ALAN MARIO ZUFFO
JORGE GONZÁLEZ AGUILERA
ORGANIZADORES

PESQUISAS AGRÁRIAS E AMBIENTAIS

Volume V

Pantanal Editora

2021

Alan Mario Zuffo
Jorge González Aguilera
Organizadores

PESQUISAS AGRÁRIAS E AMBIENTAIS VOLUME V

Pantanal Editora

2021

Copyright© Pantanal Editora
Copyright do Texto© 2021 Os Autores
Copyright da Edição© 2021 Pantanal Editora
Editor Chefe: Prof. Dr. Alan Mario Zuffo
Editores Executivos: Prof. Dr. Jorge González Aguilera
Prof. Dr. Bruno Rodrigues de Oliveira

Diagramação: A editora
Edição de Arte: A editora. Imagens de capa e contra-capa: Canva.com
Revisão: O(s) autor(es), organizador(es) e a editora

Conselho Editorial
- Prof. Dr. Adaylson Wagner Sousa de Vasconcelos – OAB/PB
- Profa. Msc. Adriana Flávia Neu – Mun. Faxinal Soturno e Tupanciretã
- Profa. Dra. Albys Ferrer Dubois – UO (Cuba)
- Prof. Dr. Antonio Gasparetto Júnior – IF SUDESTE MG
- Profa. Msc. Aris Verdecia Peña – Facultad de Medicina (Cuba)
- Profa. Arisleidis Chapman Verdecia – ISCM (Cuba)
- Prof. Dr. Arinaldo Pereira da Silva – UFESSPA
- Prof. Dr. Bruno Gomes de Araújo - UEA
- Prof. Dr. Caio Cesar Enside de Abreu – UNEMAT
- Prof. Dr. Carlos Nick – UFV
- Prof. Dr. Claudio Silveira Maia – AJES
- Prof. Dr. Cleberton Correia Santos – UFGD
- Prof. Dr. Cristiano Pereira da Silva – UEMS
- Profa. Ma. Dayse Rodrigues dos Santos – IFPA
- Prof. Msc. David Chacon Alvarez – UNICENTRO
- Prof. Dr. Denis Silva Nogueira – IFMT
- Profa. Dra. Denise Silva Nogueira – UFMG
- Profa. Dra. Dennyura Oliveira Galvão – URCA
- Prof. Dr. Elias Rocha Gonçalves – ISEPAM-FAETEC
- Prof. Me. Ernane Rosa Martins – IFG
- Prof. Dr. Fábio Steiner – UEMS
- Prof. Dr. Fabiano dos Santos Souza – UFF
- Prof. Dr. Gabriel Andres Tafur Gomez (Colômbia)
- Prof. Dr. Hebert Hernán Soto Gonzáles – UNAM (Peru)
- Prof. Dr. Hudson do Vale de Oliveira – IFRR
- Prof. Msc. Javier Revilla Armesto – UCG (México)
- Prof. Msc. João Camilo Sevilla – Mun. Rio de Janeiro
- Prof. Dr. José Luis Soto Gonzales – UNMSM (Peru)
- Prof. Dr. Julio Cezar Uzinski – UFMT
- Prof. Msc. Lucas R. Oliveira – Mun. de Chap. do Sul
- Profa. Dra. Keyla Christina Almeida Portela – IFPR
- Prof. Dr. Leandris Argentel-Martínez – Tec-NM (México)
- Profa. Msc. Lidiene Jaqueline de Souza Costa Marchesan – Consultório em Santa Maria
- Prof. Dr. Marco Aurélio Kistemann – UFJF
- Prof. Msc. Marcos Pisarski Júnior – UEG
- Prof. Dr. Marcos Pereira dos Santos – FAQ
- Prof. Dr. Mario Rodrigo Esparza Mantilla – UNAM (Peru)
- Profa. Msc. Mary Jose Almeida Pereira – SEDUC/PA
- Profa. Msc. Nila Luciana Vilhena Madureira – IFPA
- Profa. Dra. Patrícia Maurer
- Profa. Msc. Queila Pahim da Silva – IFB
- Prof. Dr. Rafael Chapman Auty – UO (Cuba)
- Prof. Dr. Rafael Felippe Ratke – UFMS
- Prof. Dr. Raphael Reis da Silva – UFPI
- Prof. Dr. Ricardo Alves de Araújo – UEMA
- Prof. Dr. Wéverson Lima Fonseca – UFPI
- Prof. Msc. Wesclen Vilar Nogueira – FURG
- Profa. Dra. Yilan Fung Boix – UO (Cuba)
- Prof. Dr. Willian Douglas Guilherme – UFT

