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Doses and application times of trinexapac-ethyl on the industrial quality of white oat grains

Doses e épocas de aplicação de trinexapac-ethyl na qualidade industrial de grãos de aveia branca

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Highlights

The years had a very significant impact on all the examined characteristics.
This work is important for the management of oat cultivation.
The application of trinexapac-ethyl interferes with the industrial quality of oats.

Abstract

The application of trinexapac-ethyl in white oats, in addition to controlling lodging, can modify the architecture of the plant, which can favor good growth and development and the production of well-formed, large and heavy grains, characteristics that are valued by the food industry oat processing. However, the responses of the white oat genotypes regarding the effect of doses and times of application of the growth reducer can be variable. The objective of this work was to evaluate the effect of different doses and application times of the growth regulator trinexapac-ethyl on the industrial quality of white oat grains. The experiment was carried out with the cultivar IPR Artemis, under a randomized block design with four replications, in a 4 x 3 factorial scheme, corresponding to four doses of trinexapac-ethyl (0, 50, 100 and 150 g ha^{-1}) and three application times (E_1: plants with the 1st noticeable node; E_2: between the 1st visible node and the 2nd noticeable node and E_3: plants with the 2nd visible node and 3rd noticeable node). The weight of one thousand grains, hectoliter weight, percentage of grains with thickness greater than two millimeters, husking index and industrial grain yield were evaluated. The application of trinexapac-ethyl regardless of the stages at doses of 0 and 50 g ha^{-1} does not interfere with the industrial quality of grains, but at doses of 100 and 150 g ha^{-1}, at times E_2 and E_3, there is a reduction in industrial quality of grains (weight of a thousand grains, hectoliter weight, percentage of grains thicker than two millimeters, hulling and industrial

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grain yield) of the cultivar IPR Artemis.
Key words: *Avena sativa* L. Growth reducer. Industrial income. Lodging. Productivity.

Resumo

A aplicação de trinexapac-ethyl em aveia branca, além de controlar o acamamento pode modificar a arquitetura da planta, o que pode favorecer o bom crescimento e desenvolvimento e a produção de grãos bem formados, grandes e pesados, características que são valorizadas pela indústria de processamento de aveia. No entanto, as respostas dos genótipos de aveia branca quanto ao efeito de doses e épocas de aplicação do redutor de crescimento podem ser variáveis. O objetivo deste trabalho foi avaliar o efeito de diferentes doses e épocas de aplicação do regulador de crescimento trinexapac-ethyl sob a qualidade industrial de grãos de aveia branca. O experimento foi conduzido com a cultivar IPR Artemis, em delineamento de blocos casualizados com quatro repetições, em esquema fatorial 4 x 3, correspondendo a quatro doses de trinexapac-ethyl (0, 50, 100 e 150 g ha-1) e três épocas de aplicação (E_1: plantas com o 1º nó visível; E_2: entre o 1º nó visível e o 2º nó perceptível e E_3: plantas com o 2º nó visível e 3º nó perceptível). Foram avaliados o peso de mil grãos, peso hectolitro, porcentagem de grãos com espessura maior que dois milímetros, índice de descasque e rendimento industrial de grãos. A aplicação de trinexapac-ethyl independente dos estádios nas doses de 0 e 50 g ha^{-1} não interfere na qualidade industrial de grãos, porém nas doses de 100 e 150 g ha^{-1}, nas épocas E_2 e E_3, ocorre redução da qualidade industrial dos grãos (peso de mil grãos, peso hectolitro, porcentagem de grãos com espessura superior a dois milímetros, descasque e produtividade industrial de grãos) da cultivar IPR Artemis.
Palavras-chave: *Avena sativa* L. Redutor de crescimento. Rendimento industrial. Acamamento. Produtividade.

Introduction

The growing demand for quality oat grains and derivatives in human food has stimulated genetic improvement programs in southern Brazil to select genotypes with superior grain characteristics (Bothona et al., 2002).

In general, these programs have sought to group physical, nutritional and functional attributes in the cultivars that meet the demands of the consumer market; that provide grains with superior industrial quality.

The physical and industrial quality of the oat grain, related to the morphological characteristics that will directly influence the industrial processing (Francisco et al., 2002), has been carried out using several criteria such as the weight of the hectoliter (HW), the thousand-grain mass (TGW), the proportion of grains thicker than two millimeters (GI>2mm) and the husking index (PI) (Ministério da Agricultura, Pecuária e Abastecimento [MAPA], 1975). In addition, these last two parameters, together with the grain yield, will define the industrial yield (IGY), also called Avenacor, which expresses the percentage of product obtained for the production of various foods from samples of whole grains (Floss et al., 2002).

Problems such as lodging in white oat cultivars are frequent, which negatively interferes in the production and quality of grains (Zagonel & Fernandes, 2007).

However, the use of growth regulators such as trinexapac-ethyl, has become a strategy to overcome this problem, which can favor the adequate growth and development of the plant and the production of well-formed, large and heavy grains, characteristics that are valued by the oat processing industry.

