

**FEDERAL UNIVERSITY OF PELOTAS  
Eliseu Maciel Agronomy Faculty  
Crop Protection Graduate Program**

**Dissertation**



**Effect of enhanced CO<sub>2</sub> atmospheric concentration on rice and weedy rice**

**Andrisa Balbinot**

**Pelotas, 2020**

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Dissertation presented to the Graduate Program in Crop Protection at the Federal University of Pelotas, as a partial requirement to obtain the title de “Doutor em Fitossanidade”.

Advisor: PhD. Luis Antonio de Avila

Committee: Dr. Nelson Diehl Kruse  
Dr. Dirceu Agostinetto  
PhD. Edinalvo Camargo  
PhD. Lewis H. Ziska

Pelotas, 2020

**Examining board:**

Prof. PhD. Luis Antonio de Avila: \_\_\_\_\_  
(Departamento de Fitossanidade/UFPEL)

Prof. Dr. Nelson Diehl Kruse: \_\_\_\_\_  
(Departamento de Defesa Fitossanitária/CCR/UFMS)

Prof<sup>a</sup>. Dr<sup>a</sup> Catarine Markus: \_\_\_\_\_  
(Departamento de Plantas de Lavoura/ Faculdade de Agronomia/UFRGS)

Prof. Dr. Anderson Luis Nunes: \_\_\_\_\_  
(IFRS – Sertão/RS)

Prof. Dr. Mauricio de Oliveira: \_\_\_\_\_  
(DCTA – LabGrãos/UFPEL)

The greatest of all my inspirations, my great friend, my safe harbor, my greatest supporter, my sister Aline Balbinot, I dedicate to you. I love you infinitely.

## ACKNOWLEDGMENT

Firstly, I'd like to thank you for my guardian angel, who rules and accompanies me since the beginning of my life, which is present daily and allows me to experience infinite possibilities.

I'm grateful to my family, who always supported me, even when supporting meant allowing me to fall, because in those moments one learns the most important lessons of life. For the understanding and unconditional love, for education and values taught to me, with all of my love Deolino José, Joira Carolina, Andreia, Aline and Henrique. To my always present godparents, Geraldo and Neiva, thank you for your love, dedication and for guiding me.

I'm also grateful for the opportunity to work with professionals dedicated to this noble profession, which is to be a teacher, to transmit knowledge, especially PhD. Franck Dayan, Dr. Dirceu Agostinetti, PhD. Nilda Burgos, Dr. Gustavo Maia and PhD Edinaldo Camargo. My thanks also go to the opportunity given to me both in terms of infrastructure and of competent professionals at UFPEL in addition to, of course, the funding agencies CAPES, CNPq and FAPERGS.

I also had the great joy of always having a wonderful team of friends who have been with me since Sarandi: Mateus Balestrin, Gabriela Signor, Eduardo Demarco, Caroline Signor, Eduarda Signor and Taylor de Oliveira. Santa Maria team: Suelen Aimi, Deise Cagliari, Edicarla Trentin, Lia Reck, Mariana Dossin, Regis Stacke, Lilian Cabrera, Gilardi Dalazen, Florencia Isasa, Tatiele Lamarque, Jonatas Maciel, Gustavo Grill and Kelen Muller. Sweet Pelotas team: Gustavo Teló, Diana Zabala, João Paulo Refatti, Magali Kemmerich, Caroline Nemitz, Fernanda Caratti, Bruna Ceolin, Rodrigo Marques da Silveira, Cedrick Benetti and Marlon Bastiani. To the tireless: Tamara Heck, Natália Garcia, Anderson Feijó, Marcus Fipke, Vinicius Gehrke and Thamiris de Moraes, for the moments of conviviality, be it in almost endless hours of work and also, beautiful moments of entertainment.

To my advisor PhD. Luis Antonio de Avila, for the teachings, confidence, patience and above all, for a humble person and humanity that he carries with him. "More important are people, not things". In addition to being an advisor, he is my friend, always respecting and encouraging me throughout this journey. I'm immensely grateful to you, Luis.

To CEHERB, our research group is a “baita time”, where we grew up together and with the same objective: knowledge. I would like to thank Bruno Fonseca, Vívian Viana, Renan Zandoná, Andrine Böhlke, Willian Lubian, Gustavo Junkes, Lucas Rezende, Ananda Sherner, Adriana Amarante, Roque Palacios, Eduarda Holdefer, Lucas Viera, Mauricio Files, Leonar Pivetta, Klaus Egewarth, Felipe Brunetto, Juan Velasquez, Lariza Benedetti, Joanei Cechin and Maicon Schmitz, for what each one represented in my journey through CEHERB.

I was able to count on another team, in fact a pair of sensational friends, who gave support, when I needed it most, at all times, gifts from the doctorate: Andressa and Dalvane. I wish that everyone can have friends with whom they can trust, just as I can trust you.

I conclude by thanking the great responsible for all this, professor Dr. Nelson Diehl Kruse, who there in 2010, during the middle of my graduation, made me develop a love for weed science, and that has been encouraging me throughout these years, being very important during my doctorate. Professor, I'd like to thank you for everything!! How nice to be able to count on you, who believed in me, so many times more than me.

To all the people who somehow contributed to my training as a professional, citizen and especially as to be a better person, thank you very much!