Conselho Técnico Científico
- Esp. Joacir Mário Zuffo Júnior

- Esp. Maurício Amormino Júnior
- Esp. Tayronne de Almeida Rodrigues
- Lda. Rosalina Eufrausino Lustosa Zuffo

Ficha Catalográfica

Dados Internacionais de Catalogação na Publicação (CIP)
(eDOC BRASIL, Belo Horizonte/MG)

P472 Pesquisas agrárias e ambientais [livro eletrônico] : volume V / Organizadores Alan Mario Zuffo, Jorge González Aguilera. – Nova Xavantina, MT: Pantanal Editora, 2021. 191p.

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
ISBN 978-65-88319-70-3
DOI https://doi.org/10.46420/9786588319703

1. Ciências agrárias – Pesquisa – Brasil. 2. Meio ambiente. 3.Sustentabilidade. I. Zuffo, Alan Mario. II. Aguilera, Jorge González.
CDD 630

Elaborado por Maurício Amormino Júnior – CRB6/2422

O conteúdo dos e-books e capítulos, seus dados em sua forma, correção e confiabilidade são de responsabilidade exclusiva do(s) autor (es) e não representam necessariamente a opinião da Pantanal Editora. Os e-books e/ou capítulos foram previamente submetidos à avaliação pelos pares, membros do Conselho Editorial desta Editora, tendo sido aprovados para a publicação. O download e o compartilhamento das obras são permitidos desde que sejam citadas devidamente, mas sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais, exceto se houver autorização por escrito dos autores de cada capítulo ou e-book com a anuência dos editores da Pantanal Editora.

Pantanal Editora
Rua Abaete, 83, Sala B, Centro. CEP: 78690-000. Nova Xavantina – Mato Grosso – Brasil.
Telefone (66) 99682-4165 (Whatsapp).
https://www.editorapantanal.com.br
contato@editorapantanal.com.br

APRESENTAÇÃO

As áreas de Ciências Agrárias e Ciências Ambientais são importantes para a humanidade. De um lado, a produção de alimentos e do outro a conservação do meio ambiente. Ambas, devem ser aliadas e são imprescindíveis para a sustentabilidade do planeta. A obra, vem a materializar o anseio da Editora Pantanal na divulgação de resultados, que contribuem de modo direto no desenvolvimento humano.

O e-book "Pesquisas Agrárias e Ambientais Volume V" é a continuação de uma série de volumes de e-books com trabalhos que visam otimizar a produção de alimentos, o meio ambiente e promoção de maior sustentabilidade nas técnicas aplicadas nos sistemas de produção das plantas e animais. Ao longo dos capítulos são abordados os seguintes temas: construção de habitação popular para pessoas de baixa renda, modelos baseados em processos aplicados à ciência florestal, efeito alelopático de *Ateleia glazioveana* Baill na germinação de picão-preto e soja, análise da viabilidade econômica de reconstituição de pastagens no sistema tradicional e consorciado, utilização do resíduo do mamão em processos biotecnológicos para produção de ração animal, valorização do coproduto do melão para a ração animal, seletividade de inseticidas a *Trichogramma Pretiosum* em ovos de *Helicoverpa Armigera*, efeito da temperatura base para emissão de nós e soma térmica do feijão-de-porco, efeito da temperatura no trigo, análise multitemporal da cobertura vegetal no município de Paracambi, caracterização e modelos estatísticos para estimativa do volume de frutos de babaçu, desempenho agronômico de cultivares de alface crespa em duas épocas de cultivo, marcadores moleculares utilizados para estudo da diversidade genética de plantas ameaçadas de extinção no Brasil, análise de transição do uso e cobertura do solo em área de preservação permanente, coinoculação de *Bradyrhizobium* e *Azospirillum* associada à aplicação de estimulantes na soja, sistema de tratamento de esgoto doméstico de baixo custo para residências familiares. Portanto, esses conhecimentos irão agregar muito aos seus leitores que procuram promover melhorias quantitativas e qualitativas na produção de alimentos e do ambiente, ou melhorar a qualidade de vida da sociedade. Sempre em busca da sustentabilidade do planeta.

