DOI: 10.5747/ca.2021.v17.n1.a416
ISSN on-line 1809-8215
Colloquium Agrariae
Submetido: 07/09/2020 Revisado: 05/01/2021 Aceito: 28/01/2021

Development of cauliflower seedlings due to the increase of silicon in substrate

Gustavo Soares Wenneck, Reni Saath, Roberto Rezende, Danilo Cesar Santi, André Felipe Barion Andrean, Larissa Leite de Araújo, Nathália de Oliveira Sá

Universidade Estadual de Maringá – UEM, PR. E-mail: gustavowenneck@gmail.com

Abstract
The production of seedlings is an important step in the establishment of the crop, with repercussions on yield, whose application of Si can improve phytosanitary and performance characteristics. The objective of the study was to analyze the increase of silicon in substrate on the development of seedlings of *Brassica oleracea* var. *botrytis*. The experiment carried out in randomized blocks, with five amounts of silicon (0, 25, 50, 75 and 100 g kg^{-1} of substrate) and four replications. Silicon oxide (98% SiO_2) used, mixed with the substrate with subsequent filling of the polyethylene trays (128 cells) and seeding. The trays kept in a greenhouse. At 30 days after sowing, the height of seedlings, number of leaves, fresh weight of leaves and stem, dry weight of leaves, stem and root evaluated. The data subjected to analysis of variance by the F test and regression analysis. Of the variables analyzed, only the dry root mass did not show a significant difference. Quadratic models can represent the variation in components. Seedling height increased with the increase of silicon up to the dose of 75 g kg^{-1}. Other variables showed increases up to a dose of 50 g kg^{-1}. The increase of silicon in the substrate was efficient in the development of seedlings of *Brassica oleracea* var. *botrytis* in an amount of up to 50 g kg^{-1} of substrate.
Keywords: *Brassica oleracea* var.; *botrytis*; efficiency; beneficial element.

Desenvolvimento de mudas de couve-flor em função do incremento de silício no substrato

Resumo
A produção de mudas é etapa importante do estabelecimento da cultura, com reflexos no rendimento, cuja aplicação de Si pode melhorar características fitossanitárias e de desempenho. O objetivo do estudo foi analisar o incremento de silício em substrato sobre o desenvolvimento de mudas de *Brassica oleracea* var. *botrytis*. O experimento foi desenvolvido em blocos casualizados, com cinco quantidades de silício (0, 25, 50, 75 e 100 g kg^{-1} de substrato) e 4 repetições. Foi utilizado óxido de silício (98% SiO_2), sendo misturado ao substrato com posterior preenchimento das bandejas de polietileno (128 células) e semeadura. As bandejas foram mantidas em casa de vegetação. Aos 30 dias após a semeadura foi avaliado a altura das mudas, número de folhas, massa fresca das folhas e caule, massa seca das folhas, caule e raiz. Os dados foram submetidos a análise de variância pelo teste F e análise de regressão. Das variáveis analisadas, apenas a massa seca de raízes não apresentou diferença significativa. Modelos quadráticos podem representar a variação dos componentes. A altura de mudas foi crescente com o incremento de silício até a dose de 75 g kg^{-1}. Demais variáveis apresentaram acréscimos até dose de 50 g kg^{-1}. O incremento de silício no substrato foi eficiente no desenvolvimento de mudas de *Brassica oleracea* var. *botrytis* em quantidade até 50 g kg^{-1} de substrato.
Palavras-chave: *Brassica oleracea* var.; *botrytis*; eficiência; elemento benéfico.

Introduction

Silicon (Si), one of the main elements in abundance in the earth's crust, is found in low content in tropical soils resulting from leaching (KAUSHIK; SAINI, 2019; MALAVOLTA, 2006). Although it not considered an essential element for the development of plants, it considered a beneficial element, due to the effect generated in plants on unfavorable physical and chemical conditions (MENEGALE *et al.*, 2015).

