



Performance of wheat varieties grown from seeds with different vigor levels¹

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ABSTRACT

The objective of this study was to evaluate the performance of wheat plant grown from seeds with different vigor levels. The experimental design was randomized blocks in a 3 x 3 factorial design (cultivar x vigor level) with four replications. The wheat cultivars were Tbio Toruk, Tbio Mestre and Tbio Iguacu. The classification of vigor levels was high, medium and low, determined by several vigor procedures. The following evaluations were performed: plant height, number of spikelets in the main tiller, number of seeds in the main tiller, seed mass in the main tiller, number of fertile tillers, number of seeds in tillers, seed mass in tillers, number of plants.m⁻², number of spikes.m⁻², and grain yield per hectare. The use of high vigor seeds provides a greater number of wheat plants and spikes per area. Grain yield is affected significantly by seed vigor level: there is an increase of up to 11% by using high vigor seeds compared to low vigor seeds.

Keywords: *Triticum aestivum* L; high vigor; grain yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most relevant crops in the world, considered among winter cereals as one of the species that has the greatest economic relevance (Takeiti, 2015).

In Brazil, production is concentrated in the Southern region, which is responsible for more than 90% in the country total wheat production. However, the Brazilian wheat production accounts for about 50% of the national demand. Thus, Brazil is a major importer of wheat. One of the factors that cause this situation is low crop productivity (Conab, 2019).

In this context, the country has an interest in increasing the production of wheat, because in addition to the demand for grains, the cultivation of the cereal contributes to the supply of mulch for the production of summer crops such as soybeans and corn (Conab, 2017). Therefore, in order to explore the potential for wheat and to meet domestic demand in Brazil, adequate crop

management strategies, promising genotypes and high quality seeds are needed (Abati *et al.*, 2017). In this sense, seed quality is defined by the sum of its genetic, physical, physiological, and sanitary attributes (Peske *et al.*, 2019). Among the attributes of physiological quality, vigor is highlighted as extremely important as it is directly related to germination, emergence and seedling growth rates in the field, also influencing the yield of several crops (Rossi *et al.*, 2017).

Several studies have pointed out the effect of seed vigor on crop growth and grain yield. Carneiro *et al.* (2020), evaluating different levels of seed vigor in soybean populations, observed that the population from seeds of high vigor presented grain yield 30% higher than the population formed by low vigor seeds. Egli & Rucker (2012) confirmed that corn seeds with high vigor always have a seedling emergence considered more uniform than those with low vigor. As for wheat, Pimentel *et al.* (2018) found that seeds with high vigor tolerated greater sowing depths,

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presenting a higher percentage of emergence and consequently a greater number of plants per area, which should be considered during the implantation and management of crop production. In this context, Abati *et al.* (2018) concluded that highly vigorous seeds favor the establishment of the stand and development of plants in the initial phenological stages and the productivity of wheat grains.

However, even though these effects of seed vigor on wheat development has been studied, it may vary according to cultivar, environment and production management.

Thus, the objective of the study was to evaluate the performance of different wheat cultivars grown from seeds with different vigor levels.

MATERIALS AND METHODS

For data collection, experiments were carried out under different field conditions at two growing sites. The cultivation Site 1 was the experimental area of the Eliseu Maciel Agronomy Faculty, Federal University of Pelotas, Capão do Leão, RS (31°48'10" S and 52°25'9" W, altitude of 67 meters). The cultivation Site 2 was an area belonging to the municipality of Nova Boa Vista, RS (27°58'45" S and 53°0'54" W, altitude of 421 meters). The area in Capão do Leão, RS, has a soil classified as Albaqualf (USDA, 1999). The soil physical and chemical characteristics at the 0-20 cm layer are pH (H₂O): 5.3, P and K: 55.7 and 88 mg.dm⁻³, respectively; Ca, Mg, Al, and CEC(pH7): 3.1, 0.9, 0.2 and 7.1 cmolc.dm⁻³, respectively; and base saturation, organic matter and clay: 61, 1.93 and 16%, respectively. The area in Nova Boa Vista (Site 2) has a soil classified as Alfisol (USDA, 1999). Its physical and chemical characteristics at the 0-20 cm layer are pH (H₂O): 5.5, P and K: 8 and 115 mg.dm⁻³, respectively; Ca, Mg, Al, and CEC(pH7): 7.9, 3.4, 0.1 and 16.5 cmolc.dm⁻³, respectively; and base saturation, organic matter and clay: 70, 3.73 and 62%, respectively.

