academicJournals

Vol. 10(46), pp. 4204-4208, 12 November, 2015
DOI: 10.5897/AJAR2015.10274
Article Number: ED9282256148
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Wind in the production of lettuce in Brazil (*Lactuca sativa* L.)

Lucas Tondo Wellington*, Flávio Gurgacz, Reginaldo Ferreira Santos, Eduardo De Rossi, Marinez Carpiski Sampaio and Cassio Duminelli

Ione Ronilde Bueno Tondo/Josemar Gilberto Tondo, Brazil.

Received 11 August, 2015; Accepted 6 October, 2015

Lettuce (*Lactuca sativa* L.) is a vegetable of higher consumption and economic value in Brazil. Due of the sensitivity of the leaves, the wind can bring losses to the perfect harmony of growth and physiological development the plant. Wind can also cause irreversible mechanical damage, such as senescence, burning, breaking, fall leaves and tear. The city of Cascavel in western Paraná is at an average altitude of 760 m enabling the continuous occurrence of strong winds. The aim of this study was to evaluate the effect of this meteorological variable in the production of lettuce and water evapotranspiration phenomenon with plants. Wind were made ducts with fans who had average wind speeds of 0, 2, 4, 6, 8 and 10 km/h, positioned at 2 m of plants in greenhouses. The evapotranspiration was verified by a evaporimeter installed in each wind duct for three sunny days, rainy and cloudy. After 49 days, they were taken and analyzed the height of plants and roots, number of leaves, fresh and dry mass of leaves and roots. It was found that the increase in wind speed also increases the evaporation, however, other environmental factors influence this parameter and the production decreases, as we increase the wind speed.

Key words: Greenhouse, evapotranspiration, *Lactuca sativa* L., wind.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a herbaceous plant belonging to the family of Asteraceae and is a typical salad vegetable. Considered as a tranquilizing properties plant and due to being consumed raw, retains all of its nutritional properties. It is a big source of vitamin A, and fewer vitamins: B1, B2, B5 and C, besides the minerals: Ca, Fe, Mg, P, K and Na. It has on average 96% water and it has low calorie (100 g of lettuce have an average of 15 calories). It is the leafy vegetable of higher consumption and economic importance in Brazil (Lisbão et al., 1990; Sonnenberg, 1985; Maroto-Borrego, 1983; Campbell-Clause, 1994; CEAGESP, 2013). Lettuce is grown in all regions of Brazil and has an area of 35,000 ha and the optimum temperature for development of lettuce is around 23°C during the day and 7°C at night. When is grown in regions with very high temperatures, burning occurs at the edges of the sheets (Resende et al., 2007; Jackson et al., 2013). American cultivars are

*Corresponding author. E-mail: wltparana@yahoo.com.br

characterized by leaves together to the center, forming a cabbage head and compact and can be curly or flat sheets. The roots are of the pivoting type having thin and short branches, exploiting only the first 25 cm of soil (Feltrim et al., 2005; Filgueira, 1982). The main purposes of the cultivation of lettuce protected structures are nullify the negative effects of low temperatures, frost, wind, excessive rain and hail; shorten the production cycle; increase productivity and get better quality products (Sganzerla, 1990).

The amount of evapotranspiration is of great importance in assessing the severity, frequency and distribution of water deficits, project design and management of irrigation and drainage. Evapotranspiration can be defined as a combined process of soil water transfer into the atmosphere, including the process of transpiration through the plant tissue and is an important factor in water balance, it helps to quantify water demand in a particular region (Junior and Resende, 2011; Vescove and Turco, 2005; Silva et al., 2007).

The wind is air movement in relation to the ground. The gradient of the atmospheric pressure is responsible for their training, being modified by the earth's rotation, the friction with the earth's surface and centrifugal force to its movement. The wind with height below 500 m going to suffer the effect of the frictional force, which acts in the same direction, but with the opposite direction to the wind speed. In this way, winds which occur continuously and excessively show up as a major problem for the development of agricultural activities, with a need for alternatives such as windbreaks to protect crops (Tubelis and Birth, 1980; Pereira et al., 2007).

