77**	3.81**	7.52**
CV (%)	23.39	26.20	28.46	24.94	14.20	21.31	26.57	28.74

AFM= aboveground fresh matter RFM= root fresh matter RDM= root dry matter ADM =aboveground dry matter HD= head diameter CFM= cover fresh matter CDM = cover dry matter WP= weed presence, ns= non-significant; \*\* and \* = significant at 1 and 5% of probability, respectively. SH= Sunn hemp; M= Millet; O= Oat; FR= Forage Radish.

**Table 2.** Biometric evaluations of American lettuce “Lucy Brown” cultivated on different dried plant cover crops, Campo Grande, 2013.

Treatments	AFM		RFM		RDM	ADM		HD		
			g pl <sup>-1</sup>			cm pl <sup>-1</sup>				
White Oat	412.01	C	7.60	B	4.92	A	22.46	BC	15.08	B
Sunn hemp	496.17	A	8.53	A	5.07	A	24.44	AB	16.40	A
Millet	422.32	BC	6.95	B	4.03	B	23.79	AB	15.18	B
Radish	430.30	BC	7.01	B	3.96	B	20.63	C	14.56	B
Control	463.82	AB	7.01	B	4.02	B	26.02	A	15.04	B

AFM= aboveground fresh matter RFM= root fresh matter RDM= root dry matter ADM = aboveground dry matter HD= head diameter. Means followed by the same letter in the column do not differ among themselves by the Tukey test at 5% of probability.

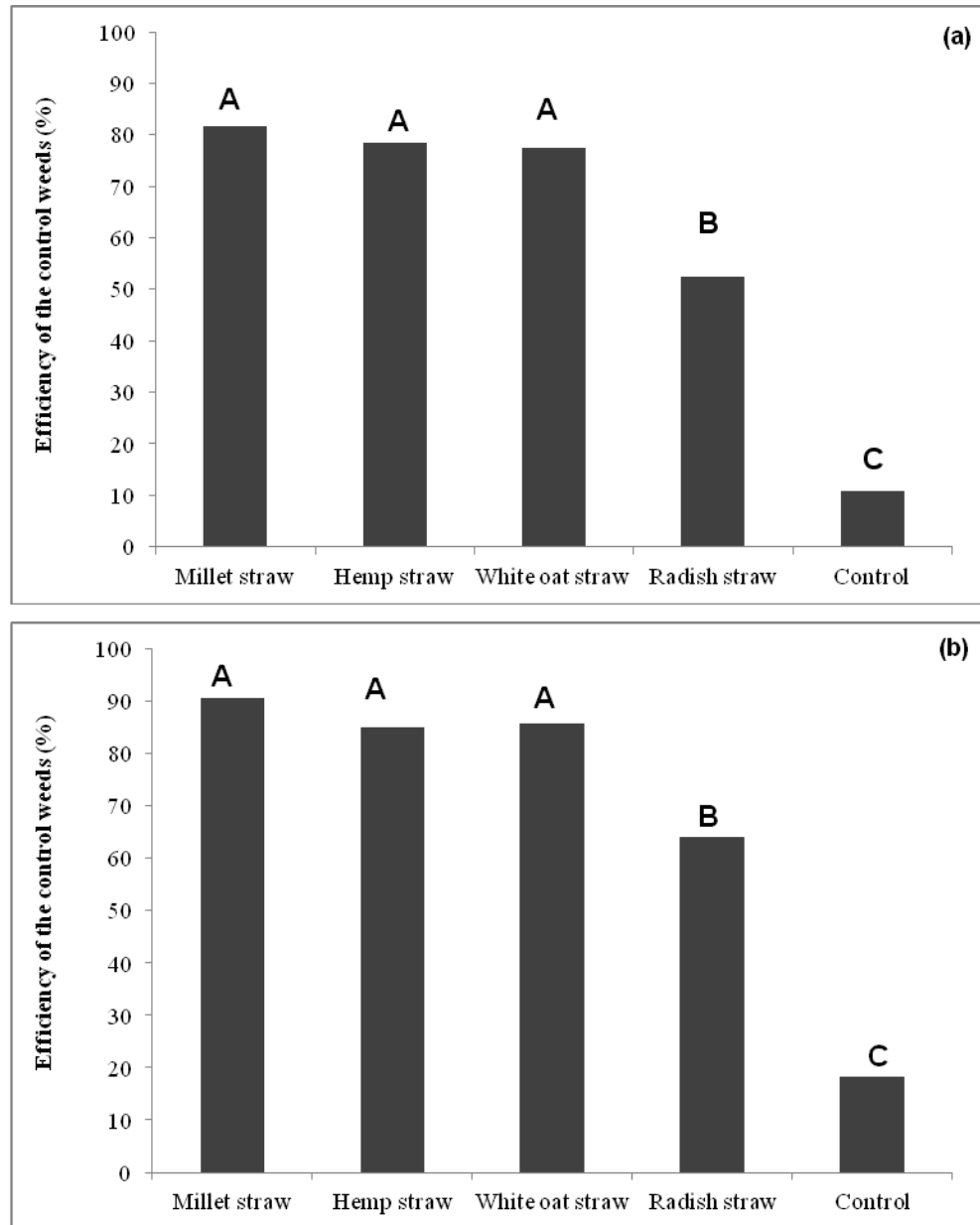
fresh matter and sunn hemp the lowest (Figure 1a). For dry matter, millet yielded the most (Figure 1b). Sunn hemp, which produced least fresh matter, provided the highest yield in terms of the lettuce crop. This can be explained by the fact that sunn hemp releases a greater amount of nutrients. However, in the present study the greater yield of dry matter from millet and oat did not provide a higher yield in the next crop, in this case for the lettuce “Lucy Brown”. For the cultivation of eggplant under direct planting, Castro et al. (2004), verified that sunn hemp made more Ca, Mg and N available than did millet. In a study carried out by Andreotti et al. (2008) millet also produced less dry matter than did a species of sunn hemp, in this case *Crotalaria juncea*.