Aos autores dos capítulos, pela dedicação e esforços sem limites, que viabilizaram esta obra que retrata os recentes avanços científicos e tecnológicos na área de Ciência Agrárias e Ciências Ambientais Volume V, os agradecimentos dos Organizadores e da Pantanal Editora. Por fim, esperamos que este e-book possa colaborar e instigar mais estudantes e pesquisadores na constante busca de novas tecnologias e avanços para as áreas de Ciências Agrárias e Ciências Ambientais. Assim, garantir uma difusão de conhecimento fácil, rápido para a sociedade.

Alan Mario Zuffo
Jorge González Aguilera

SUMÁRIO

Capítulo VIII

Heatwave implications in wheat during heading phenophase

Recebido em: 02/05/2021
Aceito em: 04/05/2021
10.46420/9786588319703cap8

Leandris Argentel Martínez[1]
Ofelda Peñuelas Rubio[1]
José Aurelio Leyva Ponce[1]
Enrico Yepez-González[2]
Jaime Garatuza Payán[2*]
Jorge González Aguilera[3]

INTRODUCTION

Among the adverse conditions of the agricultural systems worldwide, high temperatures have been the abiotic factor of greatest impact on the agronomic performance for crops (Siebert et al., 2017). Every year, thousands of hectares of crop lands are impacted by changes in temperature patterns and its combination with some other stressing factors (Gouache et al., 2017), these lands are abandoned because the plants do not overcome the stress condition and cannot, therefore, express their genetic-productive potential (Trnka et al., 2017). The Intergovernmental Panel on Climate Change reported that significant increases in the frequency and magnitude of heat stress and the occurrence of heat waves for different latitudes are predicted, which may affect crop production (IPCC, 2014).

Some studies confirm that wheat will be one of the most affected crops due to warming (Asseng et al., 2017) because of the reduction of heat units (cold hours) necessary to complete its normal phenological cycle (Arshad et al., 2017). Research has been carried on the effect of canopy warming during the tillering phenophase (Solanki et al., 2017), but there are critical wheat phenophases that can significantly be affected by heatwaves, which may cause considerable grain yield reduction. A single heatwave during a short period of time may cause irreversible damages mainly in the floral development and pollen fertilization affecting grain filling (Stratonovitch et al., 2015).

Heading phenophase, which takes place in wheat about 8-14 days after anthesis, depending on the species and variety (Jaiswal et al., 2017), could be affected by a heatwave, and may cause a significant

[1] Tecnológico Nacional de México/Instituto Tecnológico del Valle del Yaqui. Calle 600, Block 611, Bácum, San Ignacio Río Muerto, Sonora, México. C. P. 85275.1.
[2] Instituto Tecnológico de Sonora, Ciudad Obregón, Sonora, México C. P. 85000.
[3] Universidade Federal de Mato Grosso do Sul, Campus Chapadão do Sul, MS, Brasil CP 79560-000.
[*] Autor correspondente: garatuza@gmail.com

decrease in grain yield (Zampieri et al., 2017). That is why, an experimental evaluation of the possible impacts of a heatwave during this phenophase, in high yield varieties and highly productive regions, offers information on the possible impacts of a sudden climate variation in this crop and its effect on grain yield.

The present assay, was carried out in the Yaqui Valley in northwestern México, which has a hot semiarid climate and where wheat is the most important crop (Lares et al., 2016). In this region, recent climate change predictions have pointed out a temperature increase of about 2°C for the next 50 years (Cavazos et al., 2012) and a considerable variability of heatwaves occurrence (Navarro et al., 2018). The present work aims to evaluate the agronomical effects of an experimental heatwave during the heading phenophase on wheat, using as experimental model CIRNO C2008 which is still the most extensively cropped variety in this region since 2008 (Argentel et al., 2018).