The climate of both cultivation sites is Cfa, with well-distributed rains and hot summers. Meteorological data on maximum and minimum temperatures, solar radiation and rainfall, during the period of conduction of the experiments, are presented in Figure 1.

For Site 1, the climatological data were obtained from the Pelotas-RS Agroclimatic Station. For Site 2, data were collected from the meteorological station of Palmeira das Missões, RS.

The experimental design was randomized blocks in a 3 x 3 factorial design (cultivar x seed vigor level) with four replications. The treatments consisted of a combination of three wheat cultivars (Tbio Toruk, Tbio Mestre and Tbio Iguaçú) and three vigor levels (high, medium and low).

The experimental plots consisted of five lines two meters long with an interrow spacing of 0.17 meters. The seed density was 394 seeds.m⁻² with 10% correction aiming to reach a stand with 350 plants.m⁻². The three central lines of each plot were considered as the useful area; 0.25 m from each end was excluded, resulting in a useful area of 1,275 m².

The ranking of wheat seed vigor levels was determined laboratory the Graduate Program in Seed Science and Technology of the Federal University of Pelotas. For this purpose, the modified accelerated aging method was used. It consists in the packing of seeds on a metallic screen fixed inside plastic boxes ("gerbox") containing 40 mL of saturated saline solution each (Pedroso *et al.*, 2010).

From the initial seed lots with high vigor seeds of each cultivar, the modified accelerated aging periods were determined to obtain medium and low vigor lots using pre-tests. The aging periods were 96 and 108 hours for the cultivars Tbio Toruk and Tbio Mestre, and 84 and 96 hours for the cultivar Tbio Iguaçú. The high vigor seed lot of each cultivar was not submitted to accelerated aging.

The seed quality was evaluated after ranking the vigor levels aiming to maintain lots with a statistically equal germination, however with different vigor levels. For this, a germination test was performed using four samples with four subsamples of 50 seeds per treatment. The seeds were arranged to germinate in rolls composed of three sheets of germination paper moistened with 2.5 times the mass of the dry substrate. The rolls were kept in a BOD germination chamber at 20 °C and a photoperiod of 12 hours. The evaluation of the percentage of normal seedlings was performed eight days after sowing (Brasil, 2009).

In addition to germination, the vigor was evaluated by the seedling emergence in the field test using four samples of 100 seeds per treatment. The sowing was performed in the soil at a spacing of 0.17 m between lines, and at a sowing depth of 3 cm. The evaluation was performed 21 days after sowing, and the results were expressed as percentage of normal emerged seedlings.

For the evaluation of the performance of plants population in relation to productivity attributes, a manual sowing of different cultivars was carried out aiming a uniform distribution of seeds, in the two cultivation sites (Capão do Leão - Site 1 and Nova Boa Vista -Site 2).

In both crop sites, the no-tillage system was used. The fertilization was performed according to previous chemical analysis and followed the recommendations of the Handbook of Fertilization and Liming of the States of Rio Grande do Sul and Santa Catarina (CQFS, 2004). The fertilization consisted of 280 kg.ha⁻¹ of N-P-K (10-20-20) and two applications of 135 and 100 kg.ha⁻¹ of urea (45%

N), which were carried out at the tillering and elongation stages. Pest and disease controls were carried out in a preventive manner as recommended for the crop (Embrapa, 2017).

Harvesting was performed when seeds reached approximately 18% moisture. After harvesting, seeds were dried in a stationary dryer at an air temperature of 40 °C and a relative humidity in between 40 and 70% (Peske *et al.*, 2019) until reaching 12% humidity.

For the evaluation of the productivity components, ten plants of each treatment were randomly sampled per plot. The following evaluations were performed: plant height (PHe), number of spikelets in the main tiller (Nspmt), number of seeds in the main tiller (Nsmt), seed mass in the main tiller (Smmt), number of fertile tillers (Nft), number of

seeds in the tillers (Nst), seed mass in the tillers (Smt), number of plants.m⁻² (Npla), number of spikes.m⁻² (Nsp), and grain yield per hectare in kg.ha⁻² (Prod).