Growth regulators are chemical substances that have been gaining importance for improving the productive efficiency of cultivated species (Pagliosa et al., 2013), being generally used as an alternative to control plant lodging (Teixeira & Rodrigues, 2003), without decreased grain yield (Rademacher, 2000). Among them, trinexapac-ethyl stands out, which acts on plants by decreasing internode elongation; acts at the end of the metabolic pathway of gibberellic acid biosynthesis (Rajala & Peltonen-Sainio, 2001) by inhibiting the 3β-hydroxylase enzyme (Nakayama et al., 1990), drastically reducing the level of active gibberellic acid (GA1), resulting in an increase in its immediate biosynthetic precursor GA20 (Davies, 1987). The reduction in the level of active gibberellic acid (GA1), which acts on internode elongation, is the cause of plant growth inhibition (Rademacher, 2000).

The use of trinexapac-ethyl can influence the industrial quality of white oat grains, with variable responses according to doses and application times, and the soil and climate conditions of the growing region. Penckowski and Fernandes (2014), working with different doses and application times of the active ingredient trinexapac-ethyl in the white oat cultivars URS Guapa, URS Guria, URS Tarimba and IAC 7, found that the application of the plant regulator increased the industrial yield of grains, however, different levels of responses were observed depending on the dose, the time of application or the cultivar used.

In a study carried out by Almeida et al. (2012), with grain oats under different doses of trinexapac-ethyl, it was shown that as the dose of the regulator is increased, the weight of the hectoliter tends to decrease, but no change in the mass of a thousand grains was recorded.

Given the above, the objective of this work was to evaluate the effect of different doses and application times of the growth regulator trinexapac-ethyl on the industrial quality of white oat grains.

Material and Methods

The experiment was conducted in two agricultural harvests (2019 and 2020) at the Experimental Station of the Institute of Rural Development of Paraná - IAPAR-EMATER, located in the municipality of Londrina-PR (geographical coordinates: 23° 23′ S and 51° 11′ W and altitude 545 m). The soil is classified as Eutroferric Red Latosol (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA], 2018). The climate is of the Cfa type, described as humid subtropical, with an average minimum temperature in the coldest month of 0 to -3°C, and an average maximum in the hottest month of 22 °C, according to Köpen classification. The maximum and minimum temperatures and rainfall recorded during the periods of conducting the experiments are shown in Figure 1.

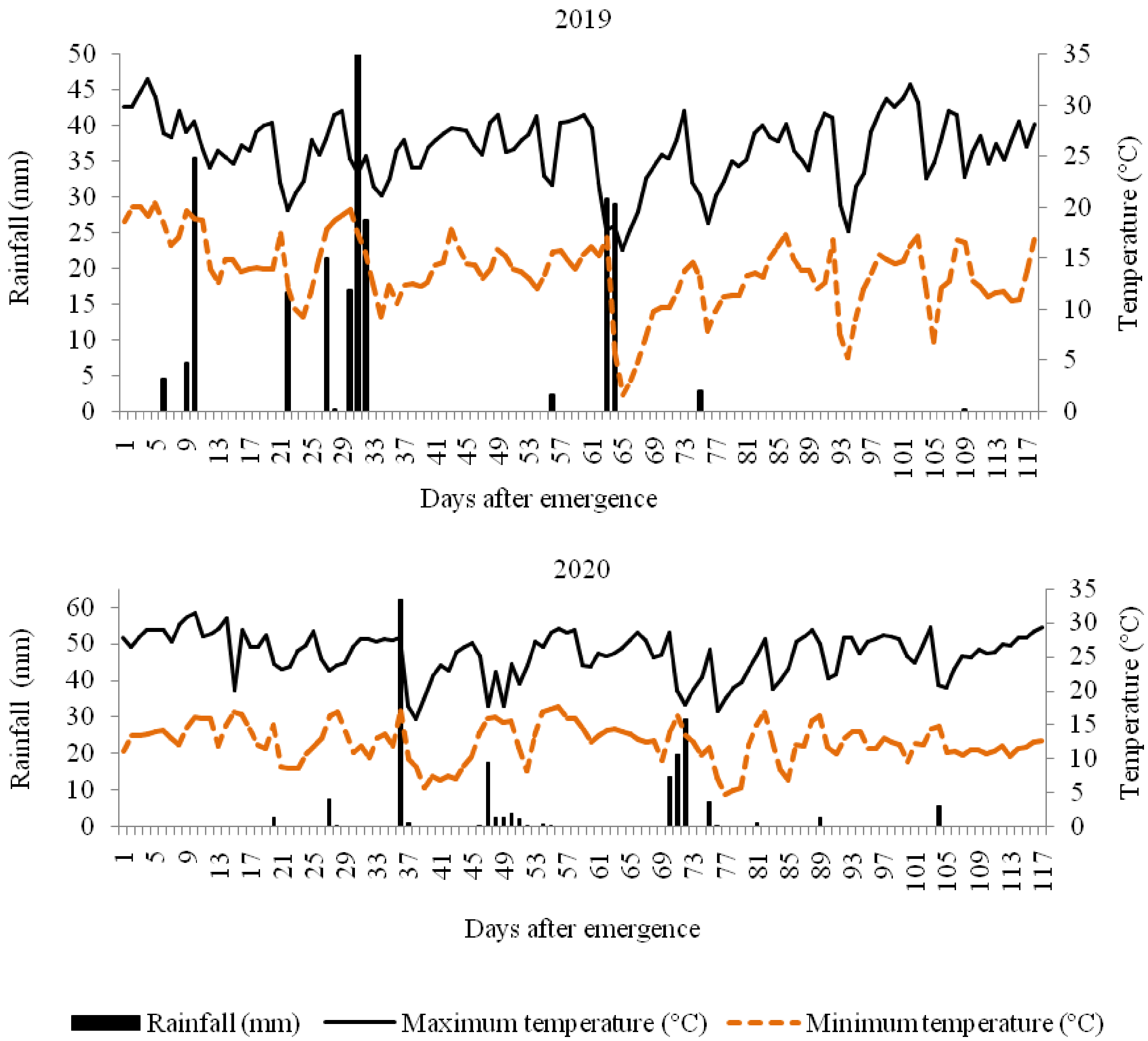

Figure 1. Daily average temperature and rainfall data (mm) for the periods of conduction of the experiments in Londrina-PR, in the 2019 and 2020 harvests.

