Revista Ciência Agronômica, v. 49, n. 4, p. 636-643, out-dez, 2018
Centro de Ciências Agrárias - Universidade Federal do Ceará, Fortaleza, CE
www.ccarevista.ufc.br

Scientific Article
ISSN 1806-6690

Physiological quality of seeds of white oat cultivars in response to trinexapac-ethyl application[1]

Qualidade fisiológica de sementes de cultivares de aveia branca em resposta à aplicação de trinexapac-ethyl

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ABSTRACT - The aim of this study was to assess the effect of the growth retardant trinexapac-ethyl on the physiological quality of seeds of different grain white oat cultivars in two growing environments. The experiments were carried out in Londrina and Mauá da Serra, Paraná State, Brazil. The experimental design was a randomized block design in a 4 × 2 factorial scheme with four replications. Treatments consisted of four white oat cultivars (IPR Afrodite, IPR Artemis, URS Corona, and URS Guria), with and without growth retardant application. Trinexapac-ethyl was applied by foliar spraying in a dose of 125 g a.i. ha^{-1} at the stem elongation stage between the first and second perceptible node. The following parameters were assessed: germination, first germination count, length and dry matter of seedling shoot and root, accelerated aging, electrical conductivity, emergence rate index, seedling emergence in sand, one-thousand-seed weight. At the end of the study, Londrina and Mauá da Serra presented a production potential white oat seed with germination above the standards for the species. Trinexapac-ethyl application reduced seed vigor of the cultivars IPR Afrodite and IPR Artemis produced in Londrina and Mauá da Serra, respectively.

Key words: *Avena sativa* L.. Growth retardant. Physiological potential. Vigor. Germination.

RESUMO - Objetivou-se avaliar o efeito do redutor de crescimento trinexapac-ethyl sobre a qualidade fisiológica de sementes de diferentes cultivares de aveia branca granífera, em dois ambientes de cultivo. Os experimentos foram conduzidos nos municípios de Londrina e Mauá da Serra, Paraná, sob o delineamento experimental de blocos casualizados em esquema fatorial 4 x 2, com quatro repetições. Os tratamentos constaram de quatro cultivares de aveia branca (IPR Afrodite, IPR Artemis, URS Corona e URS Guria), com e sem a aplicação do redutor de crescimento. O trinexapac-ethyl foi aplicado via pulverização foliar, na dose de 125 g i.a ha^{-1}, no período de elongação do colmo, entre o 1° e o 2° nó perceptível. Foram avaliados: geminação, primeira contagem de germinação, comprimento e massa seca de parte aérea e de raiz de plântulas, envelhecimento acelerado, condutividade elétrica, índice de velocidade de emergência, emergência de plântulas em areia e massa de mil sementes. Ao término do estudo, verificou-se que Londrina e Mauá da Serra apresentam potencial para produção de sementes de aveia branca, com germinação acima dos padrões de comercialização da espécie; a aplicação do trinexapac-ethyl reduz o vigor de sementes das cultivares IPR Afrodite e IPR Artemis, produzidas em Londrina e Mauá da Serra, respectivamente.

Palavras-chave: *Avena sativa* L.. Redutor de crescimento. Potencial fisiológico. Vigor. Germinação.

DOI: 10.5935/1806-6690.20180072
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Received for publication on 10/11/2016; approved on 30/11/2017
[1]Parte da Dissertação do primeiro autor apresentada ao Programa em Pós-Graduação em Agronomia da Universidade Estadual de Londrina
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INTRODUCTION

Seed quality can be interpreted as its ability to perform functions essential to its survival, characterized by germination and vigor, which affect implantation, growth, development, and productive performance of the crop under field conditions (SCHUCH; KOLCHINSKI; CANTARELLI, 2008).

The physiological behavior of seeds is related to genotype (MARCOS FILHO, 2015) due to genetic and/or morphophysiological characteristics that make them more susceptible to damage during the formation period or after physiological maturity of seeds due to adverse climatic conditions that will influence its physiological performance (VIEIRA *et al.*, 1998).

In addition to genotype, growing environment may influence growth and development of plants and, consequently, determine the physiological potential of seeds as it provides better or worse climatic conditions during their maturation (COSTA *et al.*, 2005). According to Motta *et al.* (2002), seed quality is influenced by sites and growing seasons since factors such as temperature, relative air humidity, precipitation, and photoperiod vary with season and latitude of regions.