A similar result was found by Oliveira et al. (2008) with the lettuce cultivar Regina, confirming that leguminous plants, used as cover crops, release more N to the soil compared to grasses, and thus influence lettuce growth positively. The summary of the analysis of variance and its significance in function of the F test for aboveground fresh matter (AFM), root fresh matter (RFM), aboveground dry matter (ADM), root dry matter (RDM) and head diameter (HD) of the American lettuce “Lucy Brown”, in function of the different dried cover crops, is presented in Table 1. In the same table, the cover crop fresh matter (CFM), cover dry matter (CDM) and weed presence (WP), as well as the contrasts between sunn hemp, millet and white oat (SH x M x O), forage radish,

millet and oat (FR x M x O) and forage radish and sunn hemp (FR x SH) are shown.

The results demonstrate that there was a significant effect of the treatments for all the analyzed variables. The means of the treatments for the variables AFM, RFM, ADM, RDM and HF are presented in Table 2. The lettuce plants presented more aboveground and root fresh matter, more root dry matter and a greater head diameter when cultivated under the sunn hemp cover. For the variable AFM there was a difference between the blank control and the cover with oat, corroborating the data of Maluf et al. (2004), in a study with American lettuce under direct planting, in which the authors confirmed greater fresh matter yield under black oat cover than with uncovered soil.

In studies of the effect of plant covers on lettuce production, various authors have observed better results for crops on covered soil. They have emphasized that cover crops promote better lettuce development, as confirmed by the data in the present study, for the cover with sunn hemp, for the variables RFM, RDM and HD (Mógor and Câmara, 2007 and Carvalho et al., 2005). The RDM of lettuces on oat cover was greater than on millet and forage radish covers. This may be related to the decomposition rate of oat, which occurs in up to 40 days (Crusciol et al., 2008). Thus, nutrients in the soil are mineralized more quickly than by millet and radish, benefiting the development of lettuce roots. With regard



**Figure 2.** Efficiency of the control of weeds, (a) *E. indica* and (b) *P. oleraceae*, on different dried plant covers in the cultivation of American lettuce "Lucy Brown", Campo Grande, 2013. \*Means followed by the same letter in the column do not differ among themselves by the Tukey test at 5% of probability.

to the weed presence, Indian goosegrass (*Eleusine indica*, Figure 2a) and common purslane (*Portulaca oleraceae*, Figure 2b) were identified among the weeds. The covers studied here significantly reduced the density of weeds in relation to uncovered soil (blank control). Millet, despite not differing statistically from sunn hemp and oat, was the cover that presented the best control of *E. indica* (81, 67), while for *P. oleraceae* the best cover crops were millet, sunn hemp and oat. The cover with forage radish and the blank control (uncovered soil)

presented higher indices of invasive plants.

Similar results were found by other authors in work with vegetable crops grown on straw cover. Among these we can cite Rezende et al. (2005), whose study confirmed that the use of dead cover in the production of the summer carrot crop was efficient in controlling *E. indica* and *P. oleraceae*; additionally, Carvalho et al. (2005) affirmed that dead cover favored the control of weeds in cultivation of lettuce cv. Regina.

Cover crops of millet, oat and sunn hemp did not

**Table 3.** Comparison of biometric data of American lettuce “Lucy Brown” in function of plant cover from three families, Campo Grande, 2013.