The chemical characteristics of the soil at a depth of 0-20 cm were determined before the installation of the experiments. In the 2019 harvest, the following values were obtained: pH ($CaCl_2$) 5.00; 5.21 $cmol_c$ dm^{-3} of H + Al; 5.31 $cmol_c$ dm^{-3} of Ca^{2+}; 0.98 $cmol_c$ dm^{-3} of Mg^{2+}; 0.59 $cmol_c$ dm^{-3} de K^+; 29.33 mg dm^{-3} of P and 16.98 g dm^{-3} of organic matter; in the harvest 2020: pH ($CaCl_2$) 4.85; 5.96 $cmol_c$ dm^{-3} of H + Al; 5.76 $cmol_c$ dm^{-3} of Ca^{2+}; 0.65 $cmol_c$ dm^{-3} of Mg^{2+}; 0.61 $cmol_c$ dm^{-3} of K^+; 31.09 mg dm^{-3} of P and 15.92 g dm^{-3} of organic matter.

The grainy white oat cultivar used was IPR Artemis, developed by the Institute of Rural Development of Paraná - IAPAR-EMATER and launched in 2016. This cultivar has a medium cycle (average time to maturity 117 days), moderate resistance to lodging and average height 100 cm.

Sowing was carried out in a mechanized way in the no-tillage system in succession to soybean cultivation, in both harvests. In the 2019 harvest, oats were sown on May 3rd, with emergence and harvest recorded on May 14th and August 28th, respectively. In the 2020 harvest, oats were sown on April 17th, with emergence and harvest recorded on April 25th and August 11th, respectively.

The base fertilization consisted of the application of 200 kg ha^{-1} of the 10-30-10 formula. The nitrogen topdressing fertilization was carried out with 54 kg ha^{-1} of N, divided into two applications, 27 kg ha^{-1} ten days after seedling emergence, and 27 kg ha^{-1} five days after the first application, distributed manually. The other cultivation treatments were carried out in accordance with the technical recommendations for oat culture.

Each experimental unit consisted of 6 lines of 5m in length, spaced 0.17m apart, and with a density of 300 viable seeds m^{-2}, considering the 4 central lines as useful area.

The experimental design adopted was randomized blocks with four replications, in a 4 x 3 factorial scheme, with four doses of trinexapac-ethyl and three times of application. The doses of 0, 50, 100 and 150 g ha^{-1} of the commercial product Moddus® were evaluated at three application times: E_1) plants with the 1st noticeable node; E_2) plants in the culm elongation phase, between the 1st visible node and the 2nd perceptible node; E_3) plants as 2nd visible node and 3rd visible node.

The application of the regulator was made using a costal spray at a constant pressure of 40 lb in.$^{-2}$, pressurized by compressed CO_2, equipped with two tips with flat jet nozzles XR 110-020, with a spray volume proportional to 200 L ha^{-1}.

The harvest was carried out after the grains reached harvest maturity, a stage characterized by hardening of the caryopsis, plants with a dry appearance and grains with moisture below 20%.The following physical characteristics related to industrial performance were evaluated:

Thousand grain weight (TGW): obtained by counting and weighing eight repetitions of 100 grains per plot. The mean of these values was multiplied by 10 to obtain the value of the TGW.

Hectoliter weight (HW): determined on a hectoliter scale with a capacity of a quarter of a liter of grain. Two replications were evaluated, taken from the average sample of each plot, with the result expressed in kg hL^{-1} (MAPA, 1975).

Grain index greater than two mm (IG>2 mm): determined by sieving a sample of 50 grams of grain per repetition, in an oblong mesh sieve with holes of thickness of two millimeters wide (Floss et al., 2002). Data were expressed as a percentage (%) and were calculated using the following formula:

$$GI > 2\,mm = \frac{GM > 2mm}{50}\ x\ 100$$

Where:

GI> 2mm is the grain index with thickness greater than 2 mm (%); GM> 2 mm is the mass of grains larger than 2 mm (g).

Hulling index (HI): A sample per plot consisting of 50 grams of grains larger than two millimeters were introduced into an experimental huller for a period of 75 seconds. After separating the shell, the caryopsis were weighed. Data were expressed as a percentage (%) and were calculated using the following formula:

$$PI = \frac{CM}{50} x\ 100$$

Where:

PI is the peeling index (%);

CM is the mass of caryopsis "hulled grains" (g).