MATERIAL AND METHODS

The experiment was carried out during the growing seasons of 2016–2017 and 2018-2019 (December- April), under field conditions at the Experimental Technology Transfer Center (CETT-910) of the Instituto Tecnológico de Sonora (ITSON), located in the Yaqui Valley at: 27°22'0.4" N and 109°54'50.6" W (UTM: 607393.24 m E; 3027508.34 m N). The CIRNO C2008 wheat variety was used as experimental model, this variety was released in Mexico in 2018 and normally reaches between 5.6 t ha-1 to 6.3 t ha-1 when two or three doses of flood irrigation are applied over a cropping cycle respectively (Figueroa et al., 2010). This variety, nowadays, has shown the highest yield in the Yaqui Valley while maintaining its genetic stability of grain yield (Argentel et al., 2018).

Crop management was done as described in Garatuza et al. (2018) with sowing dates in mid-December, over two cropping cycles, 2016–2017 and 2018-2019, in both years three irrigation events of about 14 cm were applied at 45, 60 and 85 days after sowing. To assess the response to heat we established two treatments: 1) Heatwave; four plots with imposed heat to get 2 °C above ambient canopy temperature for five consecutive days during the heading phenophase (about 72 and 66 days after sowing for the 2016–2017 and 2018-2019 respectively), and 2) Control: four plots at ambient canopy temperature, distributed following a randomized design.

In the Heatwave treatment crop canopy temperature was raised by 2 °C using six thermal radiators per plot (FTE-1000 model, 1000W, 240 V, 245 mm long x 60 mm wide, built by Mor Electric Company Heating Association Inc.) (Kimbal, 2015). Temperature control was achieved with infrared temperature sensors (IRTS Apogee Instruments Inc.) installed on both Control, Warming and Heatwave treatments with an inclination degree of 45° from the soil surface to cover a circle of r=1.5 m at the center of the plot as explained Garatuza et al. (2018). The electronic system was programmed to keep a constant temperature of 2°C in the Heatwave and Warming treatments, through the proportional, integrative and derivative routine described in Kimbal, (2015) and programed in a datalogger (CR1000, Campbell Sci.).

To evaluate crop responses to treatments, spike length (cm) was measured from the base to the terminal grain with a caliper just before harvesting. A total of 40 randomized spikes were taken by treatment. Spike mass (g) was measured on 30 spikes by treatment with a digital balance. The number of full and vain grains by spike (#) was counted after each panicle was carefully minced. A total of 25 panicles were used by treatment. Grain mass (g) on individual grains was measured with a balance taking a total of 90 randomized grains in each repetition for the three treatments. In the same way, thousand grains mass (g) was determined in 10 groups of 1,000 grains by treatment. Total biomass and grain yield (t ha^{-1}) were determined in the three treatments by harvesting three square meters from each plot.

Statistical analysis

Theoretical assumptions of normality and homogeneity were verified in the collected data, and the mean and its standard deviation were determined in the three treatments. For all evaluated variables, means were compared through the theoretical distribution of probability t-student for continuous quantitative variables for $p<0.05$ and $p<0.01$ (Gosset, 1917). For vain grains variable, a two-way analysis of variance with factorial arrangement was done (Fisher, 1937) and, when there were significant differences between the means, the Tukey pos-hoc for $p<0.05$ and $p<0.01$ was used (Tukey, 1960).

For the statistical processing the STATISTICA professional statistical package, version 8.4 for Windows was used (StatSoft, 2008).

RESULTS AND DISCUSSION

The majority of yield components showed significant differences among treatments, in both crop cycles, except in the grains mass (Table 1). The spike length did not decrease under the Heatwave treatment. A Similar response was observed for spike mass. The number of full grains per spike showed a significant reduction among treatments. The Heatwave treatment presented a 10.1% of affectation with respect to the Control treatment.

One of the first reports of a heatwave effect in wheat was done by Wheeler et al., (1996) where full grain number decreased by 20% when the crop experienced a heatwave of 1.5°C with respect to environmental canopy temperature immediately before anthesis. However, for CIRNO C2008 in our study the affectation percentage did not exceed 12%. It has been also found that the vein grain number of wheat can significantly increase to 5 vain grains per spike when temperature during mid-anthesis increases by 2 °C during 10 days (Yang et al., 2017).