Treatments	AFM		RFM		RDM		ADM		HD	
	g pl <sup>-1</sup>								cm pl <sup>-1</sup>	
<i>Fabaceae</i>	496.17	A	8.53	A	5.07	A	24.44	A	16.40	A
<i>Poaceae</i>	417.16	B	7.27	B	4.47	B	23.12	A	15.13	B
<i>Brassicaceae</i>	430.30	AB	7.01	B	3.96	B	20.63	A	14.56	B

AFM= aboveground fresh matter RFM= root fresh matter RDM= root dry matter ADM = aboveground dry matter HD= head diameter. Means followed by the same letter in the column do not differ among themselves by contrast using the F test of analysis of variance at 5% of probability.

present significant differences in the control of invasive plants, corroborating the data of Oliveira et al. (2008), in work with different cover crops in the cultivation of lettuce, which showed that all the covers used were efficient in controlling weeds. For Kieling et al. (2009), tomato direct-planted on different straw covers underwent efficient suppression of invasive plants, and oat and forage radish covers did not differ between themselves.

The effect of controlling invasive plants may be attributed to physical and chemical alterations in the soil, provided by the cover crops. Physically, according to Constantin (2001), dead cover alters the humidity, light and superficial temperature of the soil. According to the same author, the straw also constitutes a mechanical barrier to the development of weeds. According to Pires and Oliveira (2001), many plant residues, used as plant cover, have the capacity to produce substances that have an allelopathic effect on the seeds of invasive plants, delaying and even inhibiting their germination and growth.

In this study, when we compared sunn hemp (*Fabaceae*) with millet and oat (*Poaceae*) and forage radish (*Brassicaceae*), in lettuce yield, it was observed that the first of these stood out as a soil cover, except for AFM, which did not differ from forage radish (*Brassicaceae*) and for ADM, in which the covers did not show differences among themselves (Table 3).

Oliveira et al. (2008) also worked with plant covers and confirmed better results for fresh matter and above-ground diameter for the lettuce cultivar “Regina”, grown on a leguminous cover crop, which is in agreement with the results of the present study. Plants from species of the families *Fabaceae* and *Brassicaceae* possess faster decomposition when compared to *Poaceae*, making nutrients available to the soil in less time. Among the nutrients, nitrogen stands out, arising mainly from the association of leguminous plants with fixative bacteria. This association increases the potential performance of nitrogen in the soil, benefiting the next crop. Grasses (*Poaceae*), in turn, present a slower decomposition, thus holding back the nutrients for the subsequent crop (Barradas et al., 2001; Aita and Giacomini, 2003; Espíndola et al., 2006; Oliveira et al., 2008). Under the soil and climatic conditions of Campo Grande, MS, the

American lettuce cultivar “Lucy Brown” grown on sunn hemp (*Crotalaria spectabilis* Roth) straw is the most recommended treatment for the variables AFM, RFM, RDM and HD, when compared to straw of millet (*Pennisetum glaucum* L.), white oat (*Avena sativa* L.) and forage radish (*Raphanus sativus* L.).

### Conflict of Interest

The authors have not declared any conflict of interest.

### REFERENCES

- Aita C, Giacomini SJ (2003). Decomposição e liberação de nitrogênio de resíduos culturais de plantas de cobertura de solo solteiras e consorciadas. Rev. Brasileira de Ciênc. do Solo 27:601-612.
- Andrade Júnior VCD, Yuri JE, Nunes UR, Pimenta FL, Matos CDS, Florio FCDA, Madeira DM (2005). Emprego de tipos de cobertura de canteiro no cultivo da alface. Hort. Brasil. 23:899-903.
- Andreotti M, Araldi M, Guimarães VF, Furlani Junior E, Buzetti S (2008). Produtividade do milho safrinha e modificações químicas de um latossolo em sistema plantio direto em função de espécies de cobertura após calagem superficial. Acta Sci. Agron. 30:109-115.
- Barradas CA, Freire LR, Almeida DL, de-polli H (2001). Comportamento de adubos verdes de inverno na região serrana fluminense. Pesquisa Agro. Brasil. 36:1461-1468.
- Carvalho JE, Zanella F, Mota JH, Lima ADS (2005). Cobertura morta do solo no cultivo de alface cv. Regina 2000. Ji-Paraná/RO. Ciênc. Agrotecnol. 29:935-939.
- Castro CM, Almeida DL, Ribeiro RLD (2004). Plantio direto e adubação verde no cultivo orgânico de berinjela (*Solanum melongena* L.). Seropédica, RJ: Embrapa Agrobiologia. (Comunicado Técnico 67) P. 4.
- Ceretta CA, Aita C, Braida JA, Pavinato A, Salet RL (1994). Fornecimento de nitrogênio por leguminosas na primavera para o milho em sucessão nos sistemas de cultivo mínimo e convencional. Rev. Brasil. Ciênc. Solo. 18:215-220.
- Constantin J (2001). Métodos de manejo. In: Oliveira Junior RS, Constantin J. (Eds). Plantas daninhas e seu manejo. Guaíba: Agropecuária. pp.103-121.
- Crusciol CAC, Moro E, Lima EV, Andreotti M (2008). Taxas de decomposição e de liberação de macronutrientes da palhada de aveia preta em plantio direto. Bragantia 67:481-489.
- Embrapa- Empresa Brasileira de Pesquisa Agropecuária (2006). Cerrado: adubação verde. Planaltina, DF: Embrapa Cerrados. P. 369.
- Espíndola JAA, Guerra JGM, Almeida DL, Teixeira MG, Urquiaga S (2006). Decomposição e liberação de nutrientes acumulados em leguminosas herbáceas perenes consorciadas com bananeira. Revista Brasileira de Ciência do Solo 30:321-328.