Industrial Grain Yield (IGY): it was determined by multiplying the grain yield, the index of grains larger than two millimeters in thickness and the husking index (Floss et al., 2002), expressed in kg ha^{-1} and obtained according to the following formula:

$$IGY = GY\ x\ GI > 2mm\ x\ PI$$

Where:

IGY is the industrial grain yield;

GY is the grain yield;

GI> 2 mm is the grain index greater than 2 mm;

PI is the peeling index.

Data were subjected to analysis of normality and homogeneity of errors and, later, to analysis of variance. The means were compared using the Tukey test and submitted to regression analysis up to the 2^{nd} degree, at 5% probability. All statistical analyses were performed with the aid of the Genes computer program (Cruz, 2013).

Results and Discussion

In the 2019 harvest, there was a significant interaction between the time factors and TE doses, for all the variables studied (Table 1). In the 2020 harvest, there was a significant interaction between the factors for the variable HW; isolated dose effect for the variables GI>2mm, PI and IGY; for the variable TGW, there was no significant effect of season, doses of TE and the interaction between these factors (Table 1). The coefficients of environmental variation estimated in the 2019 and 2020 harvests ranged from 1.61 to 10.89, indicating adequate experimental precision in conducting the test.

Table 1

Mean square values of analysis of variance and estimation of coefficients of variation (CV) for five traits evaluated in the white oat cultivar IPR Artemis, considering different doses (D) of trinexapac-ethyl and application times (T). Londrina-PR, 2019 and 2020 harvests

Year	Source of Variation	GL	Mean squares				
			TGW (g)	HW (kg hL^{-1})	GI>2mm (%)	PI (%)	IGY (kg ha^{-1})
2019	Blocks		0,61^{ns}	0,30^{ns}	4,14^{ns}	1,06^{ns}	1760,57^{ns}
	D	3	22,05**	67,71**	236,62**	114,42**	542119,68**
	T	2	3,51**	24,81**	67,44**	31,66**	101369,77**
	D x T	6	4,57**	14,02**	35,26**	9,37*	51663,93*
	Residuals	33	0,44	0,83	5,95	3,64	17414,83
	CV (%)		2,19	1,61	3,88	2,61	5,56
	Mean		30,5	56,63	62,84	72,98	2373,39
2020	Blocks	3	2,64^{ns}	2,85^{ns}	5,47^{ns}	1,45^{ns}	177785,38^{ns}
	D	3	12,95^{ns}	25,82**	56,91*	93,37*	517831,83*
	T	2	9,10^{ns}	12,78*	14,25^{ns}	21,96^{ns}	35398,38^{ns}
	D x T	6	3,64^{ns}	5,83^{ns}	17,85^{ns}	45,88^{ns}	22843,82^{ns}
	Residuals	33	5,51	3,28	14,95	20,97	139359,09
	CV (%)		7,31	3,79	4,81	6,18	10,89
	Mean		32,11	47,78	80,31	73,99	3425

*/**: significant at 5 and 1% probability by the F test, respectively; ns: not significant;
CV: coefficient of variation;
Variables: TGW: thousand grain mass; HW: hectoliter weight; GI>2mm: grain index greater than two millimeters; PI: peel index; IGY: industrial grain yield.

The mass of a thousand grains was negatively affected in the 2019 harvest by the application of TE (Table 2 and Figure 2A). At the time of E_2 application, the dose of 150 g ha^{-1} provided a reduction of 11.54% for this characteristic, when compared to the dose of 0 g ha^{-1}. Similarly, for the E_3 time, there was a reduction of 10.11% from the dose of 100 g ha^{-1}. Bazzo et al. (2019), studying doses of TE and N in white oat cultivars, in two growing environments (Mauá da Serra and Londrina-PR), observed that the cultivar IPR Artemis showed a reduction in TGW with the use of TE in the municipality of Maua da Serra.Martins et al. (2021), in studies on the effects of TE in upland rice cultivars, verified that doses above 75 g ha^{-1} cause a reduction in the thousand grain weight, associated with the application period. Kaspary et al. (2015) reported that the use of 150 g of TE ha^{-1} interfered with the mass of a thousand grains of white oat cultivars. Zagonel et al. (2002), working with different wheat cultivars and N doses, also verified a negative influence of the reducer on the mass of a thousand grains, regardless of the cultivar. The reduction in the thousand mass indicates smaller amounts of reserves stored in these grains, which can compromise the size and industrial yield.

The lack of response of the thousand grain mass to the growth reducer in the experiment conducted in 2020 can be explained by the compensatory relationship between the production components, providing an increase in some and a decrease in others, aiming at the best combination between these components to obtain of satisfactory grain yield, as mentioned by Cánovas and Trindade (2003). In this study, the results demonstrate that the mass of a thousand grains was influenced by the harvests and the management practices used in the culture.