As the wind increases, the shoot tends to send efforts to support, through the deepening of the root system and greater induration the stem. Mechanical stresses induced by the wind affects the root activity since there is increased growth and diameter. The same goes for the shoot, the wind action induces changes in the development, resulting in a more compact plant (Coutts et al., 1990; Fayle, 1976; Telewski, 1993). Assuming the report, the aim of this study is to evaluate the consequences of the wind, with different rates applied on plants of lettuce.

MATERIALS AND METHODS

The survey was conducted in Cascavel, Paraná, Brazil, at latitude 24°53'47 "S and longitude 53°32'09" W, on the campus of the State University of Western Paraná, in plastic greenhouse. The average annual rainfall is 1971 mm and the average temperature is 19.6°C, with the region's climate and temperate mesothermal and super humid (Iapar, 2011).

The arrangement used was experimental entirely randomized design with 4 repetitions for each treatment, in plastic greenhouse, planted on August, 15, 2013, in pots of 20 L in humus, with 5 cm seedlings and two leaves, with one plant each, installed in wind ducts separated by fences. The pots were set at 2 m away from the fans of 40 cm diameter and an angle between the main beam and wind plants of approximately 20°. In ducts, average wind speeds over the plants were applied: 0 (T1), 2 (T2), 4 (T3), 6 (T4), 8 (T5) e 10 (T6) km/h, whereas the value of 0 km/h as witness and daily leaving the fans connected between 9:00 and 18:00 pm, and used an anemometer to measure the measurements. Every day, they collected data of the minimum and maximum temperature inside the greenhouse, as well as the minimum and maximum relative humidity.

Irrigation was 180 daily ml in each pot on sunny days, and on cloudy and rainy days, was flooded 180 ml every 2 days, amount that based on the average evapotranspiration index in the city of 7 liters per square meter per day about (Silva et al., 2007). After 49 days, samples were collected and analyzed: the number of sheets (NF), plant height (AP) and root (AR) fresh mass of the leaves (MFF) and roots (MFR) and dry mass of the leaves (MSF) and roots (MSR). These results were submitted to analysis of variance (ANOVA) and their means compared by Tukey test, adopting the level 1-5% significance using the statistical Assistat® version 7.7 beta package (Silva, 2014).

RESULTS AND DISCUSSION

Figure 1 shown the contents of average daily evapotranspiration, on sunny days, rain and cloudy for each wind speed used in the ducts. It was found that the evaporation is larger as the wind speed increases. The typical of evapotranspiration values in Western Rio Grande do Sul region is 6 to 7 mm/day in sunny days and 4 to 5 mm/day in days rainy, differing from those obtained that were between 2.123 and 11.818 mm/day on sunny days and 0.557 mm and 1.337 mm/day on rainy days (Tabbal et al., 2002).

Figure 2 shows the values of minimum and maximum temperature and the maximum and minimum relative humidity collected. It was observed that the average temperature during the experiment was 20.37°C, however, there is a large variation in temperature of the region, and days 35.4°C with maximum temperature only 0.9°C minimum temperature, testifying to the measurements made by Iapar (2011).

The average relative humidity during the trial period was 65.51%, but with wide variations, with a minimum of 28% and a maximum of 94%, confirming Amorim et al. (2001) who obtained the average relative humidity 75 to 81%.

It showed that rainy days have a higher relative humidity and consequently, low evaporation. In contrast, the sunny days have a high evapotranspiration and lower relative humidity. The microclimatic behavior of rainy and cloudy days were similar, however, the sunny days showed high amplitude variation in temperature, relative humidity and evaporation.

The results of the samples taken are shown in Table 1. It was found that strong winds cause a deficit in the production of lettuce, having damage and reducing the amount of fresh dough, so the leaves, the roots.