To understand the relationship between the environmental conditions of growing sites and productive performance of cultivars is essential for producing seeds of superior quality and with satisfactory productivity levels (SILVA *et al.*, 2014).

Due to the different growing environments, diversity of genotype characteristics, and interaction between these factors, a wide variation in the behavior of white oat cultivars is observed in relation to the occurrence of plant lodging, which is a recurrent problem in this crop (OLIVEIRA *et al.*, 2011). The use of growth retardants is an important strategy to overcome this problem (ESPINDULA *et al.*, 2009) and favor the obtaining of seeds with a high physiological quality (KAPPES *et al.*, 2012).

Growth regulators are synthetic chemicals that can be applied directly to plants, with hormone balance modification (FERRARI *et al.*, 2008) and regulation of plant development (ESPINDULA *et al.*, 2010). The trinexapac-ethyl has been stood out for decreasing the internode elongation, resulting in a reduction in plant height and hence lodging in different species such as wheat (ESPINDULA *et al.*, 2010), rice (ALVAREZ *et al.*, 2007), and soybean SOUZA *et al.*, 2013).

The use of growth retardant aiming at avoiding a possible plant lodging can alter the partition of photoassimilates, redirecting them to reproductive structures, which can increase the number of reserves and seed size and, consequently, favor its physiological performance. However, the recommendation for using trinexapac-ethyl is very broad and does not distinguish cultivars, which have their cycle governed by their genetic constitution and edaphoclimatic conditions of the growing site.

In this sense, this study aimed to assess the effect of the growth retardant trinexapac-ethyl on the physiological quality of seeds of different grain white oat cultivars in two contrasting growing environments regarding soil and climatic conditions.

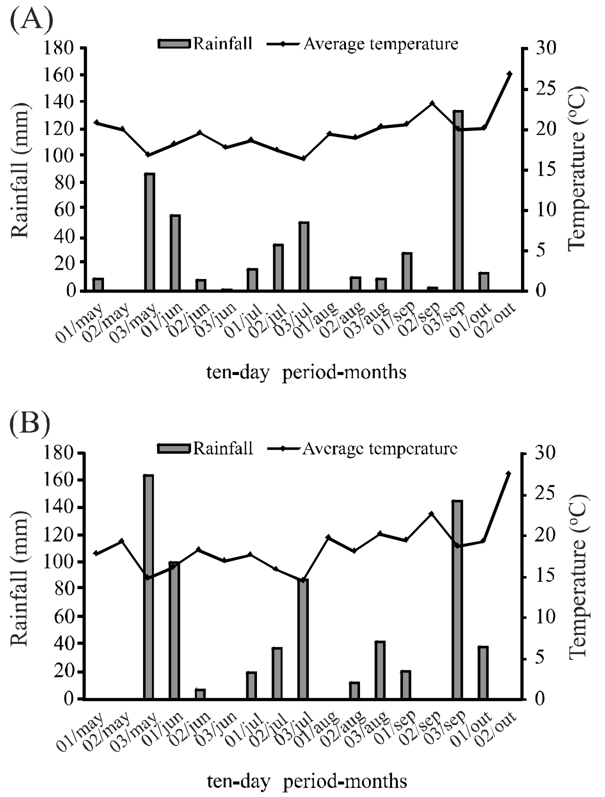
MATERIAL AND METHODS

The experiments were carried out in two contrasting growing environments regarding their edaphoclimatic characteristics located in Londrina and Mauá da Serra, Paraná State, Brazil. In Londrina, the experiment was conducted at the Experimental Farm of the Agronomic Institute of Paraná (IAPAR), located at the geographical coordinates 23°23′ S and 51°11′ W, with an altitude of 610 m, and soil classified as an Oxisol (Latossolo Vermelho eutroférrico, Brazilian Soil Classification System). Regional climate is classified by Köpen as Cfa, i.e. a humid subtropical climate with warm summers. In Mauá da Serra, the experiment was conducted at the Fazenda Estância 3M, located at the geographical coordinates 23°58′ S and 51°19′ W, with an altitude of 847 m, and soil classified as an Oxisol (Latossolo Vermelho distroférrico, Brazilian Soil Classification System). According to Köpen classification, regional climate is type Cfb, described a temperate mesothermic climate with fresh summers. The data of precipitation and temperature were obtained through the IAPAR meteorological station records (Figure 1).