- Filgueira FAR (2008). Manual de olericultura. Agrotecnologia moderna na produção e comercialização de hortaliças. Viçosa: UFV, 2. ed. P. 421.
- Furlani PR, Purquerio LFV (2010). Avanços e desafios na nutrição de hortaliças. In: Mello RP. Nutrição de Plantas: diagnose foliar em hortaliças. Jaboticabal: FCAV/CAPES/FUNDUNESP. pp. 45-62.
- Henz GP, Suinaga F (2009). Tipos de Alface Cultivadas no Brasil. Brasília: Embrapa Hortaliças. (Comunicado Técnico 75) P. 7.
- Kieling A, Comin JJ, Fayad JA, Lana MA, Lovato PE (2009). Plantas de cobertura de inverno em sistema de plantio direto de hortaliças sem herbicidas: efeitos sobre plantas espontâneas e na produção de tomate. Ciênc. Rural 39:2207-2209.
- Maluf LEJ, Madeira NR, Biguzzi FA, Dariolli L, Santos FHV, Gomes LAA (2004). Avaliação de cultivares de alface americana em diferentes tipos de coberturas do solo. In: CONGRESSO BRASILEIRO DE OLERICULTURA, 44. Anais... Campo Grande, MS. Also published as an abstract in: Hort. Brasil. Brasília 22:492-493.
- Marouelli WA, Abdalla RP, Madeira NP (2008). Irrigação de Cebola em Sistema de Plantio Direto. Revista Plantio Direto 105. Available at: <[http://www.plantiodireto.com.br/?body=cont\\_int&id=859](http://www.plantiodireto.com.br/?body=cont_int&id=859)>. Accessed on: May 25, 2013.
- Mógor AF, Câmara FLA (2007). Produção de alface no sistema orgânico em sucessão a aveia preta, sobre a palha, e diferentes coberturas do solo. Sci. Agraria 8:239-245.
- Oliveira FF, Guerra JG, M, Almeida DL, Ribeiro RLD, Espindola JAA, Ricci MSF, Ceddia MB (2008). Avaliação de coberturas mortas em cultura de alface sob manejo orgânico. Hort. Brasil. 26:216-220.
- Pires NM, Oliveira VR (2001). Alelopatia. In: Oliveira Junior, RS; Constantin J. (Eds). Plantas daninhas e seu manejo. Guaíba: Agropecuária. pp. 145-185.
- Purquerio LFV, Factor TL, Lima JRS, Tivelli SW, Trani PE, Breda JR JM, Rocha MAV (2009). Produtividade e qualidade de beterraba em plantio direto em função do nitrogênio e do molibdênio. Hort. Brasil. Vol. 27 (Supplement - CD-ROM).
- Purquerio LFV, Tivelli SW (2007). Multicultivo de alface em sistema de plantio direto. In: CONGRESSO BRASILEIRO DE OLERICULTURA, 47. Anais... Brasília. Also published as an abstract in: Hort. Brasil. Vol. 25 (Supplement - CD-ROM).
- Research Methods in Weed Science, (1997). Design of field experiments and the measurement and analysis of plant responses. 2 ed. Cap. 2. Champaign, IL.
- Rezende FV, Souza LD, Oliveira PD, 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. Ciênc. Agrotecnol. 29:100-105.
- Ribeiro AC, Guimarães PTG, Alvarez VH (1999). Recomendação para uso de corretivos e fertilizantes em Minas Gerais: (5ª aproximação). Viçosa: UFV, P. 359.
- Sala FC, Costa CP (2012). Retrospectiva e tendência da alfacicultura brasileira. Horticultura Brasileira 30:187-194.
- Sas User's Guide: Statistics, 6. ed. Cary: SAS Institute, (2001). P. 846.
- Setubal WJ, Silva AR (1992). Avaliação do comportamento de alface de verão em condições de calor no município de Teresina- PI. Teresina: UFPI, P. 17.
- Souza JL, Resende P (2003). Manual de horticultura orgânica. Viçosa: Aprenda Fácil, P. 564.
- Tivelli SW, Purquerio LFV, Kano C, (2010). Adubação verde e plantio direto em hortaliças. Pesquisa & Tecnologia 7.