Thus, it is seen that strong winds cause a deficit in the

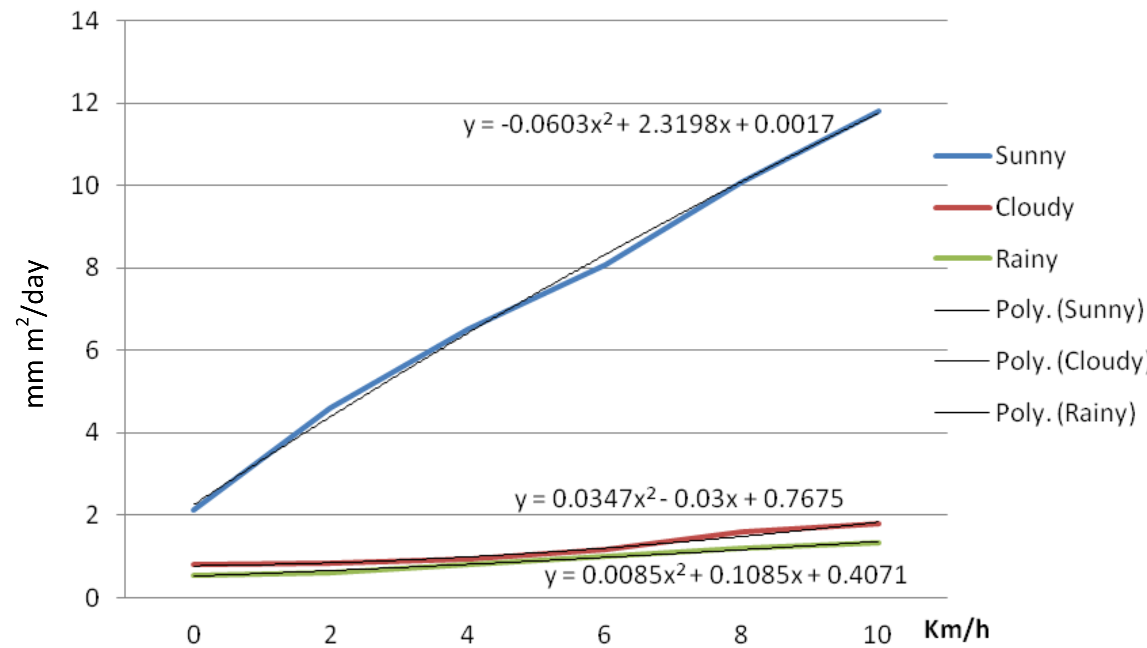

Figure 1. Evaporation average (mm day -1) in the wind ducts in sunny, cloudy and rainy days.