Soil chemical characteristics at a depth of 0-10 cm, determined before the experiment setup in Londrina, presented the following values: pH ($CaCl_2$) of 5.40, $H+Al^{3+}$ of 5.34 $cmol_c\ dm^{-3}$, Ca^{2+} of 5.22 $cmol_c\ dm^{-3}$, Mg^{2+} of 3.08 $cmol_c\ dm^{-3}$, K^+ of 0.95 $cmol_c\ dm^{-3}$, P of 32.0 mg dm^{-3}, and organic matter of 16.98 g dm^{-3}. Mauá da Serra presented the following soil chemical characteristics: pH ($CaCl_2$) of 4.90, $H+Al^{3+}$ of 7.20 $cmol_c\ dm^{-3}$, Ca^{2+} of 6.80 $cmol_c\ dm^{-3}$, Mg^{2+} of 1.64 $cmol_c\ dm^{-3}$, K^+ of 0.50 $cmol_c\ dm^{-3}$, P of 23.5 mg dm^{-3}, and organic matter of 29.92 g dm^{-3}.

The experimental design for each environment was a randomized block design in a 4 × 2 factorial scheme with four replications. Treatments consisted of four cultivars (IPR Afrodite, IPR Artemis, URS Corona, and URS Guria), with and without the application of the growth retardant trinexapac-ethyl.

Figure 1 - Average data of temperature and rainfall in a ten-day period for the experimental periods in Londrina (A) and Mauá da Serra (B), PR, Brazil, 2014



The main agronomic characteristics of the cultivar IPR Afrodite, launched in 2012 by IAPAR, are a medium cycle, moderate resistance to lodging, and medium height. IPR Artemis, launched in 2016 by IAPAR, presents a medium cycle, moderate susceptibility to lodging, and medium height. URS Corona, launched in 2010 by UFRGS, presents a medium cycle, moderate susceptibility to lodging, and high size. URS Guria was launched in 2010 by UFRGS and has an early cycle, susceptibility to lodging, and high size (COMISSÃO BRASILEIRA DE PESQUISA DE AVEIA, 2014).

The cultivars were mechanically sown under a no-tillage system and in areas previously occupied with soybean in Londrina and Mauá da Serra on May 8, 2014, and December 5, 2014, respectively, with a density of 300 seeds m^{-2}. Plots were composed of six rows of 5 m in length, with a spacing between rows of 0.17 m, totaling a useful area of 5.1 m^2.

Base fertilization was based on soil chemical characteristics of the experimental areas and was the same for all treatments, being applied in the sowing furrow 30 kg N ha^{-1}, 90 kg P_2O_5 ha^{-1}, and 30 kg K_2O ha^{-1} in Londrina and 20 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1}, and 30 kg K_2O ha^{-1} in Mauá da Serra. The formula 10-30-10 was used in both environments. A topdressing nitrogen fertilization was broadcasted applied at a dose of 60 kg N ha^{-1} as urea (45% N) at the tillering phase.

The trinexapac-ethyl was applied at the stem elongation stage between the first and second perceptible node at a dose of 125 g a.i. ha^{-1}, corresponding to 400 mL ha^{-1} of the commercial product Moddus®. The application was carried out with a CO_2-pressurized backpack sprayer equipped with two flat-jet nozzles XR 110-020, spray solution volume proportional to 200 L ha^{-1}, and at a constant pressure of 30 lb inch^{-2}.

Phytosanitary treatments for disease control and other crop management were carried out according to the need and recommendations for the crop (COMISSÃO BRASILEIRA DE PESQUISA DE AVEIA, 2014). Harvest was performed after seeds reached harvest maturation, characterized by hardening of caryopsis, dry-looking plants, and grains with a moisture content below 20%. To determine the physiological quality of seeds, the following assessments were performed:

Germination: this test was performed with eight replications of 50 seeds per treatment on germitest® paper sheet moistened with distilled water at a ratio of 2.5 times the mass of the substrate. Paper rolls were maintained in a germinator at 20 °C. The assessment consisted of computing the percentage of normal seedlings at five (first count) and at ten (second count) after the experiment setup (BRASIL, 2009).

Seedling shoot and root length: this test was performed by sowing four replications of 20 seeds per treatment on the upper third of the germitest® paper sheet moistened with distilled water at a ratio of 2.5 times the mass of the dry substrate. Paper rolls containing the seeds remained for five days in a germinator at 20 °C, when shoot and root length of normal seedlings was assessed using a millimeter ruler. The results were expressed in centimeters (NAKAGAWA, 1999).