The main sources of Si are associated with the release of oxides and hydroxides, decomposition of plant residues and dissociation of polymeric silicon acid (MENEGALE *et al.*, 2015). With silicate fertilizations being carried out in addition to fertilizers and/or specific applications with positive results for crops of grains and cereals, such as rice, oats, corn, soybeans and wheat, with effects mainly on phytopathogenic control as observed in vegetables, with positive effects on post-harvest (LOZANO *et al.*, 2018; CURVELO *et al.*, 2019; ALMEIDA *et al.*, 2017).

The Si in vegetables adds physical and chemical resistance in vegetables, increasing the resistance of tissues and with the production of phenolic compounds, phyto-alexins and other metabolic, acting in defense against the attack of pathogens (WEERAHEWA; SOMAPALA, 2016; JADHAO *et al.*, 2020). From the Si sources available are steel slag, potassium silicates, calcium, aluminum and silicon oxides (GUALBERTO, 2018; MENEGALE *et al.*, 2015).

Although several studies address the use of Si in the control and prevention of pathogen attack (CANTUÁRIO *et al.*, 2014, JADHAO *et al.*, 2020), from the point of view of the performance of vegetable seedlings, few studies allow its interpretation. This deficit is associated with the lack of information specifying the nutrient content of the material used as a substrate and the efficiency of silicon sources (MENEGALE *et al.*, 2015).

Research on the topic is mainly developed for the production of forest and vegetable species seedlings, whose increment generated is economically viable (BRAGA *et al.* 2009; GONZAGA *et al.*, 2020; NAVAS *et al.*, 2016; QUEIROZ *et al.*, 2018), justifying the development of studies with cauliflower. In this sense, assuming that increasing dosage of silicon added to the substrate to form seedlings may favor the initial development of vegetables, the research aimed to analyze the increase in different proportions of silicon oxide to the substrate and the effects on cauliflower seedlings. (*Brassica oleracea* var. *Botrytis*).

Materials and methods

The experiment was conducted at the Technical Irrigation Center (CTI) belonging to the State University of Maringá (UEM), whose geographical coordinates are latitude 23°25'57 ”S, longitude 51°57’08” W and altitude of 542 m. The local climate is characterized as Cfa, with temperature between 22.1 to 22°C, solar radiation from 14.5 to 15 MJ m^{-2} day^{-1}, annual precipitation of 1400 to 1600 mm with evapotranspiration between 1000 to 1100 mm (NITSCHE *et al.*, 2019). The seedlings conducted between August 27 and October 26, 2019, with temperatures ranging between 12.9 and 37.1°C and relative humidity between 42 to 93% in the protected environment.

Cauliflower seeds (cultivar sharon®) were sown at an inch of depth in plastic trays with 128 cells. The plastic trays remained on a bench at 1.5 m in height, in protected environment (greenhouse) with an arch cover with 150 micron plastic screen, height of the right foot of 3 meters and with sides protected with anti-aphid screen.

A randomized block design adopted, with five doses of Si (0, 25, 50, 75 and 100 g kg^{-1} of substrate) and four replications, composed of 12 cells. In order to determine the doses, quantities adopted in studies aiming at the efficiency of the application of the element to the soil, fertigation and leaf were considered. The substrate had an initial Si content of 16.04 mg kg^{-1} of substrate, being incremented, according to the treatment, homogenized to the material and then the plastic trays filled. The source of Si adopted was Agrisil® (98% SiO_2), constituted in the form of wettable powder with pH (1%) between 7.5 and 8. In the culture management, the application of water in the trays was carried out with a manual watering can, in three periods of the day (7am, 12:00 and 6 pm). The water from semi-artesian well as characteristics with pH 7.78; electrical conductivity 158.55 µS cm^{-1}; total hardness ($CaCO_3$) 48.85 mg L^{-1} and dissolved silica (SiO_2) 45.94 mg L^{-1}.