Data were submitted to analysis of variance by F test at 5% probability and, if significant, the means were compared by Duncan test at 5% probability.

RESULTS AND DISCUSSION

The characterization of seed lots of the three cultivars after accelerated aging can be observed in Table 1. Accelerated aging differentiated lots into three vigor levels (high - 80-85%, medium - 71-77%, low - 60-63%), corroborating the results of seedling emergence in the field. However, it kept germination rates without statistical differences, regardless of the evaluated cultivar.

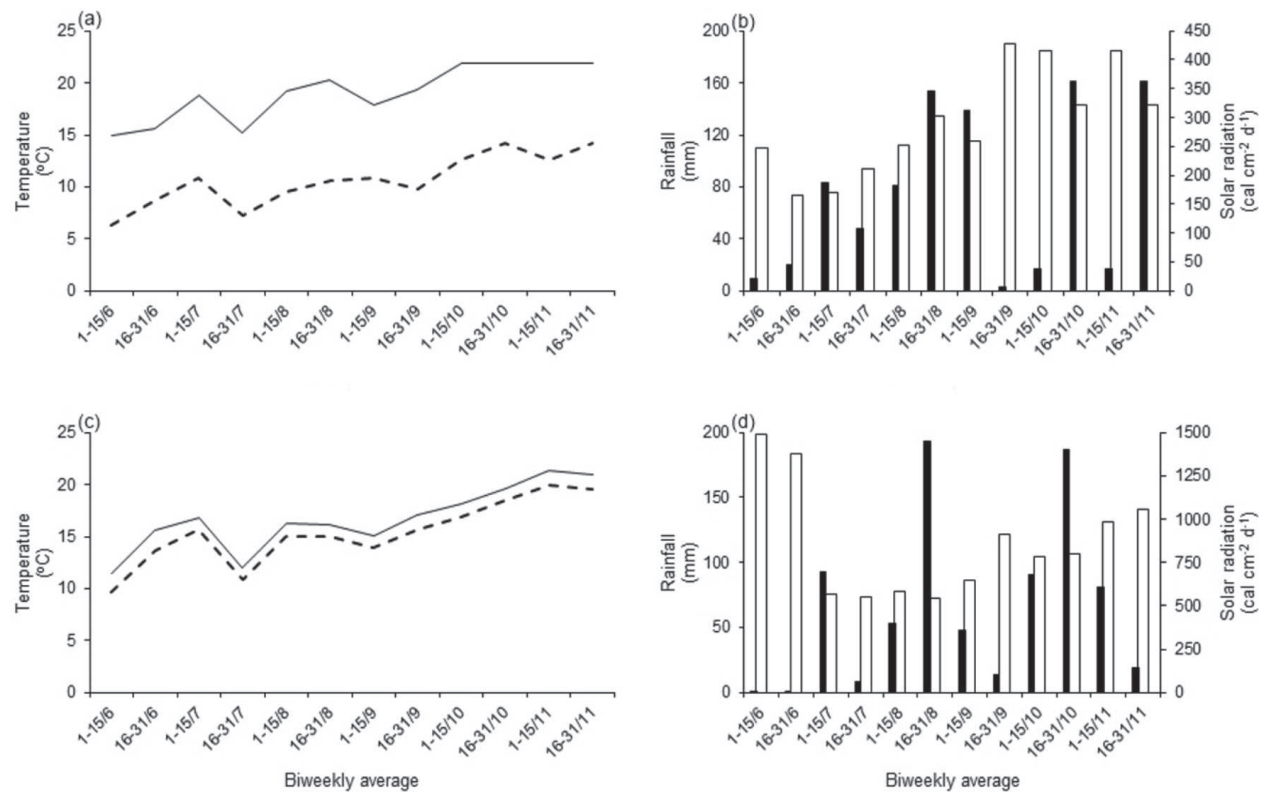


Figure 1: Maximum temperature, minimum temperature, rainfall and solar radiation at Capão do Leão, RS (a, b), and Nova Boa Vista, RS (c, d), during the development of wheat plants.