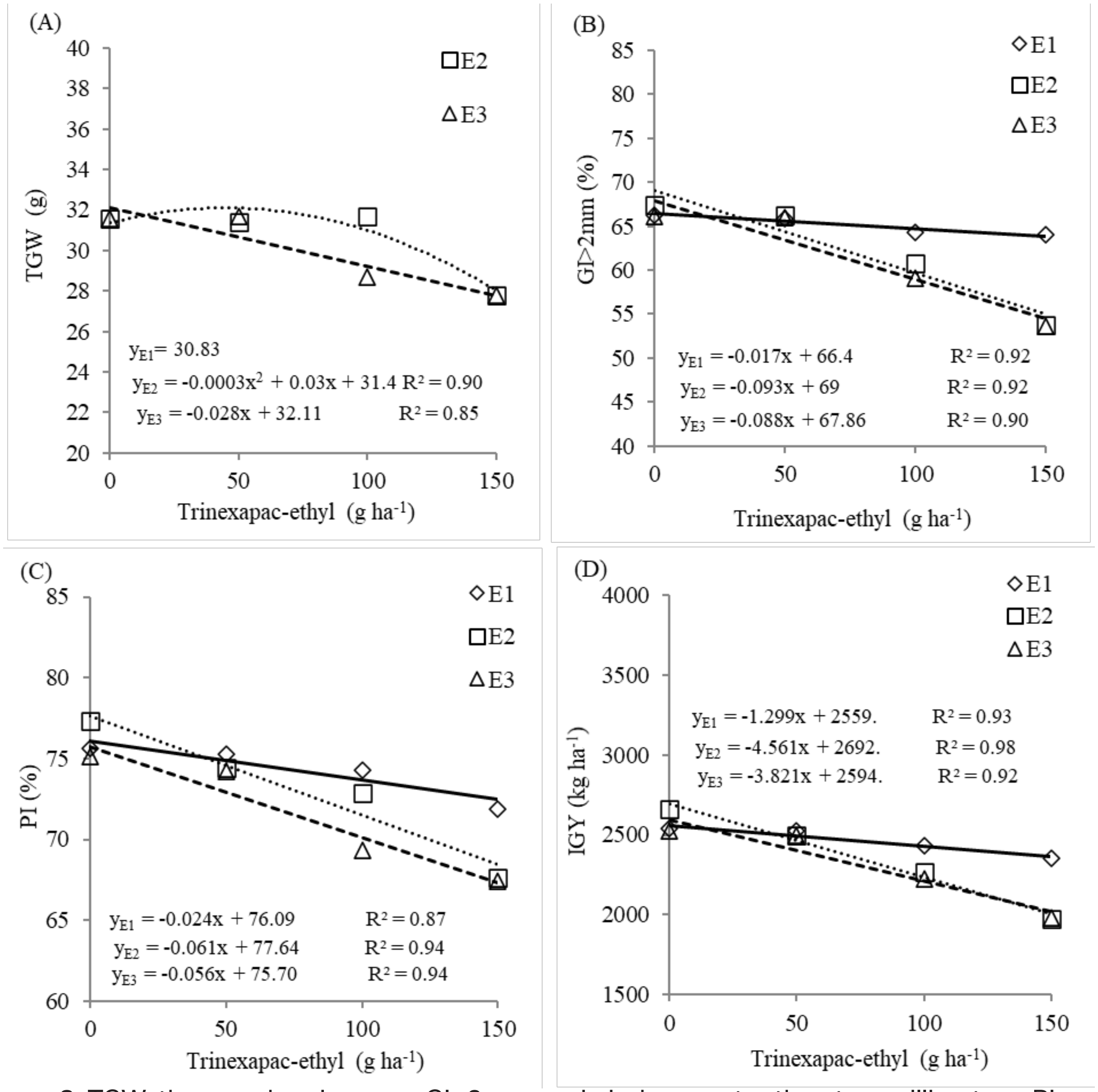

Figure 2. TGW: thousand grain mass; GI>2mm: grain index greater than two millimeters; PI: peel index; IGY: industrial grain yield of the cultivar IPR Artemis as a function of the application of the growth reducer trinexapac-ethyl at different doses and application times. Londrina-PR, 2019 harvest.

between these components to obtain of satisfactory grain yield, as mentioned by Cánovas and Trindade (2003). In this study, the results demonstrate that the mass of a thousand grains was influenced by the harvests and the management practices used in the culture.

Table 2

Mean values of four traits evaluated in the white oat cultivar IPR Artemis under four doses of trinexapac-ethyl growth reducer at three application times. Londrina-PR, 2019 harvest

Variable[/1]	Application times[/2]	2019 Harvest			
		Trinexapac-ethyl (g ha^{-1})			
		0	50	100	150
	E_1	31,1 ^{a}	31,1 ^{a}	31,1 ^{a}	30,1 ^{a}
TGW	E_2	31,6 ^{a}	31,4 ^{a}	31,7 ^{a}	27,8 ^{b}
(g)	E_3	31,6 ^{a}	31,7 ^{a}	28,7 ^{b}	27,8 ^{b}
	E_1	66,3 ^{a}	65,9 ^{a}	64,3 ^{a}	64,0 ^{a}
GI>2mm	E_2	67,4 ^{a}	66,2 ^{a}	60,8 ^{ab}	53,7 ^{b}
(%)	E_3	66,1 ^{a}	66,0 ^{a}	59,1 ^{b}	53,6 ^{b}
	E_1	75,6 ^{a}	75,3 ^{a}	74,3 ^{a}	71,9 ^{a}
PI	E_2	77,3 ^{a}	74,4 ^{a}	72,9 ^{a}	67,6 ^{b}
(%)	E_3	75,1 ^{a}	74,2 ^{a}	69,3 ^{b}	67,4 ^{b}
	E_1	2538 ^{a}	2523 ^{a}	2435 ^{a}	2351 ^{a}
IGY	E_2	2659 ^{a}	2498 ^{a}	2266 ^{a}	1976 ^{b}
(kg ha^{-1})	E_3	2528 ^{a}	2497 ^{a}	2224 ^{a}	1982 ^{b}

Means followed by the same lowercase letter in the column do not differ by Tukey's test ($P<0.05$).