At 30 days after sowing (DAS) the morphological development of the seedlings was evaluated, measuring their height with a digital caliper (±0.01 mm) and weighing the fresh weight of the leaves and stem on an analytical scale (± 0.001g). To determine the root mass, the removal of the adhered substrate carried out in running water, wiping them with paper towels and the clean samples weighed on an analytical balance. The samples were kept in a forced air circulation oven (65°C) for 72 hours, obtaining from the weight difference (initial and final), the dry mass values of the plant parts (leaf, stem and root) being expressed in mg.

Descriptive analysis, correlation of variables, analysis of variance performed by the F test with 5% significance, using the SISVAR software (FERREIRA, 2019) and regression analysis.

Results and discussion

Considering that the development of seedlings is related to the potential in the field, considering the productive capacity, resistance to the attack of pests and pathogens, tolerance to adverse conditions, for this the supplementation of nutrients in the substrate is carried out (BEZERRA, 2003).

The performance of cauliflower seedlings is reflected in the yield of the crop, and genetic characteristics can influence the production potential and preparation period of the seedlings until transplanting (Hossain *et al.*, 2020). According to the analysis of variance, the variables height, fresh leaf weight, fresh weight of the stem, dry weight of the leaf, dry weight of the stem and number of leaves per seedling showed a significant variation for Si applied. The root dry mass did not show any significant effect ($p < 0.05$) due to the increase in Si.

When analyzing the correlation data (Table 1), the dry mass of the plant parts and the fresh matter of the stem and leaves showed an interaction (correlation greater than 0.85). It found that the variables height and number of leaves per seedling showed a correction of less than 0.7 with the other variables.

Table 1. Correlation of the morphological variables of cauliflower (*Brassica oleracea* var. *Botrytis*) seedlings with increment of Si in the substrate.

	Height	FM sheets	FM stalk	DM sheets	DM stalk	DM root	NLS
Height	1.00	-	-	-	-	-	-
FM sheets	0.55	1.00	-	-	-	-	-
FM stalk	0.57	0.96	1.00	-	-	-	-
DM sheets	0.51	0.92	0.91	1.00	-	-	-
DM stalk	0.55	0.87	0.92	0.95	1.00	-	-
DM root	-0.03	0.13	0.13	0.13	0.02	1.00	-
NLS	0.33	0.65	0.65	0.65	0.63	0.24	1.00

* FM: Fresh mass; DM: Dry mass; NLS: Number of Leaves per Seedling.

The correlation between height and root dry matter was negative (-0.03). Studies developed with eucalyptus species (*Eucalyptus camaldulensis* and *Eucalyptus urograndis*) the application of silicon promoted an increase in the development and translocation of the nutrient in the seedlings (QUEIROZ *et al.*, 2018; NAVAS *et al.*, 2016). The increase in Si can be a viable technique for the production of lettuce seedlings, increasing morphological development (Gonzaga *et al.*, 2020). When analyzing the size of the aerial part, seedlings handled on substrate with Si increase showed greater development in height (Table 2) up to the dose of 75 g kg^{-1}, and a reduction in the dose of 100 g kg^{-1}, being even less than the control (0 g kg^{-1}).

Table 2. Effect of the increase of Silicon in substrate on the development of cauliflower seedlings (*Brassica oleracea* var. *Botrytis*) of aerial part height and number of leaves per seedling.