Table 1. Grain yield components comparison in established treatments during 2016-2017 and 2018-2019 crop cycles. [(SL: panicle length (cm); SM: spike mass (g); FG/S: full grains per spikes; VG/S: vain grains by spike; MTG: mass of one thousand grains (g)].

Treatments	Grain yield components (2016-2017 crop cycle)				
	SL (cm)	SM (g)	FG/S	VG/S	MTG (g)
Control	7,61±0,02*	5,95±0.07*	51,00±0,3**	3,74±0,31**	53,2±0,7ns
Heatwave	7,33±0,01	5,72±0,02	45.88±0,2	9,35±0,8	53,4±1,2
	Grain yield components (2018-2019 crop cycle)				
	SL (cm)	SM (g)	FG/S	VG/S	MTG (g)
Control	6,9±0,4ns	5,4±0,32**	53,12±0,9**	2,3±0,9**	53,04±0,6ns
Heat wave	6,52±0,1	4,81±0,04	45,33±0,6	10,00±0,9	53,1±1,5

* and ** represent differences for p <0.05 and p<0.01, respectively. ns: non-significant.

In the present study, vain grains increased in the Heatwave treatment to 9.35 and 10.00 respectively for the 2016-17 and 2018-19 cropping cycles (Table 1). In agreement with Dwivedi et al. (2017), the higher effects of heat stress on grain yield in wheat, in general, is a reduction in the number of full grains, and also to an increase in vain grains and not due to their individual grain mass decrease. In our study the largest presence of vain grains, in both crop cycles, was obtained at the distal part (Figure 1).

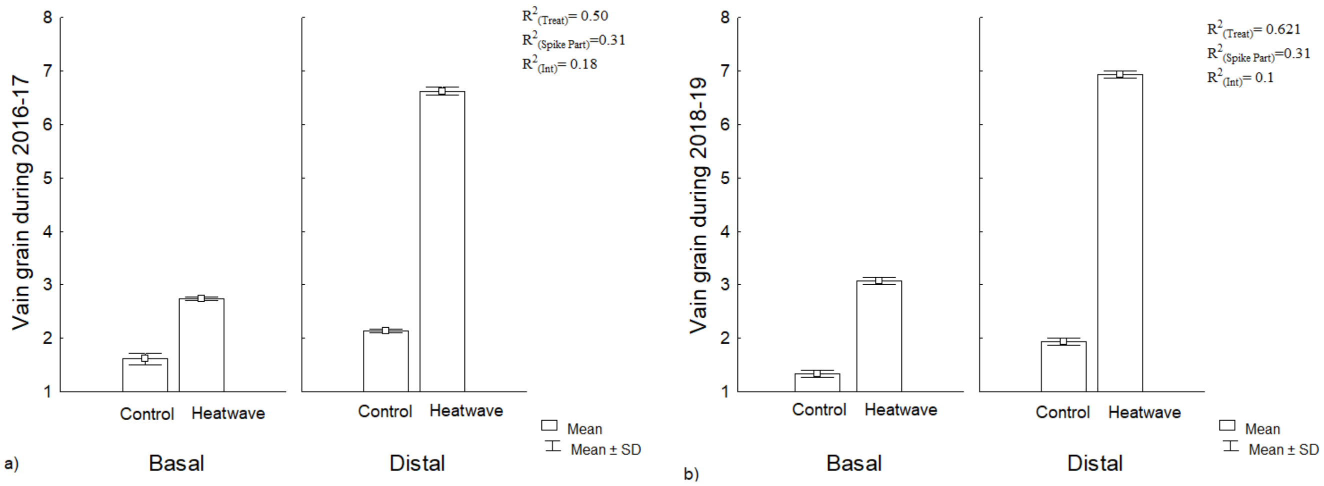

Figure 1. Vain grains number at the basal and distal part of the spikes in Warming, Heatwave and Control treatments during a) 2016-2017 and b) 2018-2019 crop cycles. Rectangular bars represent the standard deviation of mean. $R^2_{((Trat),(Spike\ Part),(Int))}$: Determination coefficient without adjust for treatments, spike part, and interaction Treatment-Spike part, respectively. SD: Standard deviation from the means.