[/1]Variable: TGW: thousand grain mass; GI>2mm: grain index greater than two millimeters; PI: peel index; IGY: industrial grain yield.

[/2]Application Times: E_1: plants with the 1st noticeable node; E_2: plants in the culm elongation phase, between the 1st visible node and the 2nd perceptible node; E_3; plants with the 2nd node visible and 3rd node noticeable.

The hectoliter weight (HW) showed similar behavior in the two evaluation seasons (Table 3 and Figures 3A and B) in response to the doses and times of application of the regulator. For the time of application E_1 in both seasons, there were no changes for this characteristic, however, when the application of TE occurred at the time of E_2, at the dose of 150 g ha^{-1} the HW was reduced by 12.19% and 8.51 %, in the 2019 and 2020 harvests, respectively. Considering the time of application E_3, the negative effect of the reducer could be observed from the dose of 100 g ha^{-1}. When relating the TGW with the HW, the same behavior is observed, in front of the growth regulator. Similar results are reported by Bazzo et al. (2021), Guerreiro and Oliveira (2012) and Souza et al. (2014), who, in studies with white oat, also observed a reduction in TGW and HW as a function of trinexapac-ethyl doses. Penckowski et al. (2010), aiming to evaluate the effect of nitrogen fertilization and the use of trinexapac-ethyl growth rugulator on the agronomic characters of three wheat cultivars (TBIO Mestre, TBIO Iguaçu and TBIO Itaipú), found no effect of N rates on mass thousand grains, however, they observed a positive response of this variable to the application of the phytoregulator, regardless of the cultivar.

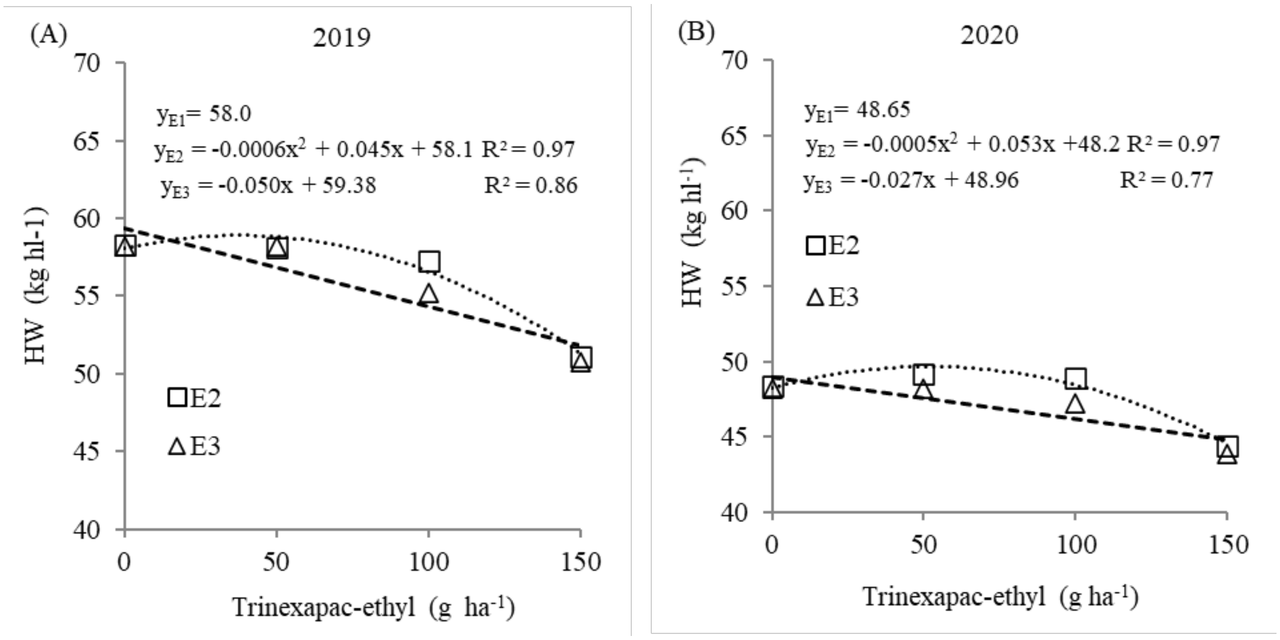

Figure 3. Hectoliter weight (HW) of the cultivar IPR Artemis as a function of the application of the growth reducer trinexapac-ethyl at different doses and application times. Londrina-PR, 2019 and 2020 harvests.

Table 3
Mean values of hectoliter weight of the white oat cultivar IPR Artemis under four doses of trinexapac-ethyl growth reducer at three application times. Londrina-PR, 2019 and 2020 harvests

Variable/1	Application times/2	2019 Harvest				2020 Harvest			
		Trinexapac-ethyl (g ha-1)				Trinexapac-ethyl (g ha-1)			
		0	50	100	150	0	50	100	150
HW (kg hL-1)	E_1	58,1 a	58,2 a	58,2 a	57,5 a	49,0 a	48,5 a	48,7 a	48,4 a
	E_2	58,3 a	58,1 a	57,3 a	51,1 b	48,4 a	49,2 a	48,9 a	44,4 b
	E_3	58,2 a	58,2 a	55,2 b	50,8 b	48,2 a	48,2 a	47,2 a	43,9 b

Means followed by the same lowercase letter in the column do not differ by Tukey's test (P<0.05).
/1 Variable: HW: hectoliter weight
/2 Application Times: E_1: plants with the 1st noticeable node; E_2: plants in the culm elongation phase, between the 1st visible node and the 2nd perceptible node; E_3; plants with the 2nd node visible and 3rd node noticeable.