Si increment	Height (mm)	NLS

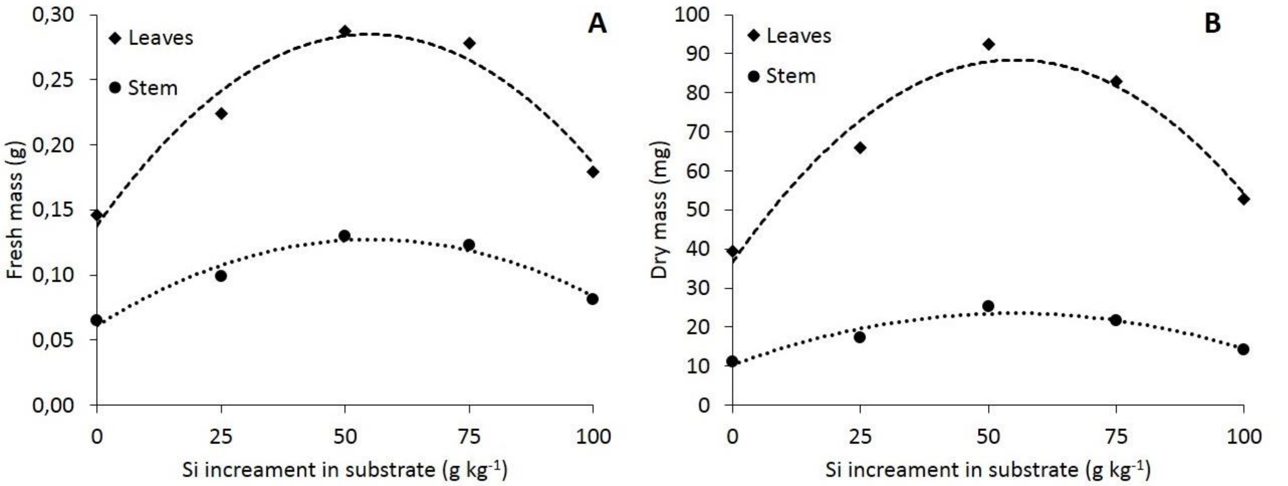
(g kg^{-1})	mean	SD	mean	SD
0	19.78	(0.21)	2.14	(0.10)
25	21.46	(0.36)	2.80	(0.43)
50	22.98	(0.41)	3.00	(0.23)
75	22.59	(0.48)	2.88	(0.36)
100	19.15	(0.59)	2.52	(0.32)

*NLS- Number of leaves per seedling; SD- Standard deviation.

Increase of more than 50 g kg^{-1} caused the presence of seedlings with a higher height and a smaller number of leaves (Table 2), a characteristic similar to estiolation, whose direct consequence negatively reflected in the development and yield of the crop, being an unwanted characteristic. According to Ribeiro *et al.* (2011) in a study developed with *Coffea arabica* using calcium silicate concluding that high doses reduced root development without altering the development of the aerial part and gas exchange.

The results indicate similarity with cauliflower seedlings, with a decrease in height with an increase greater than 75 g kg^{-1}, and with an increase greater than 50 g kg^{-1} without number of leaves per seedling (Table 2), fresh mass (Figure 1A) and dry mass of the aerial part (Figure 1B). Mathematical models that representation accumulation of fresh mass and dry masses on stem and leaf shown in Table 3.

Figure 1. Mass accumulation in cauliflower (*Brassica oleracea* var. *Botrytis*) seedlings at 30 days after sowing, by increasing Si in the substrate. A) Accumulation of fresh mass on the leaves and stem; B) Accumulation of dry mass on the leaf and stem.



The literature does not mention effects on plant development resulting from Si toxicity, with low concentration conditions in nature more easily (MALAVOLTA, 2006). However, the source of Si used can alter the pH and dynamics of nutrients, resulting in nutritional imbalances and/or modifying mineral and physiological characteristics (KORNDORFER, 2006; CANTUÁRIO *et al.*, 2014). When analyzing that the response to Si application presents a quadratic model, it is observed that the increase is efficient up to a maximum point, followed by the decrease in development, whose response is not only related to the Si concentration, but also to the interaction with other elements and with the changes caused by the characteristics of the font used.

Table 3. Equations of regression models for leaf and stem of cauliflower (*Brassica oleracea* var. *Botrytis*) seedlings.

Component	Variable	Equation	R^2
Stalk	Fresh mass	$Y= -2E\text{-}05x^2 + 0.0024x + 0.0613$	0.96
	Dry mass	$Y = -0.0044x^2 + 0.4849x + 10.276$	0.92
Sheets	Fresh mass	$Y= -5E\text{-}05x^2 + 0.0053x + 0.1379$	0.96
	Dry mass	$Y = -0.017x^2 + 1.878x + 36.641$	0.96

In hydroponic lettuce cultivation, the use of sodium metasilicate in the nutrient solution reduced the development of plants with the intensity of the effect varying with the cultivar (NEVES *et al.*, 2020). Still on lettuce, the application of potassium silicate improved physiological processes in conditions of water restriction, with a better dose in the estimated dose of 125 mg L^{-1} (FATIMA *et al.*, 2019).