In both crop cycles, the total variability found in the number of vain grains in the basal and distal parts of the spike, it was explained in more than 50% due to the heatwave effect, while the spike part contributed in a 31%. There was a significant interaction between the treatments and the spike part both crop cycles, although in 2016-17 the interaction was highly significant. These results show that heat causes an increase in the number of vain grains in the distal spikelets in wheat, with a greater effect when the heat comes in a form of a heat wave. Garatuza et al. (2018) found that when a Warming treatment was applied during all crop cycle the total variability of vain grain was explained a 43% by Warming, this response maybe took place doe to plant adaptation to heat during growth, activating some physiological and biochemical mechanisms (Argentel et al., 2019), then, a heatwave may cause more reductions in the number of vain grains than a warming during all crop cycle. According to IPCC predictions for northwestern Mexico, maybe significant heatwaves events will also take place in Yaqui Valley which may cause a significant reduction on wheat performance.

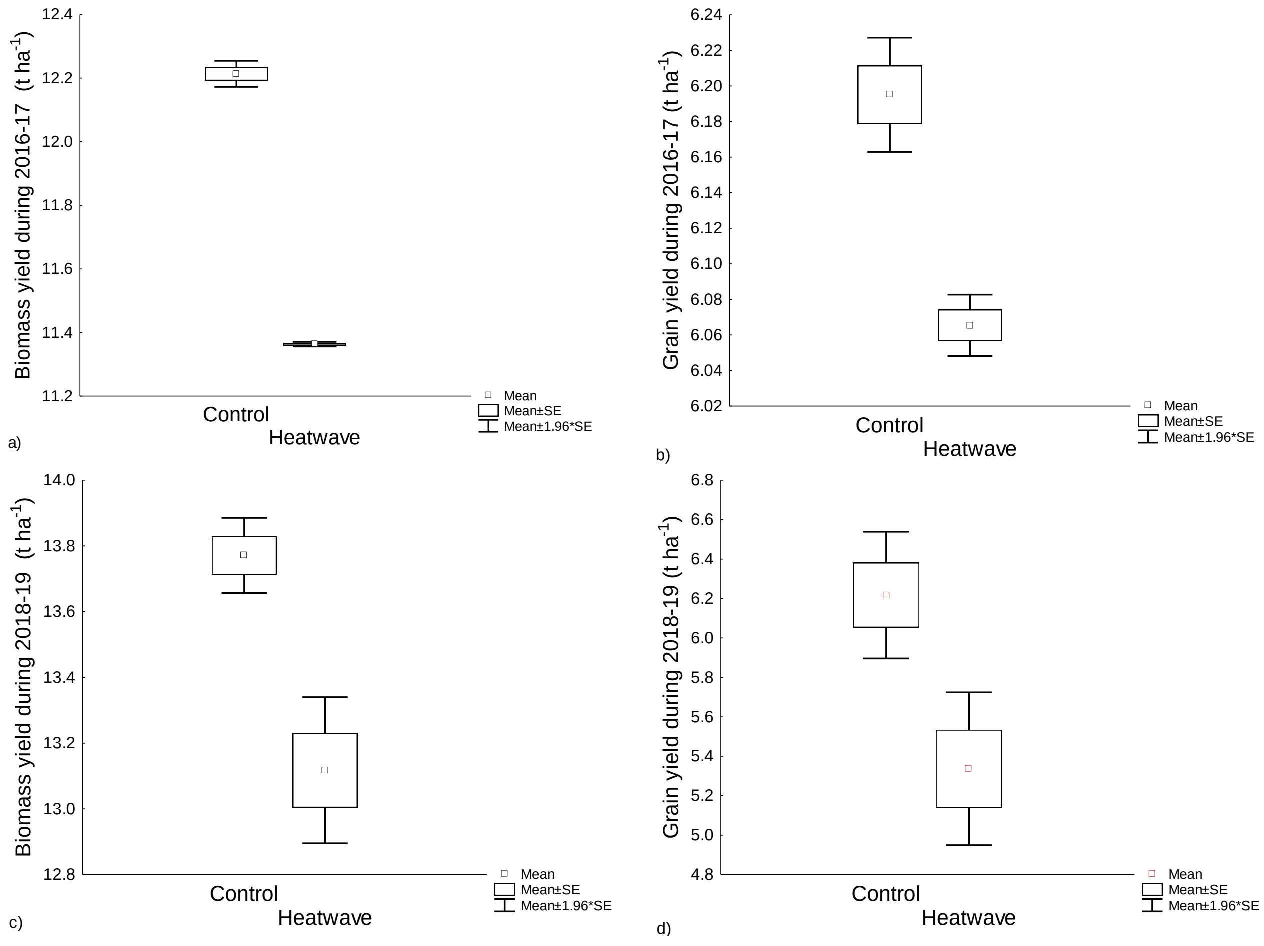

Figure 2. Biomass (a;c) and grain yield (b;d) in treatments during a) 2016-17 and b) 2018-19 crop cycles. SE: Standard error.

In contrast to the other yield components, the grain mass did not vary statistically between the heat treatments in the present study (Table 1). This result indicates the ability of CIRNO C2008, to support seed filling even under higher temperatures, by means of a heatwave during the heading phenophase.

Biomass and grain yield, showed a significant decrease on Heatwave with respect to the Control treatment and the largest reduction was obtained when warming occurred over the whole cropping cycle (Figure 2).

The heatwave affected biomass yield more than grain yield, resulting on a yield reduction of 6.9% and 2.1% respectively during 2016-17, while during 2018-19 crop cycle the reductions were in the order of 6.8 % and 6.5%.

CONCLUSIONS

The occurrence of a heat wave during the heading phenophase increases the number of vain grains at the spike, averaging 9 vain grains during the two experimental crop cycles. The major presence of vain grains was found at the distal part of the spike.

