PRODUCTION OF ICEBERG LETTUCE USING MULCHES

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ABSTRACT: Mulches bring several benefits to lettuce cultivation. This work evaluated the effect of mulches on the cultivation of iceberg lettuce, cv. Lucy Brown. The treatment plots were: 1- no mulch and no weed control (control); 2- no mulch and weed control every 15 days; 3- sugarcane bagasse mulch of 2 cm thickness; 4- black plastic mulch; 5- double-faced plastic mulch (silver/black). Data were collected in regard to plant cycle when in the field, amount of chlorophyll in the leaves, productivity (individual weight per head) and amount of nutrients absorbed by the leaves. Double-faced plastic mulch provides the highest productivity and the highest values for the amount of chlorophyll, nitrogen, phosphorus, sulfur, boron and iron accumulation in the leaves.
Key words: *Lactuca sativa,* mulching, soil temperature, nutrient

PRODUÇÃO DE ALFACE TIPO AMERICANA SOB COBERTURAS DE SOLO

RESUMO: A utilização da cobertura do solo pode trazer inúmeros benefícios ao cultivo de alface. Este experimento teve como objetivo avaliar o efeito de tipos de coberturas de solo no cultivo de alface tipo americana cv. Lucy Brown. Os tratamentos foram: 1- canteiro sem cobertura e sem capina (testemunha), 2- canteiro sem cobertura, com capina quinzenal, 3- canteiro com cobertura de bagaço de cana de 2 cm de espessura, 4- canteiro com cobertura de plástico preto, 5- canteiro com cobertura de plástico dupla face (prateado/preto). Foram avaliados o ciclo das plantas no campo, a quantidade de clorofila nas folhas, a produção em peso individual de cabeça e a quantidade de nutrientes absorvidos nas folhas. A utilização de cobertura plástica do tipo dupla face proporcionou os maiores valores médios de produção. Foi também o tratamento em que foram obtidos os maiores valores para quantidade de clorofila, nitrogênio, fósforo, enxofre, boro e ferro acumulado nas folhas.
Palavras-chave: *Lactuca sativa,* mulching, temperatura do solo, nutriente

INTRODUCTION

The cultivation of iceberg (head) lettuce in Brazil had a high increase at the end of the 1980's, mainly due to its use by fast-food chains. For being a recent crop, however, the national lettuce marketing data still does not include the American variety, since the Brazilian classification is based on the crispy or smooth (butter) types.

Within the several techniques used in lettuce cultivation, the use of mulches is known to be worthwhile, being an important reason for the crop's quality and productivity improvement. Among the several mulches advantages, we can point out the weed control, the increase of the soil moisture, the preservation of the soil profile aeration, among others (Muller, 1991).

According to Goto (1998), first of all, the economic compensation for the use of mulches in lettuce must be evaluated, as it depends on the region of cultivation and the increase in the soil temperature can affect the development of roots, and consequently, nutrient absorption. The variation in nutrient accumulation, due to the increase in the soil temperature, and the decrease in fertilizer leaching with the use of mulches, are issues that have not been well studied.

Because of the increase in temperature and better aeration promoted by plastic mulch, helping the nitrification process, more nitrogen can be available to the plants (Pinto, 1997). Besides, the reduction in the leaching improves nitrate retention, reducing nitrogen loss in the soil profile.

An increase in the soil temperature may interfere in the nutrient levels in plants. As the temperature rises, calcium and phosphorus tend to diminish and nitrogen and potassium tend to increase, as well as the growth or the aerial part of the plant (Walker, quoted by Muller, 1991). Siriratpiriya et al. (1985) cultivating lettuce cv. Tom Thumb in vases plugged to a phytotron conditioning temperatures of 9, 12, 15 18 and 24°C, relate that higher temperatures increased concentrations of Cd, Zn, Mn and Fe, but had little effect over the absorption of Cu, Ni and Mo. On the other hand, foliar analysis in coffee tree suggested that reduced plant growth under higher soil temperatures (above 33°C) is mainly due to the lower translocation of P absorbed by the roots to the aerial parts of the plant (Franco, 1982).

The relationships between air and soil temperatures in relation to the environmental conditions are altered by the change in the surface albedo and thermal diffusivity, which are characteristics that vary according to the use of the soil covering (Muller, 1991). This technique may cause lower thermal amplitude and lower maximum soil temperature when compared to bare soil, as well as the response for the average soil temperature that may vary according to the period of the year. The increase in the biological processes and the consequent increase in the nutrient release reveal that there are several ranges of responses to the various types of mulches.

Pinto (1997) relates that evapotranspiration in lettuce leaves with polyethylene mulch may present values 25% lower, on average, than those of evapotranspiration on treatments without mulch.

This work aimed at evaluating the cultivation of iceberg lettuce cv. Lucy Brown on different mulches, studying their effects on productivity and in the amount of accumulating nutrients in the leaves.

MATERIAL AND METHODS

The experiment was carried out in São Manuel - SP, at the São Manuel Experimental Farm, which belongs to the "Faculdade de Ciências Agronômicas" (Agronomic Science College – FCA) of the "Universidade Estadual Paulista" (Sao Paulo State University – UNESP), Botucatu campus, from March to May 1999.