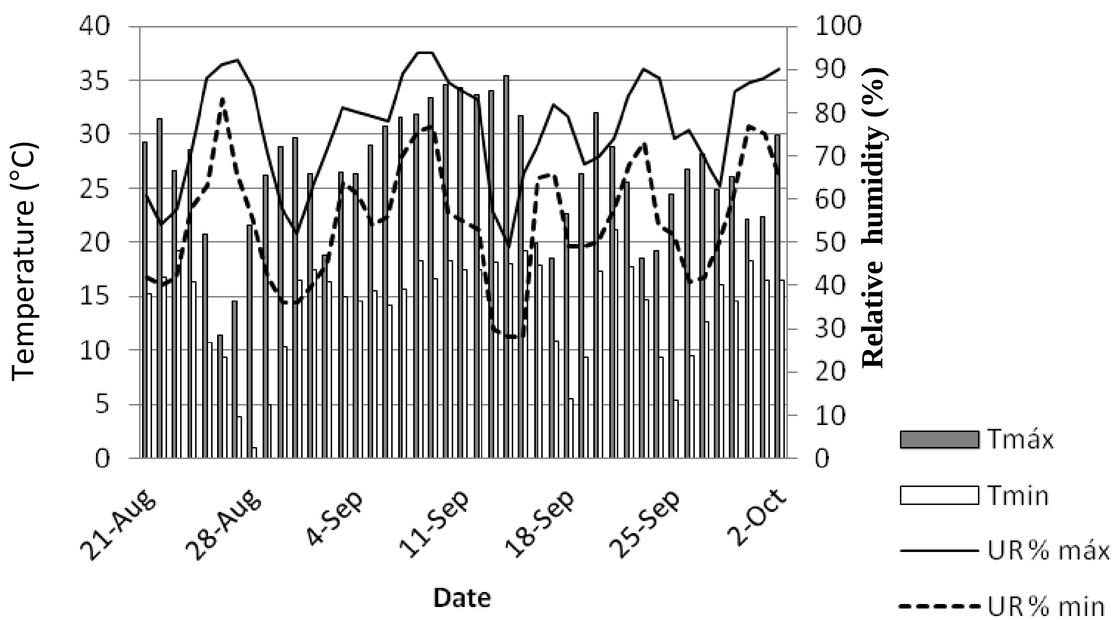

Figure 2. Temperature (T °C) Minimum (Tmin) and maximum (Tmax) and relative humidity (%) Minimum (URmin) and maximum (URmáx).

production of lettuce crop, or increased as the wind speed, the plants showed damage to leaves by reducing the amount of fresh mass, so the leaves, the roots. In winds of 10 km/h only remaining 2 plants, and fresh mass of leaves average was only 2.46 g. Campbell-Clause (1994) evaluated the effect of the winds in grape cultivars Rubi and Italy, using windbreaks, with permeability of 40% and height around 4 m, arranged perpendicular to

Table 1. Results obtained in the experiment.

Wind	AP (cm)	NF	MFF (g)	MSF (g)	AR(cm)	MFR (g)	MSR(g)
T1	24.125[a]	18.500[a]	159.292[a]	5.807[a]	9.750[ab]	5.965[a]	1.237[ab]
T2	26.625[a]	19.750[a]	126.622[ab]	5.282[ab]	12.000[a]	4.945[a]	1.437[a]
T3	29.625[a]	18.500[a]	104.150[bc]	4.182[bc]	9.500[ab]	3.460[ab]	0.910[abc]
T4	24.125[a]	16.250[a]	72.125[cd]	3.104[c]	7.625[b]	2.032[bc]	0.297[c]
T5	23.375[a]	14.500[a]	67.105[d]	3.075[c]	7.625[b]	2.210[bc]	0.500[bc]
T6	5.475[b]	3.000[b]	1.232[e]	0.170[d]	2.807[c]	0.222[c]	0.042[c]
F	17.437**	28.191**	44.587**	38.814**	14.698**	13.738**	7.919**
CV%	18.37	15.51	18.59	17.96	19.72	36.01	52.83
GA	22.222	15.083	88.421	3.604	8.218	3.199	0.737

[a] Means followed by the same letter within each analyzed parameter (column), do not differ by Tukey test at 5% error probability. (**) = Significant at 1% probability (*) = significant at the 5% probability (NS) = not significant. CV%: coefficient of variation. GA: General Average.

the direction of the winds, in Western Australia and obtained a productivity and fresh pasta grape of up to 23% compared to the control that did not use the windbreak, corroborating the data obtained in the experiment and noting that, for different cultures, the winds are harmful.

Conclusion

Winds applied to the crop of lettuce significantly increase evapotranspiration on sunny days, but on cloudy and rainy days, this occurs less. Wind action result in mechanical damage and disorderly growth of leaves, which reduces the fresh mass of aerial part of the plant. At speeds of 10 km/h, the culture is practically lost.

Conflict of Interests

The authors have not declared any conflict of interest.

REFERENCES

Amorim RCF, Ricieri RP, Son JSV, Amorim RFC, Di Pace LT, Second GHC, Milk CC (2001). Probability of maximum temperature, minimum and average air for corn in Cascavel, western Paraná. Proceedings XII Brazilian Congress of Agrometeorology / III Latin American Meeting of Agrometeorology, Fortaleza - CE, 2001.

Campbell-Clause J (1994). The effect of wind on table grape production. International Symposium on table grape production. Davis Am. Soc. Enol. Viticult. pp. 171-174.

CEAGESP (2013). (Warehouse Center and Storage General of the State of São Paulo). Lettuce rating. São Paulo, 2013. Access 18 mai 2015. Online. Addtional in <http://www.ceagesp.gov.br>.