Seedling shoot and root dry matter: shoot and root of seedlings from the seedling length test were placed in paper bags and taken to a forced air circulation oven at 80 °C until constant mass. The dry matter was assessed and the results were expressed as mg per seedling (NAKAGAWA, 1999).

Accelerated aging: this test was performed with eight replications of 240 seeds per treatment in gerbox boxes containing 40 mL of water and an aluminum screen on which seeds were evenly distributed. These boxes were maintained in an accelerated aging chamber at 42 °C for 48 hours (MARCOS FILHO, 1999). Subsequently, the germination test was performed at a temperature of 20 °C. The number of normal seedlings was counted after five days of test setup (BRASIL, 2009).

Electrical conductivity: this test was conducted by using the mass system with four replications of 50 seeds per treatment. Seed mass was determined and then placed in plastic cups with 75 mL of deionized water and maintained at 25 °C. After 24 hours of soaking, the electrical conductivity of this solution was determined, with results expressed in μS cm^{-1} g^{-1} (VIEIRA; KRZYZANOWSKI, 1999).

Seedling emergence in sand: this test was conducted in a greenhouse with four replications of 50 seeds per treatment sown at a depth of 3 cm. The sand was previously washed and then placed in plastic trays. Moisture was maintained with irrigations as needed. The assessment of the number of normal emerged seedlings was performed on the fifteenth day (NAKAGAWA, 1999).

Seedling emergence rate index: this test was performed together with the test of seedling emergence in sand by means of daily counts of the number of normal seedlings emerged until emergence stabilization, as the equation proposed by Maguire (1962).

One-thousand-seed weight: this parameter was obtained by counting and weighing eight replications of 100 seeds per plot. The average values were multiplied by 10 in order to obtain the value of 1,000-seed weight (BRASIL, 2009).

The data were submitted to analysis of normality and homogeneity of errors and then to the analysis of variance. The means were compared by the Tukey's test at 5% probability.

RESULTS AND DISCUSSION

For seeds produced in Londrina, a significant interaction between the factors growth retardant and cultivar was observed for the characteristics first count and accelerated aging. For length and dry matter of seedling shoot and root and electrical conductivity, an isolated effect was observed for growth retardant. For seedling shoot length, an isolated effect of cultivar was observed. The emergence rate index, seedling emergence in sand, one-thousand-seed weight were not affected by the studied factors.

For seeds produced in Mauá da Serra, we observed an interaction effect between growth retardant and cultivar for germination, first count, length and dry matter of seedling root, accelerated aging, and electrical conductivity. An isolated effect of growth retardant was observed only for seedling shoot length and an isolated effect of the cultivar for length and dry matter of seedling shoot, emergence rate index, and one-thousand-seed weight. No isolated effect of factors and interaction between them were observed on seedling emergence in sand.

In Londrina, no significant effect of growth retardant, cultivar, and interaction between factors was observed for seed germination. A similar result was found by Souza *et al.* (2010) when assessing the physiological quality of wheat seeds obtained under different doses and periods of application of three growth regulators (chlormequat, paclobutrazol, and trinexapac-ethyl). Alves and Kist (2011) worked with three cultivars of grain white oat and also did not observe the effect of genotypes on seed germination.

In Mauá da Serra, growth retardant application positively influenced seed germination of the cultivar IPR Afrodite and negatively influenced the cultivars IPR Artemis and URS Corona. No significant difference was observed between treatments for the cultivar URS Guria (Table 1). The increased seed germination with trinexapac-ethyl application may be related to a decrease in plant height, as well as to a probable modification of leaf architecture, which favors the use of environmental resources, mainly solar radiation (PENCKOWSKI; ZAGONEL; FERNANDES, 2010). These effects may alter the partition of photoassimilates and improve their redirection to seeds (ZAGONEL; FERNANDES, 2007), with implications for their physiological performance.

In the absence of trinexapac-ethyl application, the cultivars IPR Artemis and URS Corona produced seeds with a higher germination when compared to the cultivar IPR Afrodite, but not differing from the cultivar URS Guria. However, among plants treated with growth retardant, the cultivars IPR Afrodite and URS Guria presented the highest values for this characteristic (Table 1).