Although not evaluated by this study, the increase of silicon in the substrate tends to increase its availability to the plant. The interaction of this element influences the absorption dynamics of other nutrients, increasing the availability of phosphorus and reducing the toxicity of other elements (ALMEIDA, *et al.*, 2017; BARRETO *et al.*, 2017). In relation to the control (0 g kg^{-1}) the increase in Si reduced the fresh mass/dry mass ratio of the stem, and increased the leaf/stem ratio for dry mass. For the other relations analyzed, the response varies with the quantity adopted (Table 4).

Table 4. Relationship of the morphological components of cauliflower seedlings (*Brassica oleracea* var. *Botrytis*) as a function of the Si increase in the substrate.

Silicon (g kg^{-1})	Sheets FM/DM	Stalk FM/DM	Sheets/Stalk	Sheets/Root	Stalk/Root
			-------------Dry mass-------------		
0	3.59	5.67	3.53	7.98	2.26
25	3.32	5.69	3.83	7.32	1.91
50	3.24	5.37	3.65	9.65	2.64
75	3.33	5.69	3.83	8.15	2.13
100	3,.40	5.78	3.74	6.49	1.74

*FM- Fresh mass; DM- Dry mass.

When analyzing the maximum values observed for the development of the aerial part of the seedlings (Figure 1), the amount of 50 g kg^{-1} showed better results, whose relationship between components (Table 4) confirms the greater accumulation of dry mass, and not only elevation of water content. The development of leaves and stem, in the condition of 50 g kg^{-1}, was closer to that obtained in the control treatment, in comparison to the other quantities adopted.

Still, in relation to the development of the aerial part compared to the development of roots (Table 4), the doses of 25 and 100 g kg^{-1} presented a lower leaf/root and stem/root ratio than the control (0 g kg^{-1}), while the dose of 50 g kg^{-1} showed a higher relationship. At a dose of 75 g kg^{-1} the leaf/root ratio was higher than the control, however the stem/root ratio was lower.

The increase in Si by plants does not have a direct relationship with the production of biomass and it not considered an essential element for the plant cycle, however the results of its use can be satisfactory or because a decrease in development according to the quantity adopted. According to Couto *et al.* (2020), utilization showed efficiency with maximum estimated dose for application in rice of 1.68 g L^{-1}, using sodium and potassium silicate stabilized with sorbitol as a source. Positive results, through the application of Si, also reported in the productive performance and in the post-harvest of cauliflower (BARRETO *et al.*, 2017; CURVELO *et al.*, 2019; HOSSAIN *et al.*, 2020).

Considering the initial Si content in the substrate of 16.04 mg kg^{-1} of substrate and in water of 45.94 mg L^{-1}, the increase, using as source the silicon oxide, in quantities greater than 50 g kg^{-1} caused a reduction to the analyzed variables, this being the maximum recommended amount of increment, according to the adopted conditions. The obtained results allow improving the efficiency in the production of cauliflower seedlings by the use of Si, increasing the morphological development until the transplant period. Further studies needed to determine the dynamics of Si in the analyzed environment and the rate of Si absorption by seedlings of *Brassica oleracea* var. *botrytis*.

Conclusions

The increase of silicon in the substrate has an effect on seedling development.

The use of silicon, in the form of oxide, increased the morphological development of seedlings of *Brassica oleracea* var. *botrytis* when applied in an amount of up to 50 g kg^{-1} of substrate.

Acknowledgments

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001; To Agrobiológica for making material available.