Coutts MP, Walker C, Bumand AC (1990). Effects of establishment method on root form of Lodgepole pine and Sitka spruce and on the production of adventitious roots. Fac. For. Univ. Toronto 63(2):143-159.

Fayle DCF (1976). Radial growth in tree roots. Technical report no. 9. Faculty of Forestry, University of Toronto. P 183.

Feltrim AL, Cecílio Filho AB, Branco RBF, Barbosa JC, Salatiel LT (2005). Iceberg lettuce production in soil and in hydroponics, in winter and summer in Jaboticabal, SP., Campina Grande, PB. J. Agric. Environ. Eng. 9(4):505-509.

Filgueira FAR (1982). Cichoriáreas: Lettuce, chicory and endive. In: horticulture Guide: Culture and marketing of vegetable. 2nd Ed Sao Paulo: Agron. Ceres 2(3):77-93.

IAPAR Agronomic Institute of Paraná. (2011). Historical averages in IAPAR stations. Acesso: 06 May 2015. Online. Available in: <http://www.iapar.br/arquivos/Image/monitoramento/Medias_Historicas/Cascavel.html>.

Jackson L, Mayberry K, Laemmlen F, Koike S, Schulbach K, Chaney W (1996). Iceberg lettuce production in California, 1996. Accessed on: 16 may. 2015. Online. Available in: http://www.agmrc.org/media/cms/7215_9E0CF0CBDF80E.pdf.

Lisbão RS Nagai H, Trani PE (1990). Alface. In: INSTITUTO AGRONÔMICO DE CAMPINAS. Instruções agrícolas para o Estado de São Paulo. 5.ed. Campinas pp. 11-12. (Boletim, 200).

Maroto-Borrego JV (1983). Horticulture: Special herbaceous, 2nd Ed, Madrid: Mundi-Prensa, P 590.

Pereira AR, Angelocci LR, Sentelhas PC (2007). Agricultural Meteorology. Piracicaba, College of Agriculture "Luiz de Queiroz" – USP. P 25.

Resende FV, Saminêz TCO, Vidal MC, Souza RB, Clemente FM (2007). Cultivation of lettuce in an organic system, EMBRAPA, Brasília, Nov. 2007.

Resende SAA, Resende Junior JC (2011). Interference of the winds in the cultivation of plants: Harmful effects and preventive practices, Encyclopedia Biosphere Scientific Centre Know, Goiânia 7(12):1.

Sganzerla E (1990). The fascinating art of growing with plastics, New Agriculture, 2nd Ed, Porto Alegre, Triunfo, p. 303, Accessed on: 19 may. 2015. Online. Available in: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-05362009000200025

Silva FAS (2014). ASSISTAT: Version 7.7 beta. DEAG-CTRN-UFCG - Updated April 1, 2014. Accessed: 19 May. 2015. Available at: <http://www.assistat.com/>.

Silva WCM, Ricieri RP, Souza JL, Ribeiro A (2007). agro-climatic characterization of Cascavel - Paraná for corn, Ceres Mag. 54:341-348.

Sonnenberg PE (1985). Vegetable Crops special. 5. Ed. Goiânia, UFGO, 1:187.

Tabbal DF, Bouman BAM, Bhuiyan SI, Sibayan EB, Sattar MA (2002). On-farm strategies for reducing water input irrigated rice: Case studies in the Philippines. Agricultural water management, Amsterdam. 56(2):93-113.

Telewski FW (1993). Wind induced physiological and developmental responses in trees. In: Wind and wind-related damage to trees. (Eds. J. Grace & M.P. Coutts). Proceedings of the IUFRO conference, July 1993.

Tubelis A, Birth FJL (1980). descriptive Weather: Brazilian fundamentals and applications. Sao Paulo: Nobel Bookstore, P 374.

Vescove HV, Turco JEP (2005). Comparison of three methods of estimation of reference evapotranspiration for the region of Araraquara. - SP, J. Agric. Eng. Jaboticabal 25(3):713-721.