For the 2019 harvest, the TE at a dose of 150 g ha^{-1} reduced the grain index larger than two millimeters (GI>2mm) in the order of 19.37 and 19.52% at the times of applications E_2 and E_3, respectively (Table 2 and Figure 2B). Still in relation to GI > 2mm, however, for the 2020 crop, it is observed that there was a decreasing quadratic adjustment in response to increasing doses of the growth regulator TE, at three application times (Figure 4). With the application of trinexapac-ethyl, the maximum point (82.30%) was obtained at the estimated dose of 42.74 g ha^{-1} (Figure 4). It can be seen that with the use of increasing doses of the growth regulator there was a reduction in the GI > 2mm of the cultivar IPR Artemis. Trinexapac-ethyl reduces height and modifies the leaf architecture of plants, which probably allowed for better light capture, a factor that stimulates the development of fertile tillers and, consequently, a greater number of panicles m^{-2}. Castro and Kluge (1999) state that tillering in annual grasses is favored by high light intensity. In this case, the increase in tillers and reproductive units per area increases competition in the partition of nutrients and photoassimilates in the plant, hindering adequate grain filling and favoring the formation of thinner grains.

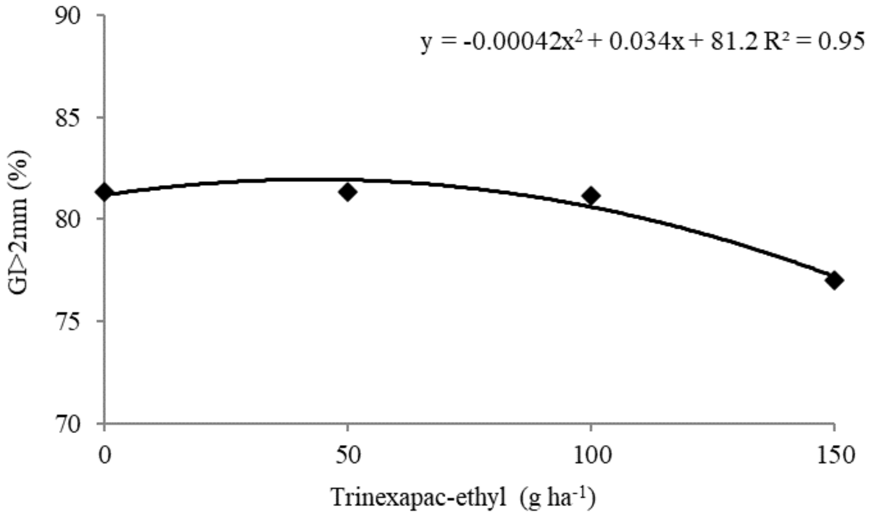

Figure 4. GI>2mm: grain index greater than two millimeters of the IPR Artemis cultivar as a function of the application of four doses of trinexapac-ethyl at three application times. Londrina-PR, 2020 crop.

It is observed that the husking index (PI) in the 2019 harvest was not altered by the time of application E_1, however, when the application of TE occurs at the time of E_2, at a dose of 150 g ha^{-1}, there is a reduction of 11.05% for the PI; for the E_3 time, the reduction occurs from the dose of 100 g ha^{-1} on average 10.07% (Table 2 and Figure 2C). Still in relation to the PI, however, for the 2020 crop, there is an adjustment of the quadratic function in response to the use of the TE growth regulator, at three application times (Figure 5). With the application of trinexapac-ethyl, the maximum point (75.90%) was obtained at the estimated dose of 31.63 g ha^{-1} (Figure 5). Souza et al. (2014), working with three cultivars of white oat grain (UPFA Gaudéria, UPF 18 and URS Guria) and four doses of the plant regulator trinexapac-ethyl (0, 50, 100 and 150 g ha^{-1}), found a response only in the cultivar UPF 18, which presented the highest percentage of husked grains (54.41%) at the estimated dose of 60.56 g ha^{-1} of the active ingredient.

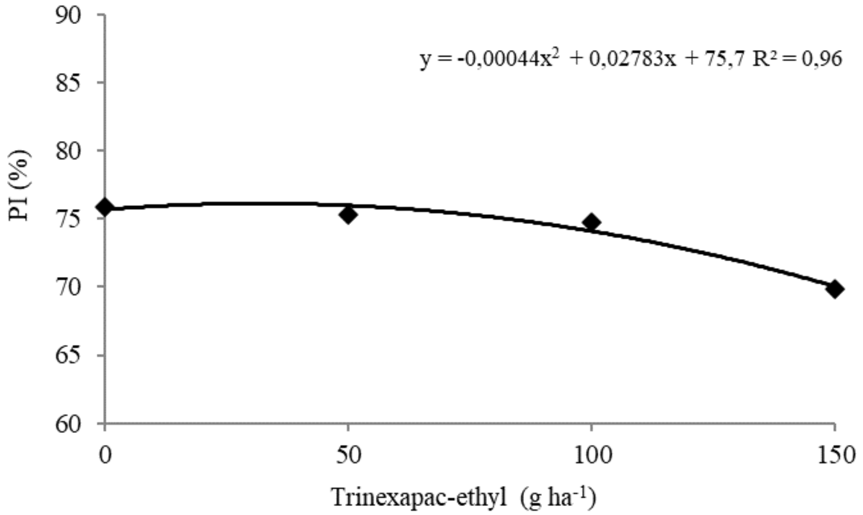

Figure 5. PI: peeling rate of the cultivar IPR Artemis as a function of the application of four doses of trinexapac-ethyl at three times of application. Londrina-PR, 2020 crop.