References

ALMEIDA, L. H. C.; KLEIN, P. H.; OLIVEIRA, E. C.; MIGLIORANZA, E. Silício e disponibilidade de fósforo no crescimento e desenvolvimento de mudas de café. **Cultura Agronômica**, v. 26, n. 2, p. 123-131, 2017. https://doi.org/10.32929/2446-8355.2017v26n2p123-131

BARRETO, R. F.; SCHIAVON JÚNIOR, A. A.; MAGGIO, M. A.; PRADO, R. M. Silicon alleviates ammonium toxicity in cauliflower and in broccoli. **Scientia Horticulturae**, v. 225, n. 18, p. 743-750, 2017. http://dx.doi.org/10.36560/1312020863

BEZERRA, F. C. **Produção de mudas de hortaliças em ambiente protegido**. Fortaleza, CE: Embrapa Tropical, 2003. (Embrapa Agroindústria Tropical. Documentos, 72). 22 p. Disponível em: https://www.infoteca.cnptia.embrapa.br/bitstream/doc/425185/1/doc72.pdf. Acesso em: 01 set. 2020.

BRAGA, F. T.; NUNES, C. F.; FAVERO, A. C.; PASCAL, M.; CARVALHO, J. G.; CASTRO, E. M. Características anatômicas de mudas de morangueiro micropropagadas com diferentes fontes de silício. **Pesquisa agropecuária brasileira**, v. 44, n. 2, p. 128-132, 2009. https://doi.org/10.1590/S0100-204X2009000200003

CANTUÁRIO, F. S.; LUZ, J. M. Q.; PEREIRA, A. I. A.; SALOMÃO, L. C.; REBOUÇAS, T. N. H. Podridão apical e escaldadura em frutos de pimentão submetidos a estresse hídrico e doses de silício. **Horticultura Brasileira**, v. 32, p.215-219, 2014. https://doi.org/10.1590/S0102-05362014000200017

COUTO, C. A.; FLORES, R. A.; CASTRO NETO, J.; PEIXOTO, M. M.; SOUZA JUNIOR, J. P.; PRADO, R. M.; MESQUITA, M. Crescimento, biomassa e qualidade fisiológica do arroz em função da aplicação foliar de silício. **Brazilian Journal of Development**, v. 6, n. 4, p. 18997-19014, 2020. https://doi.org/10.34117/bjdv6n4-170

CURVELO, C. R. S.; FERNANDES, E. F.; DINIZ, L. H. B.; PEREIRA, A. I. A. Desempenho agronômico da couve-flor (*Brassica oleracea* var. *botrytis*) em função da adubação silicatada. **Revista Agricultura Neotropical**, v. 6, n. 1, p. 87-91, 2019. https://doi.org/10.32404/rean.v6i1.2556

FATIMA, R. T.; JESUS, E. G.; GUERRERO, A. C.; ROCHA, J. L. A.; BRITO, M. E. B. Adubação silicatada como atenuante do estresse hídrico no crescimento e trocas gasosas da alface. **Revista Engenharia na Agricultura**, v. 27, n. 2, p. 170-179, 2019. https://doi.org/10.13083/reveng.v27i2.892

FERREIRA, D. F. SISVAR: a computer analysis system to fixed effects Split plot type designs. **Revista Brasileira de Biometria**, v. 37, n. 4, p. 529-535, 2019. https://doi.org/10.28951/rbb.v37i4.450

GONZAGA, T. O. D.; ARAÚJO, C.; ANDRADE, A. L.; SANTOS, J. M. R.; SILVA, G. B.; SILVA, V. L. Produção de mudas de alface (*Lactuca sativa*) submetidas a diferentes doses de Silício. **Scientific Electronic Archives**, v. 31, n. 1, p. 1-7, 2020. https://doi.org/10.1016/j.scienta.2017.08.014

GUALBERTO, C. A. C. **Subprodutos industriais como fontes de silício e condicionadores de solos tropicais em cultivo de arroz inundado**. 2018. 64 f. Dissertação (Mestrado em Agronomia) - Universidade Federal de Uberlândia, Uberlândia, 2018. Disponível em: http://dx.doi.org/10.14393/ufu.di.2018.747. Acesso em: 02 set. 2020.