A heat wave during heading phenophase caused a significant affectation on biomass and grain yield of 7% and 4 %, respectively.

REFERENCES

Argentel-Martínez L et al. (2019). Water regime and osmotic adjustment under warming conditions on wh eat in the Yaqui Valley, Mexico. Peerj, 7: e7029.

Argentel ML et al. (2018). Physiological and Agronomic Traits of Hard Wheat Cirno Variety C2008 Confirm its Genetic Stability. Agrociencia, 52: 419-435.

Arshad M et al. (2017). Climate variability and yield risk in South Asia's rice–wheat systems: emerging evidence from Pakistan. Paddy and Water Environ, 15: 249-261.

Asseng S et al. (2017). Hot spots of wheat yield decline with rising temperatures. Glob. Change Biology, 23:2464-2472.

Cavazos T et al. (2012). Downscaled Climate Change Scenarios for Baja California and the North American Monson during the Twenty-First Century. J. of Climate, 25: 5904-5915.

Dwivedi SK et al. (2017). Heat stress induced impairment of starch mobilisation regulates pollen viability and grain yield in wheat: Study in Eastern Indo-Gangetic Plains. Field Crops Res, 206: 106-114.

Figueroa P et al. (2010). CIRNO C-2008, nueva variedad de trigo cristalino con alto rendimiento potencial para el estado de Sonora. Rev. Mexicana de Ciencias Agrícolas, 1:739-744

Fisher RA (1937). The Design of Experiments. Edinburgh; London: Oliver and Boyd.

Garatuza-Payan J et al. (2018). Initial response of phenology and yield components of wheat (*Triticum durum* L., CIRNO C2008) under experimental warming field conditions in the Yaqui Valley. PeerJ 6: e5064.

Gosset E (1917). Another differences calculus based on standard deviation and confidence interval. Statistical References, 26: 66-72

Gouache D et al. (2017). Bridging the gap between ideotype and genotype: Challenges and prospects for modelling as exemplified by the case of adapting wheat (*Triticum aestivum* L.) phenology to climate change in France. Field Crops Research, 202: 108-121.

Intergovernmental Panel on Climate Change (2014). Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects. Cambridge University Press.

Jaiswal B et al. (2017). Study of Yield and Yield Components of Wheat (*Triticum aestivum* L.) Genotypes at Grain Filling Stage under Heat Regimes. Indian Journal of Pure & Applied Biosciences, 5: 331-340.

Kimball BA (2015). Using canopy resistance for infrared heater control when warming open-field plots. Agronomy journal, 107: 1105-1112.