The characteristic industrial grain yield (IGY) in the 2019 harvest was negatively influenced by the use of TE in the E_2 and E_3 application seasons, with an average reduction of 23.14% (Table 2 and Figure 2D). In the 2020 crop, the IGY characteristic adjusted to the quadratic function in response to the use of the TE growth regulator, at three application times (Figure 6). With the application of trinexapac-ethyl, the maximum point (3,542.0 kg ha^{-1}) was obtained at the estimated dose of 43.98 g ha^{-1} (Figure 6). Penckowski and Fernandes (2014), working with different doses and application times of the active ingredient trinexapac-ethyl in the white oat cultivars URS Guapa, URS Guria, URS Tarimba and IAC 7, found that the application of the regulator increased the industrial yield of grains, however, different levels of responses were observed depending on the dose, the time of application or the cultivar used.

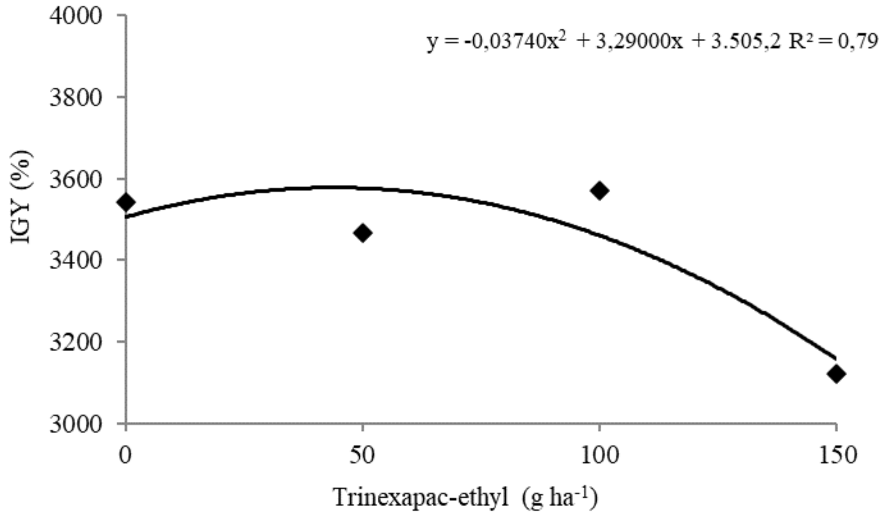

Figure 6. IGY: industrial grain yield of the cultivar IPR Artemis as a function of the application of four doses of trinexapac-ethyl at three times of application. Londrina-PR, 2020 crop.

The Comissão Brasileira de Pesquisa de Aveia [CBPA], (2014) suggests two levels of classification for the index of grains greater than two millimeters: type 1 with at least 75% of the grains with a thickness greater than two millimeters; type 2 and type 3 with less than 75% of the grains thicker than two millimeters. In addition to the grain thickness, the difference between the types is given by the percentage of stained and/or dark grains, damaged grains, impurities and foreign materials and grain acidity. Observing the results of this work, it appears that the maximum value (67.4%) obtained for the thickness of the grains in the 2019 harvest was at the dose of 0 g ha^{-1} (Table 2 and Figure 2B), however, it does not fit in the type 1 classification levels. On the other hand, in the 2020 crop the only treatment that did not fit into type 1 was the dose of 150 g ha^{-1} at the time of application E_3. Under this treatment, only 73.7% of the grains of the cultivar IPR Artemis were thicker than two millimeters (Figure 4).

The tests that characterized the industrial quality of the grains showed differences between the crops, demonstrating the influence of the environment on the development of the physical characteristics of the grains. Thus, it is clear that the edaphoclimatic characteristics of the crops directly affect the growth, development and productive performance of the evaluated genotype, as well as its responses to the adopted management and the interaction between them. This information is extremely important for the formulation of recommendations for the cultivation of oats, and the necessary care must be taken for the adequate choice of genetic materials best adapted to the different regions of cultivation and the adoption of the correct management, in order to use with the inputs applied in the culture, in search of the reduction of losses and greater yields.

In view of the above, TE negatively impacts the industrial quality of the grains of the cultivar IPR Artemis.

Conclusions

The application of trinexapac-ethyl regardless of the stages at doses of 0 and 50 g ha^{-1} does not interfere with the industrial quality of grains, but at doses of 100 and 150 g ha^{-1}, at times E_2 and E_3, there is a reduction in industrial quality of grains (weight of a thousand grains, hectoliter weight, percentage of grains thicker than two millimeters, hulling and industrial grain yield) of the cultivar IPR Artemis.

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