Among treatments with and without growth retardant application, no cultivar presented normal seedlings with a percentage lower than 89% in the germination test, which classifies all cultivars as suitable for seed commercialization according to the current legislation that requires a minimum of 80% germination (BRASIL, 2013).

The cultivars IPR Afrodite and IPR Artemis in Londrina and Mauá da Serra, respectively, had the percentage of normal seedlings reduced in the first count of the germination test with the use of trinexapac-ethyl, indicating a lower vigor due to a lower seed germination rate (Table 1). Kaspary *et al.* (2015) assessed the effect of doses of the same growth regulator (0, 50, 100, and

Table 1 - First germination count (FC), germination (G), root length (RL), root dry matter (RDM), accelerated aging (AA), and electrical conductivity (EC) of four white oat cultivars as a function of the growth retardant trinexapac-ethyl. Londrina and Mauá da Serra, PR, Brazil, 2014

Cultivars	Londrina			
	FC (%)		AA (%)	
	Growth retardant			
	Without	With	Without	With
IPR Afrodite	96.00 aA	61.00 bB	92.00 aA	77.00 bB
IPR Artemis	98.00 aA	98.00 aA	90.00 aA	92.00 aA
URS Corona	87.00 aA	93.00 aA	92.00 aA	80.00 bAB
URS Guria	96.00 aA	95.00 aA	79.00 aA	83.00 aAB
CV (%)	10.38		8.30	

Cultivars	Mauá da Serra					
	G (%)		FC (%)		RL (cm)	
	Growth retardant					
	Without	With	Without	With	Without	With
IPR Afrodite	92.00 bB	97.00 aA	83.00 aA	91.00 aA	14.59 aA	14.35 aA
IPR Artemis	98.00 aA	89.00 bB	96.00 aA	39.00 bB	14.37 aA	11.15 bB
URS Corona	98.00 aA	90.00 bB	87.00 aA	80.00 aA	12.07 bB	15.29 aA
URS Guria	95.00 aAB	97.00 aA	87.00 aA	85.00 aA	11.83 bB	15.88 aA
CV (%)	2.26		8.99		7.71	
	RDM (mg)		AA (%)		EC (µS cm^{-1} g^{-1})	
	Growth retardant					
	Without	With	Without	With	Without	With
IPR Afrodite	3.21 bB	3.97 aAB	94.00 aA	83.00 aA	15.00 bA	25.00 aA
IPR Artemis	2.79 aB	2.42 aC	90.00 aA	8.00 bB	12.00 bA	20.00 aAB
URS Corona	2.89 bB	3.31 aB	71.00 bB	94.00 aA	13.00 aA	15.00 aB
URS Guria	4.95 aA	4.54 aA	94.00 aA	91.00 aA	14.00 aA	11.00 aC
CV (%)	9.80		11.96		13.97	

Means followed by the same lowercase letter in the row and uppercase letter in the column do not differ from each other by the Tukey's test (p<0.05)

150 g a.i. ha^{-1}) on the physiological quality of seeds of the cultivar of grain white oat URS Guapa and also observed a reduction in the value of this characteristic.

Treatments without growth retardant application in both growing sites showed no significant differences between cultivars for the first count (Table 1). This effect was also found by Kappes *et al.* (2012) when analyzing the application of three growth regulators (mepiquat chloride, trinexapac-ethyl, and paclobutrazol) at different doses (0, 75, 150, 225, and 300 g ha^{-1}) on the physiological quality of seeds and growth of seedlings of crotalaria.

For seedling growth, an isolated effect of the factors growth retardant and cultivar was observed in Londrina for shoot length and of growth retardant for root length (Tables 2). Seedlings originated from seeds from treatments with trinexapac-ethyl application presented a lower shoot and root development, regardless of the cultivar (Table 2).

These results are in accordance with those observed by Kaspary *et al.* (2015), who also worked with white oat. In Londrina, the cultivar IPR Afrodite presented a higher shoot length when compared to the cultivar URS Corona, being similar to the cultivars IPR Artemis and URS Guria (Table 2).

Shoot length of seedlings originated from seeds produced in Mauá da Serra was also affected in isolation by the factors growth retardant and cultivar. Contrary to that observed in Londrina, trinexapac-ethyl application positively influenced shoot development, originating most vigorous seedlings (Table 2). The highest value found for this characteristic was verified in the cultivar URS Corona (Table 2).