Iceberg lettuce cv. Lucy Brown was sow in expanded polystyrene trays of 200 cells containing commercial substrate made of pine bark and vermiculite.

The treatment plots were based on different types of soil coverings, as follows: 1- no mulch and no weed control (control); 2- no mulch and weed control every 15 days; 3- sugarcane bagasse mulch (2 cm thickness); 4- black plastic mulch; 5- double-faced plastic mulch (silver/ black).

Transplanting was carried out 35 days after sowing in a seedbed (6.0 m long) previously fertilized with organic compounds consisting of humus (20 L m^{-2}) and NPK 4-14-8 (100 g m^{-2}). The pattern of plant distribution used was four rows of plants spaced at 0.3 m $\times$ 0.3 m. Two superficial fertilizer applications of Nitrocalcium (260 Kg ha^{-1}) were performed (Katayama, 1990).

The average amount of chlorophyll in leaves was evaluated using the "Minolta SPAD-502 Chlorophyll Meter". Ten plants per plot were analyzed (three readings per plant for average leaves).

Soil temperature was also measured at a depth of 5.0 cm under different coverings. The temperatures were measured daily at 12:00, during the month of May, by a portable thermometer (model "Hanna Hi-93530"). Lettuce was harvest 45 days after transplant. (Ten plants from the central rows were collected at random). After the harvest, the productivity, in weight per head and weight of dry mater per head, was evaluated.

Nutrients concentrations in the aerial part of the plants was also analyzed. From these data, and from the weight of dry matter per head, the total amount of nutrients extracted by the plants was determined. The experimental design was randomized complete block, with 5 treatments and 4 replications, with 80 plants per plot. The data obtained were compared by the Tukey Test at 5%.

RESULTS AND DISCUSSION

Treatments 4 and 5 had the highest averages of chlorophyll, weight per head and dry matter weight per head (TABLE 1). The superior performance presented by these treatments when compared to others can be explained by the higher N, S and Zn absorption by the plants (TABLE 2). The higher N absorption may be favored by the increase in the soil temperature and moisture caused by the plastic mulch.

For average head weight and average dry matter head weight, Treatment 5 was statistically superior to Treatment 4. The better development of plants for the treatment with double-faced plastic covering could be explained by the higher reflection of the light caused by the silver side of this kind of mulch, which could have increased the accumulation of photosynthates by the leaves (Muller, 1991).

Among the treatments without plastic mulch, Treatment 3 had the highest average for the dry matter weight per head when compared to the control and to the manual weed control treatment, although it did not differ significantly from the latter. This treatment, however, showed the lowest N concentration (TABLE 2). This is explained by the high consumption of nitrogen by the sugarcane bagasse in the balancing process of the C/N ratio. Besides, the sugarcane bagasse mulch favored a lower soil temperature compared to the other treatments, probably due to the greater insulation of the soil surface. This lower temperature may have negatively influenced the nitrogen absorption (Pinto, 1997).

Treatment 5 had the highest average for the nitrogen concentration in the aerial part of the plant. Despite not being the treatment with the highest soil temperatures observed, its temperature was relatively high to Treatment 1 (1,46°C). This might have influenced the higher nitrogen absorption by the plants. The results obtained are in accordance with Walker, quoted by Muller (1991). According to the author, higher soil temperatures lead to higher absorption of nitrogen and greater vegetative growth.

Pinto (1997) mentioned the loss of nitrogen in the soil profile by leaching of nitrate in bare soils. Furthermore, there was a decrease in the oxygen

TABLE 1 - Average values of average head weight (HW), average value of dry matter per head (DMHW), chlorophyll amount in leaves (CLO) and soil temperature at a depth of 5.0 cm, measured daily at 12h00, during month of may for lettuce cv. Lucy Brown, grow with different soil mulches. Sao Manuel, 1999.

Treatment	PMC	PMSC	CLO	T
	g		g m^{-2}	°C
1. Control	96.50 d	5.24 d	16.48 c	23.56
2. Weeding	148.50 c	6.30 cd	21.81 b	23.4
3. Sugarcane bagasse	141.00 c	7.84 c	18.99 c	21.4
4. Black plastic	409.00 b	23.56 b	31.36 a	25.12
5. Double-faced plastic	491.00 a	25.93 a	33.18 a	25.02
c.v.(%)	4.88	5.4	4.79	

Averages followed by the same letter (column) do not differ statistically, by Tukey Test at 0.01.

TABLE 2 - Nutrient concentration in the aerial part of iceberg lettuce cv. Lucy Brown, grow with different soil mulches. Sao Manuel,1999.