HOSSAIN, B.; RUHI, R. A.; MOHSIN, G. M. Effects of varieties and seedlings age on growth and yield of cauliflower. **Tropical Agroecosystems**, v. 1, n. 2, p. 62-66, 2020.

JADHAO, K. R.; BANSAL, A.; ROUT, G. R. Silicon amendment induces synergistic plant defense mechanism against pink stem borer (*Sesamia inferens* Walker.) in finger millet (*Eleusine coracana* Gaertn.). **Scientific Reports**, v. 10, n. 4229, 2020. https://doi.org/10.1038/s41598-020-61182-0

KAUSHIK, O.; SAINI, D. K. Silicon as a vegetable crops modulator- a review. **Plants**, v. 8, n. 6, p. 1-18, 2019. https://doi.org/10.3390/plants8060148

KORNDORFER, G. H. Elementos Benéficos. *In:* FERNANDES, M. S (ed). **Nutrição mineral de plantas.** Viçosa: Sociedade Brasileira de Ciência do Solo, 2006. p. 355-370.

LOZANO, C. S.; REZENDE, R.; HACHMANN, T. L.; SANTOS, F. A. S.; LORENZONI, M. Z.; SOUZA, A. H. C. Yield and quality of melon under silicon doses and irrigation management in a greenhouse. **Pesquisa Agropecuária Tropical**, v. 48, n. 2, p. 140-146, 2018. https://doi.org/10.1590/1983-40632018v4851265

MALAVOLTA, E. **Manual de nutrição mineral de plantas**. São Paulo: Agronômica Ceres, 2006. 638 p.

MENEGALE, M. L. C.; CASTRO, G. S. A.; MANCUSO, M. A. Silício: interação com o sistema solo-planta. **Journal of Agronomic Sciences**, v. 4, n. especial, p. 435-454, 2015.

NAVAS, R.; NUNES, M. C.; VASCONCELLOS JUNIOR, J. B. Aplicação de ferro e silício na produção de mudas de eucalipto. **Revista Agrarian**, v. 9, n. 32, p. 137-136, 2016.

NEVES, M. G.; PINHEIRO, S. M. G.; CARDOSO, F. L.; MACHADO R. S.; MAMBRI, A. P. S.; ANDRIOLO, J. L. Silício no crescimento e desenvolvimento de plantas de alface em cultivo fora do solo. **Brazilian Journal of Development**, v. 6, n. 1, p. 2330-2337, 2020. https://doi.org/10.34117/bjdv6n1-170

NITSCHE, P. R.; CARAMORI, P. H.; RICCE, W. S.; PINTO, L. F. D. **Atlas Climático do Estado do Paraná**. Londrina, PR: IAPAR, 2019.

QUEIROZ, D. L.; CAMARGO, J. M. M.; DEDECEK, R. A.; OLIVEIRA, E. B.; ZANOL, K. M. R.; MELIDO, R. C. N. Absorção e translocação de silício em mudas de *Eucalyptus camaldulensis*. **Ciência Florestal**, v. 28, n. 2, p. 632-640, 2018. https://doi.org/10.5902/1980509832053

RIBEIRO, R. V.; SILVA, L.; RAMOS, R. A.; ANDRADE, C. A.; ZAMBROSI, F. C. B.; PEREIRA, S. P. O alto teor de silício no solo inibe o crescimento radicular de cafeeiros sem afetar as trocas gasosas foliares. **Revista Brasileira de Ciência do Solo**, v. 35, p. 939-948, 2011. https://doi.org/10.1590/S0100-06832011000300028

WEERAHEWA, D.; SOMAPALA, K. Role of silicone on enchancing Disease Resistance in Tropical Fruits and vegetables: A Review. **OUSL Journal**, v. 11, p. 135-162, 2016. https://doi.org/10.4038/ouslj.v11i0.7347