Root length of seedlings originated from seeds produced in Mauá da Serra showed an interaction between factors. Trinexapac-ethyl application promoted the root growth of the cultivars URS Corona and URS Guria but resulted in a lower root length of the cultivar IPR Artemis (Table 1). No significant difference was observed between treatments for the cultivar IPR Afrodite.

In treatments without growth retardant application, root length was higher in the cultivars IPR Afrodite and IPR Artemis. For plants that received growth retardant application, root growth of the cultivar IPR Artemis was lower than that observed in the others.

Kappes *et al.* (2012) found a significant effect of doses of the growth retardant trinexapac-ethyl on the total length of crotalaria seedlings. In this case, the use of 150 and 300 g a.i. ha^{-1} of the phytoregulator caused a reduction and an increase in seedling length, respectively.

For shoot and root dry matter of seedlings produced in Londrina, treatments with trinexapac-ethyl application resulted in the development of seedlings with a lower dry matter accumulation when compared to those from treatments with growth retardant absence (Table 2). Kaspary *et al.* (2015) studied the physiological quality of white oat seeds in response to trinexapac-ethyl and also observed a reduction of in seedling dry matter, corroborating the results observed in our study.

In Mauá da Serra, seeds of the cultivar URS Corona originated seedlings with a higher shoot dry matter when compared to the other cultivars (Table 2). Prando *et al.* (2012) assessed the physiological quality of seeds of three wheat genotypes (cultivars BRS 208 and BRS Pardela and strain IWT 04008) in two growing environments (Londrina and Ponta Grossa, PR, Brazil) and also observed a significant effect of genotypes for seedling dry matter.

For root dry matter, an interaction effect was observed between factors in Mauá da Serra, with better results for IPR Afrodite and URS Corona in the presence of trinexapac-ethyl. For the cultivars IPR Artemis and URS Guria, no significant differences were observed between treatments with and without growth retardant application. In the absence of the growth retardant, the highest root dry matter accumulation was observed in the cultivar URS Guria, followed by other cultivars. On the other hand, a higher vigor was observed in the cultivars URS Guria and IPR Afrodite with the use of growth retardant (Table 1).

In the accelerated aging test carried out with material from Londrina, the cultivars IPR Afrodite and URS Corona presented the highest and lowest percentage of germination in the treatments with and without trinexapac-ethyl application, respectively (Table 1). The averages of accelerated aging for the cultivars IPR Artemis and URS Guria showed no significant difference between treatments.

Seeds produced by cultivars without the growth retardant did not differ from each other when the

Table 2 - Shoot (SL) and root length (RL), shoot (SDM) and root dry matter (RDM), electrical conductivity (EC), seedling emergence rate index (ERI), and on-thousand-seed weight (TSW) as a function of four white oat cultivars and the growth retardant trinexapac-ethyl. Londrina and Mauá da Serra, PR, Brazil, 2014

Growth retardant	Londrina					Mauá da Serra
	SL (cm)	RL (cm)	SDM (mg)	RDM (mg)	EC (µS cm^{-1} g^{-1})	SL (cm)
Without	9.90 a	13.26 a	6.33 a	2.64 a	68.18 b	8.24 b
With	7.66 b	9.19 b	5.05 b	1.85b	78.90 a	9.45 a
CV (%)	13.07	13.64	16.29	21.91	12.71	8.38

Cultivars	Londrina	Mauá da Serra			
	SL (cm)	SL (cm)	SDM (mg)	ERI (%)	TSW (g)
IPR Afrodite	9.97 a	8.43 b	5.15 b	8.94 b	2.97 c
IPR Artemis	8.57 ab	7.70 b	5.09 b	9.02 ab	3.29 b
URS Corona	7.94 b	10.64 a	6.64 a	9.29 ab	3.61 a
URS Guria	8.65 ab	8.61 b	5.41 b	9.66 a	3.15 b
CV (%)	13.07	8.38	12.74	5.15	3.84

Means followed by the same letter in the column do not differ from each other by the Tukey's test ($p<0.05$)

percentage of normal seedlings in the germination of the accelerated aging test was analyzed. On the other hand, in treatments with trinexapac-ethyl, the cultivar IPR Artemis presented a higher vigor, followed by the cultivar IPR Afrodite, not differing from the other cultivars.