Table 1: Initial characterization of seed lots of wheat (*T. aestivum* L.) used in the evaluation of the performance of plants in the field, Capão do Leão, RS

Vigor Level	Germination after accelerated aging (%)			Germination (%)			Seedling emergence in the field (%)		
	Toruk	Mestre	Iguaçu	Toruk	Mestre	Iguaçu	Toruk	Mestre	Iguaçu
High	85 a*	83 a	80 a	93 a	92 a	88 a	67 a	62 a	60 a
Medium	77 b	75 b	71 b	90 a	90 a	87 a	54 b	51 b	48 b
Low	60 c	63 c	61 c	88 a	90 a	88 a	41 c	41 c	40 c
CV (%)	4,02			3,05			8,82		

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

By evaluating the performance of plants grown from seeds with different levels of vigor, it was verified for the study carried out in Capão do Leão (Site 1) that only plant height showed a significant interaction between cultivar factors and vigor levels (Table 2). For the study carried out in Nova Boa Vista (Site 2), the number of plants.m⁻² showed a significant interaction between cultivars and vigor levels. There were no significant differences at the cultivar Site 1 as for the number of plants.m⁻² among cultivars (Table 2).

The use of high vigor seeds allowed obtaining the highest number of plants per unit area. Even if the germination was the same among seeds of the three lots, the greater vigor allows a superior establishment of plants in the field. After sowing, there was a period of absence of rainfalls of 11 and 25 days, respectively, at cultivation Sites 1 and 2 (Figure 1). The lack of rainfalls reduced soil moisture. This possibly affected seedling emergence, with a more pronounced effect on treatments with low vigor seeds (Table 2).

According to França-Neto *et al.* (2016), the use of high vigor seed lots is highly recommended, aiming to ensure an adequate population of plants even when under stress conditions, which ensures crop productivity.

It can be seen in table 3 that the plant height was higher for Tbio Iguacú for all vigor levels. For the Tbio Toruk cultivar, the lowest values were observed for this variable (Table 3). No significant differences were observed in plant height between seed vigor levels for the Tbio Toruk cultivar. For the cultivar Tbio Mestre, plant height values were higher when grown from low vigor seeds. However, values did not differ from plants grown from high vigor seeds. For the cultivar Tbio Iguacú, plant height values were higher for plants grown from high and medium vigor seeds.

Due to the differences between the wheat cultivars and the edaphoclimatic conditions of the southern region of Brazil, it is essential to evaluate the different genotypes, and their interaction with the environment, since the success of a cultivar depends directly on its performance in the cultivation area (Scheeren *et al.*, 2011).

Thus, the cultivars have several inherent characteristics of development and are responsive according to the conditions of cultivation. In this sense, the cultivar Tbio Toruk has as one of its characteristics the short stature, while the cultivars Tbio Mestre and Tbio Iguacu have plant stature considered medium to low and medium to high, respectively, which may explain the different results obtained referring to the height of plants, when comparing the three cultivars.

Table 2: Plant height (PHe), number of plants.m⁻² (Npla.m⁻²), number of spikes.m⁻² (Nsp.m⁻²), number of spikelets.spikes⁻¹ in the main tiller (Nspmt), number of seeds in the main tiller (Nsmmt), and seed mass (g) in the main tiller (Smmt) of plants of different wheat cultivars (*T. aestivum* L.) grown from seeds with three different vigor levels, Capão do Leão, RS