Treatment	N	P	K	Ca	Mg	S	B	Cu	Mn	Zn	Fe
	g kg^{-1}						mg kg^{-1}				
1. Control	16.0 d	5.2 a	26.9 ab	7.5 b	2.5 b	1.8 b	20.3 a	4.2 a	224.2 c	42.5 c	433.6 b
2. Weeding	19.3 c	5.4 a	21.7 b	8.5 ab	3.6 a	1.7 b	19.7 a	4.7 a	227.5 c	43.7 c	439.5 b
3. Sugarcane bagasse	15.3 d	5.4 a	26.2 ab	10.7 a	3.6 a	1.8 b	18.7 a	4.7 a	276.0 b	59.7 b	472.5 ab
4. Black plastic	23.9 b	4.2 b	31.0 a	10.2 a	3.7 a	1.9 b	18.7 a	5.0 a	286.7 a	73.2 a	499.7 a
5. Double-faced plastic	25.4 a	4.5 ab	30.3 a	9.2 ab	3.6 a	2.4 a	19.2 a	4.7 a	275.7 b	70.2 a	473.2 a
c.v.(%)	3.5	5.68	7.55	12.56	9.29	10.28	7.75	9.8	4.19	4.06	3.87

Averages followed by the same letter (column) do not differ statistically, by Tukey Test at 0.01.

concentration in the rhizosphere for treatments no mulch, which promoted present better aeration. Thus, the nitrate is used by microorganisms as an alternative electron receptor, increasing the risk of nitrogen loss by denitrification or partial nitrification of the ammoniacal nitrogen (Marschner, 1995).

The phosphorus concentration in the above-ground part was higher for Treatments 1, 2 and 3, where the soil temperatures were lower than the temperatures in treatments with plastic mulch (TABLE 2). The highest calcium concentration was observed in Treatment 3. There is, therefore, agreement with Walker, quoted by Muller (1991). According to the author, the increase in soil temperature caused the reduction in calcium and phosphorus levels in corn. Higher average values for the potassium concentration were found in treatments with plastic mulch. Than in the treatment with manual weed control every 15 days.

The control treatment was the only one that differed from the others, having the lowest average concentration of magnesium (TABLE 2). On the other hand, as regards the average concentration of sulfur, the only treatment that differed was the double-faced plastic mulch, one, with is better than the others.

There were no statistical differences among means of all the treatments regarding the concentration of boron and copper. As for manganese and zinc, the data are in accordance with Siriratpiriya et al. (1985), growing lettuce cv. Tom Thumb, where higher soil temperatures increased the Cd, Zn, Mn and Fe concentrations. Mn and Fe had lower averages in the treatments without mulch: the lower aeration, caused a decrease in the oxidation potential in the rhizosphere of the plant, diminishing the availability of Mn, Fe and occasionally P (Marschner, 1995).

Haag & Minami (1988), cultivating lettuce cv. Grand Rapids on open fields, found the following concentrations for foliar analyses 50 days after sowing: N, 3.5%; P, 0.46%; K, 4.4%; Ca, 0.92%; Mg, 0.32%; S, 0.23%; B, 43 mg Kg^{-1}; Cu. 21 mg Kg^{-1}; Mn, 71 mg Kg^{-1}; Zn, 98 mg Kg^{-1} and Fe, 513 mg Kg^{-1}. Comparing these figures with the ones from TABLE 2, it is noticed that the level of the elements P, Ca, Mg and S were similar, mainly for the double-faced plastic mulch. The level of Mn the was higher, and N, K, B, Cu, Fe and Zn levels were lower.

Average values related to the total amount of nutrients extracted by the aerial parts of the plants are found in TABLE 3. The double-faced plastic mulch promoted higher average values for the total amounts of N, P, S, B, and Fe, due to a higher dry matter weight in the plants these treatments.

As for the other elements, the double-faced mulch treatment resulted in plants with no significant differences when compared to the treatment using black plastic, except for Mn, which was lower in the treatment using silver plastic mulch. The treatments without mulch had lower average values for total quantities of nutrients when compared to the treatments using plastic mulch.

TABLE 3 - Total amounts of nutrients extracted in the aerial part of iceberg lettuce cv. Lucy Brown, grow with different soil mulches. Sao Manuel, 1999.

Treatment	N	P	K	Ca	Mg	S	B	Cu	Mn	Zn	Fe
	---------- mg/plant ----------						---------- µg/plant ----------				
1. Control	84.3 c	27.1 c	211.6 b	53.5 c	22.9 c	10.5 c	106.2 c	22.2 b	1379.1 d	274.8 c	2476.0 d
2. Weeding	123.3 c	37.7 c	137.5 b	80.1 b	27.8 b	11.5 c	124.2 c	30.0 b	1432.6 d	275.0 c	3149.5 cd
3. Sugarcane bagasse	120.2 c	35.0 c	205.9 b	83.9 b	28.5 b	14.4 c	146.7 c	37.2 b	2160.7 c	467.9 b	3361.5 c
4. Black plastic	564.6 b	111.0 b	730.5 a	241.7 a	87.2 a	43.6 b	441.4 b	116.8 a	6753.8 a	1731.8 a	10340.6 b
5. Double-faced plastic	660.6 a	143.9 a	778.3 a	233.6 a	94.6 a	62.8 a	499.0 a	123.1 a	5712.0 b	1821.3 a	12066.0 a
c.v.(%)	6.05	10.36	9.13	14.26	11.57	12.57	7.71	13.33	5.86	6.74	5.5

Averages followed by the same letter (column) do not differ statistically, by Tukey Test at 0.01.

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