In Mauá da Serra, the response to treatments with and without trinexapac-ethyl in the accelerated aging test occurred for two cultivars, being the effect of the growth retardant positive for the cultivar URS Corona and negative for IPR Artemis. In treatments without growth retardant, the cultivar URS Corona showed the lowest vigor. With trinexapac-ethyl application, the cultivars with the highest averages in the accelerated aging test were IPR Afrodite, URS Corona, and URS Guria (Table 1).

In a study conducted with the wheat crop (PRANDO *et al.*, 2012), a significant effect of cultivars was also observed on the percentage of normal seedlings in the germination of the accelerated aging test. On the other hand, in studies carried out by Kappes *et al.* (2012) and Souza *et al.* (2010) with three growth regulators (mepiquat chloride, trinexapac-ethyl, and paclobutrazol) in crotalaria and wheat, respectively, no significant effect of phytoregulators was observed on seed vigor (accelerated aging).

According to Marques *et al.* (2011), in general, genotypes differ from each other regarding the physiological potential of their seeds and these responses are conditioned to the growing environment. This may justify the seed vigor differences found in our study between genotypes for each growing site and between sites for the same cultivar.

The electrical conductivity test carried out with seeds produced in Londrina detected higher values for treatments that received growth retardant application, regardless of the cultivar (Table 2). Thus, seeds originated from plants that were sprayed with trinexapac-ethyl have a low vigor in relation to seeds originated from crops without application. According to Vieira and Krzyzanowski (1999), higher values of electrical conductivity are caused by a higher release of exudates in the soaking medium due to the impairment of membrane integrity, being related to lower-quality seeds.

In Mauá da Serra, trinexapac-ethyl increased the value of this characteristic for seeds produced from the cultivars IPR Afrodite and IPR Artemis. However, no difference was observed between treatments with and without growth retardant application for the cultivars URS Corona and URS Guria (Table 1). The values of electrical conductivity in seeds from cultivars not treated with trinexapac-ethyl did not differ from each other. In treatments with growth retardant, seeds of the cultivar IPR Afrodite presented a low vigor.

Kappes *et al.* (2012) found a different result since the application of 300 g a.i. ha^{-1} of trinexapac-ethyl in crotalaria favored the obtention of seeds with a higher vigor. On the other hand, Kaspary *et al.* (2015), working with four doses of the same growth retardant, observed a decrease in the vigor of white oat seeds by assessing the electrical conductivity. Studies carried out with wheat crop by Brzezinski *et al.* (2014) and Prando *et al.* (2012) also verified the influence of genotypes on the electric conductivity of seeds.

In Londrina, seedling emergence rate index presented no significant effect of isolated factors nor interaction between them. Similar results were found by Souza *et al.* (2010) when analyzing the effect of doses and periods of application of three growth retardants on the physiological quality of wheat seeds.

In Mauá da Serra, a significant difference was observed between cultivars for the emergence rate index. The cultivar URS Guria produced seeds with a higher vigor when compared to the IPR Afrodite, showing no difference from the other cultivars (Table 2).

In experiments conducted in Londrina and Mauá da Serra, no effect of growth retardant, cultivar, and interaction between factors was observed for seedling emergence in sand. Souza *et al.* (2010) studied the physiological quality of wheat seeds obtained under the application of different growth retardants and corroborated the results found in our study. However, the data found for the wheat crop (PRANDO *et al.*, 2012) detected a difference in seed vigor in cultivars by seedling emergence test.

The one-thousand-seed weight of white oat cultivars cultivated in Londrina was not affected by the growth retardant, cultivar, and interaction between factors. However, for Mauá da Serra, the values of this characteristic showed significant differences between cultivars (Table 2). The highest value of one-thousand-seed weight in Mauá da Serra was observed in the cultivar URS Corona. Alves and Kist (2010) also found a significant difference between cultivars for one-thousand-seed weight in white oat, confirming the existence of genotypic variations for this characteristic.

The divergence of the response of one-thousand-seed weight in the experiments carried out in Londrina and Mauá da Serra may be related to the climatic characteristics of the different cultivation sites. In fact, according to Silva *et al.* (2014), in addition to intrinsic genotype characteristics, one-thousand-seed weight can also be influenced by growing environment conditions.

CONCLUSIONS

1. Londrina and Mauá da Serra present a potential for producing white oat seeds with germination above the standards of the species;

2. Trinexapac-ethyl application reduces seed vigor of the cultivars IPR Afrodite and IPR Artemis produced in Londrina and Mauá da Serra, respectively.

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