Cultivar	PHe (cm)		Npla.m ⁻²		Nsp.m ⁻²		Nspmt		Nsmmt		Smmt (g)	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Toruk	70.99c*	59.24c	197.67	254.41	470.39b	548.53a	14.55 a	13.97b	35.19	34.27b	1.48	0.708
Mestre	79.17b	70.26b	199.46	254.89	513.35a	594.92a	14.49 a	13.92b	36.29	35.97a	1.36	0.728
Iguacú	92.04a	82.03a	212.54	245.58	480.55ab	463.57b	13.98 b	14.57a	33.93	37.17a	1.35	0.775
Vigor												
High	81.06	71.26	233.78a	294.61a	505.01a	578.08a	13.87b	13.95	32.77b	34.45b	1.32	0.741
Medium	80.95	69.27	199.83b	248.03b	503.78a	505.79b	14.59a	14.24	37.23a	36.29a	1.45	0.737
Low	80.15	70.99	176.06b	212.25c	455.51b	523.16b	14.55a	14.27	35.41ab	36.66a	1.42	0.734
Value of F												
Cultivar (C)	155.4*	167.5*	0.786 ^{ns}	0.537 ^{ns}	2.75 ^{ns}	15.74*	3.38 ^{ns}	4.44*	1.22 ^{ns}	6.55*	2.12 ^{ns}	1.91 ^{ns}
Vigor (V)	0.338 ^{ns}	1.51 ^{ns}	10.05*	33.35*	4.34*	5.05*	5.78*	1.06 ^{ns}	4.379*	4.32*	1.86 ^{ns}	0.019 ^{ns}
C x V	7.301*	0.665 ^{ns}	0.648 ^{ns}	4.68*	1.43 ^{ns}	0.422 ^{ns}	0.926 ^{ns}	0.55 ^{ns}	0.333 ^{ns}	0.457 ^{ns}	0.446 ^{ns}	0.171 ^{ns}
CV (%)	3.65	4.33	15.60	9.84	9.62	13.03	4.08	4.19	10.56	5.52	12.42	11.63

* Means followed by the same lowercase letter in rows do not differ by Duncan test (p ≤ 0.05).

Site 1: Pelotas; Capão do Leão; Site 2: Nova Boa Vista.

As for the number of plants.m⁻², only for high vigor seeds, the cultivars showed a significant difference between themselves, in which Tbio toruk presented the highest values, differing from Tbio Mestre and Tbio Iguaçu which did not differ between them. Furthermore, for all cultivars treatments consisting of high vigor seeds obtained a greater number of plants.m⁻². However, for the cultivars Tbio Mestre and Tbio Iguaçu, there were no significant differences between high and medium vigor seeds.

The use of low vigor seeds may lead to a decrease in emergence speed, uniformity, total seedling emergence, initial size, dry matter production and plant growth rates, which can affect the establishment of adequate stands (Kolchinski *et al.*, 2005). Thus, the influence of seed vigor on the emergence of seedlings in the field, in the establishment of the population and in the initial development of plants is a consensus in the scientific environment and also in the productive sector (Marcos Filho, 2015; Ebone *et al.*, 2020). According to Abati *et al.* (2017) seeds with high vigor have greater ability to use the resources of the environment, resulting in plants that establish themselves in the field in less time, occupy the cultivation environment better and have greater potential for growth and productivity, which can be associated in this case to the results obtained.

Other studies also corroborate the data obtained, in which plants from seeds of high vigor showed better performance. Rossi *et al.* (2017) found influence of the vigor of soybean seeds in the emergence of seedlings in the field, with the highest values obtained by plants from seeds with high vigor. In addition, the authors observed that the use of seeds with high vigor resulted in better stands in the field and plants with better development. Abati *et al.* (2018) observed in their study that high vigor wheat seeds obtained better establishment in the field, growth and performance of plants.

The number of spikes.m⁻² was higher for Tbio Mestre and Tbio Iguaçu cultivars at Site 1. At cultivation Site 2, Tbio Mestre and Tbio Toruk cultivars reached a higher number of spikes.m⁻² (Table 2). The number of spikes.m⁻² was higher when high vigor seeds were used at both

cultivation sites, but this number did not differ for medium vigor seeds at the cultivation Site 1. The decrease in the plant population in the treatments with low vigor seeds (Table 2) can be related to the reduction of number of spikes per area.

In this sense, it is worth noting that there was an increase in the number of fertile tillers per plant when low vigor seeds were used (Table 4). Wheat is a crop with potential for producing tillers with fertile ears, which gives the species a certain plasticity that gives it the capacity to occupy empty spaces between plants (Mundstock, 1999). This result may be due to the plasticity of plants to occupy spaces because of the lack of plants in the sowing line. However, there was not enough compensation to match the number of spikes.m⁻².