*“Every dream that you leave behind, is a piece of your future that will no longer exist.”*

Steve Jobs

## ABSTRACT

BALBINOT, Andrisa. **Effect of enhanced CO<sub>2</sub> atmospheric concentration on rice and weedy rice**. 2020. 115f. Dissertation (Doctor) – Crop Protection Program. Federal University of Pelotas, Pelotas.

Global climate change causes stresses that can limit crop productivity and threaten food production in the future. Increased production implies an increase in the demand for water, with irrigation being the activity that most uses fresh water today. The culture of rice represents an important staple food and effects of the increase in atmospheric CO<sub>2</sub> atmospheric can affect development and production, in addition to affecting weedy rice, the most important weed in flooding rice system. Therefore, the present research aimed to evaluate the effect of increasing CO<sub>2</sub> atmospheric associated with different water regimes on rice and weedy rice. For this, experiments were carried out to evaluate development and water use efficiently in rice crop and also, quantify the total concentration of arsenic and cadmium in grains; the effects in weedy rice growth, development, seed shattering and longevity of seed bank; the gene expression to genes to be related to involve on seed shattering in rice, and to evaluated on the quality of grains and physicochemical proprieties in rice and red rice. The results allowed indicated that increase in CO<sub>2</sub> affects the growth, development and water use efficiency in rice. In addition, in the assessment of total arsenic, intermittent regime decreased the absorption of the element. Considering the studies development with weedy rice, the effect of increase CO<sub>2</sub> was observed for growth and development, in addition to increasing the seed shattering and seed viability at seedbank. In addition, gene expression demonstrated that the genes *OsCPL1*, *qSH1*, *SHAT1*, *OsXTH8*, *OSH15* and *SH5* are affected by the increase in CO<sub>2</sub>, making the characteristic more complex because involve several metabolic pathways. Contemplating the grain yield analysis, white rice had a decrease in head rice yield in high CO<sub>2</sub>, in addition an increase in the chalkiness area and a decrease in crude protein, with changes in cooking parameters. These results contribute to characterization of increase CO<sub>2</sub> in rice crop, being the basis for future studies, which continue in search to elucidate the effects of climate change in agriculture, assisting in the planning of the adoption of sustainable management, in order to minimize the negative effects.

**Key-words:** Climate change, water regimes, water use efficiently, rice shattering, phenolic compounds, head yield rice.



## RESUMO

BALBINOT, Andrisa. **Efeito do aumento da concentração de CO<sub>2</sub> atmosférico na cultura do arroz e no arroz daninho**. 2020. 115f. Tese (Doutorado) – Programa de Pós-Graduação em Fitossanidade. Universidade Federal de Pelotas, Pelotas.

As mudanças climáticas globais causam estresses que podem limitar a produtividade das culturas e ameaçar a produção de alimentos no futuro. Aumento da produção implica no aumento da demanda por água, sendo que a irrigação é a atividade que mais utiliza água doce atualmente. A cultura do arroz (*Oryza sativa*) representa importante alimento básico para população mundial e os efeitos do aumento de CO<sub>2</sub> atmosférico podem afetar seu desenvolvimento e produção, além de afetar o arroz daninho, uma das principais plantas daninhas na cultura do arroz. Diante disso, a presente pesquisa teve como principal objetivo avaliar o efeito do aumento da concentração atmosférica de CO<sub>2</sub> (400 e 700  $\mu\text{mol mol}^{-1}$ ) associada a diferentes regimes hídricos (contínuo e intermitente) em arroz e arroz daninho. Para isso, estudos foram desenvolvidos para avaliar parâmetros de crescimento e produtivo, eficiência no uso da água pela cultura do arroz e quantificar o total de arsênio e cádmio nos grãos; efeito nos parâmetros de crescimento e produtivo de arroz daninho, bem como o degrane e a viabilidade de sementes no banco de sementes; expressão gênica de genes associados ao processo de degrane; e avaliar o rendimento de grãos e propriedades físico-químicas de arroz branco e vermelho. Os resultados permitiram inferir que o aumento do CO<sub>2</sub> afeta o crescimento, desenvolvimento e a eficiência do uso da água em arroz. Além disso, na avaliação de arsênio total, o regime intermitente diminuiu a absorção do elemento. Considerando os estudos realizados com arroz daninho, o efeito do CO<sub>2</sub> foi observado para crescimento e desenvolvimento, além de aumentar a taxa de degrane e a viabilidade de sementes no banco de sementes do solo. Em adição, a expressão gênica demonstrou que os genes *OsCPL1*, *qSH1*, *SHAT1*, *OsXTH8*, *OSH15* e *SH5* são afetados pelo aumento do CO<sub>2</sub>, tornando a característica ainda mais complexa, visto que o CO<sub>2</sub> tem ação em diversas rotas metabólicas. Contemplando a análise de rendimento de grãos, o arroz branco teve diminuição no rendimento de inteiros em alto CO<sub>2</sub>, além de aumento na área gessada e diminuição da proteína bruta, com alterações nos parâmetros de cocção. Estes resultados auxiliam na caracterização das implicações do aumento de CO<sub>2</sub> na cultura do arroz sendo base para estudos futuros, que seguem na busca em elucidar os efeitos das mudanças climáticas na agricultura, auxiliando no planejamento da adoção de manejo sustentável, de modo a minimizar os efeitos negativos.

**Palavras-chave:** Mudança climática, regimes hídricos, eficiência do uso da água, degrane de arroz, compostos fenólicos, rendimento de grãos.