Lares-Orozco MF et al. (2016). Global warming potential of intensive wheat production in the Yaqui Valley, Mexico: a resource for the design of localized mitigation strategies. Journal of Cleaner Production, 127: 522-532.

Navarro-Estupiñan J et al. (2018). Observed trends and future projections of extreme heat events in Sonora, Mexico. International Journal of Climatology, 38: 5168-5181.

Rezaei EE et al. (2015). Intensity of heat stress in winter wheat—phenology compensates for the adverse effect of global warming. Environmental Research Letters, 10: 024012.

Siebert S et al. (2017). Heat stress is overestimated in climate impact studies for irrigated agriculture. Environmental Research Letters, 12: 054023.

StatSoft (2008). STATISTICA (data analysis software system), version 8.0. www.statsoft.com

Stratonovitch P et al. (2015). Heat tolerance around flowering in wheat identified as a key trait for increased yield potential in Europe under climate change. Journal of Experimental Botany, 66: 3599-3609.

Trnka M et al. (2017). Paper on model responses to selected adverse weather conditions. FACCE MACSUR Reports, 10: 1-2.

Tukey JW (1960). A survey of sampling from contaminated distributions. In: Olkin I, ed. Contribution to Probability and Statistics: Essays in Honor to Harold Hotelling.

Wheeler T et al. (1996). The duration and rate of grain growth, and harvest index, of wheat (*Triticum aestivum* L.) in response to temperature and CO2. Journal of Experimental Botany, 47: 623–30.

Yang X et al. (2017). The impacts of increased heat stress events on wheat yield under climate change in China. Climatic Change, 140: 605-620.

Zampieri M et al. (2017). Wheat yield loss attributable to heat waves, drought and water excess at the global, national and subnational scales. Environmental Research Letters, 12:064008.

ÍNDICE REMISSIVO

S

T

V

W

Z

SOBRE OS ORGANIZADORES

Alan Mario Zuffo

Engenheiro Agrônomo, graduado em Agronomia (2010) na Universidade do Estado de Mato Grosso (UNEMAT). Mestre (2013) em Agronomia - Fitotecnia (Produção Vegetal) na Universidade Federal do Piauí (UFPI). Doutor (2016) em Agronomia - Fitotecnia (Produção Vegetal) na Universidade Federal de Lavras (UFLA). Pós - Doutorado (2018) em Agronomia na Universidade Estadual de Mato Grosso do Sul (UEMS). Atualmente, possui 150 artigos publicados/aceitos em revistas nacionais e internacionais, 124 resumos simples/expandidos, 52 organizações de e-books, 32 capítulos de e-books. É editor chefe da Pantanal editora e revisor de 18 revistas nacionais e internacionais. Contato: alan_zuffo@hotmail.com.

Jorge González Aguilera

Engenheiro Agrônomo, graduado em Agronomia (1996) na Universidad de Granma (UG), Bayamo, Cuba. Especialista em Biotecnologia (2002) pela Universidad de Oriente (UO), Santiago de Cuba, Cuba. Mestre (2007) em Fitotecnia na Universidade Federal do Viçosa (UFV), Minas Gerais, Brasil. Doutor (2011) em Genética e Melhoramento de Plantas na Universidade Federal do Viçosa (UFV), Minas Gerais, Brasil. Pós - Doutorado (2016) em Genética e Melhoramento de Plantas na EMBRAPA Trigo, Rio Grande do Sul, Brasil. Professor Visitante na Universidade Federal de Mato Grosso do Sul (UFMS) no campus Chapadão do Sul (CPCS), MS, Brasil. Atualmente, possui 61 artigos publicados/aceitos em revistas nacionais e internacionais, 29 resumos simples/expandidos, 39 organizações de e-books, 24 capítulos de e-books. É editor da Pantanal Editora e da Revista Agrária Acadêmica, e revisor de 19 revistas nacionais e internacionais. Contato: jorge.aguilera@ufms.br.

ISBN 978-658831970-3

Pantanal Editora
Rua Abaete, 83, Sala B, Centro. CEP: 78690-000
Nova Xavantina – Mato Grosso – Brasil
Telefone (66) 99682-4165 (Whatsapp)
https://www.editorapantanal.com.br
contato@editorapantanal.com.br