The number of spikelets in the main tiller at Site 1 for Tbio Toruk and Tbio Mestre cultivars was higher than for the Tbio Iguaçu cultivar, but it did not differ significantly between them. At Site 2, the cultivar Tbio Iguaçu reached the highest values for number of spikelets (Table 2).

When analyzing seed vigor levels, the number of spikelets in the main tiller was lower at the crop Site 1 using high vigor seeds. However, no significant differences were observed between the number of spikelets in the tillers when the crop Site 2 was analyzed.

For the number of seeds in the main tiller, no significant differences were observed between wheat cultivars grown at Site 1. However, when considering the cultivation Site 2, the cultivars Tbio Mestre and Tbio Iguaçu reached higher values, without differing between them (Table 2). The expression of the productivity potential of the crops is dependent on the genetic attributes, environmental factors and the interaction between both, which culminates in differences in the performance of the genotypes (de Leon *et al.*, 2016). Therefore, the expression of the performance of the different cultivars in this study, may be related not only to the characteristics inherent to each one of them, but also to their interaction with the cultivation environments.

In both cultivation sites, plants grown from medium and low vigor seeds showed a superiority in relation to the number of seeds in the main tiller, but they did not

Table 3: Unfolding of simple interaction effects between cultivars and vigor levels for plant height at Site 1 (Pelotas, Capão do Leão - RS) and number of plants.m⁻² at Site 2 (Nova Boa Vista - RS), Capão do Leão, RS

Vigor Level	Plant height (cm)			Number of plants.m ⁻²		
	Toruk	Mestre	Iguaçu	Toruk	Mestre	Iguaçu
High	68.58 aC*	78.20 abB	96.40 aA	330.88 aA	270.59 aB	282.35 aB
Medium	72.96 aC	77.28 bB	92.60 aA	232.35 bA	264.70 abA	247.05 aA
Low	71.45 aC	81.87 aB	87.14 bA	199.99 bA	229.41 bA	207.35 bA
CV (%)		3,65			9,84	

* Means followed by the same lowercase letter in columns and uppercase in lines do not differ by Duncan test (p ≤ 0.05).

differ statistically regarding low seed vigor (Table 2). According to Pimentel *et al.* (2018) certain compensatory strategies developed by the plants often cause certain yield components to be negatively related, thus increasing certain components and reducing others. In this sense, the results obtained can be explained by the plasticity capacity characteristic of wheat and the development of these compensation strategies.

The seed mass in the main tiller did not present significant differences between cultivars and seed vigor levels at both cultivation sites (Table 2). This result indicates that the highest number of seeds formed in spikes of the main wheat plant grown from medium and low vigor seeds is not sufficient to influence the production of seed mass, indicating a probable compensation during seed filling. In this sense, seed filling may have occurred more efficiently in plants grown from high vigor seeds. Bagateli (2015) in his study, found linear increases in the mass of a thousand soybean seeds, according to the increase in the seed vigor level.

By evaluating the number of fertile tillers at both sites, no significant differences were found between cultivars (Table 4). Plants grown from low vigor seeds reached a superiority in the number of fertile tillers for both crop sites. However, plants grown from high vigor seeds did not differ statistically from plants grown from low vigor seeds at the cultivation Site 2.

The results for the number of fertile tillers may be related to the lower plant population established using low vigor seeds (Table 2). This indicates a plasticity effect of plants in an attempt to compensate for failures in sowing lines. As described by Santos & Mundstock (2002),

changes in the morphological structures of wheat stem occur from differences in management conditions, sowing density, and competitive and compensatory capacity (phenotypic plasticity) of cultivars.

The number of seeds produced in tillers did not differ between cultivars grown at both sites. The seed mass evaluated in tillers did not differ among the cultivars at Site 1. However, at Site 2, the Tbio Iguaçú cultivar reached higher values, but it did not differ from the cultivar Tbio Mestre (Table 4).

Regarding seed vigor level, the number of seeds produced in tillers was higher in plants grown from the low vigor seed lot at both sites. However, plants grown from seeds with a high vigor did not differ from plants grown from low vigor seeds at Site 2 as for the number of seeds in tillers (Table 4).

Similarly to the response of the number of seeds in tillers, plants grown from seed lots with a low vigor reached higher values of seed mass in tillers at both sites, whereas plants grown from high vigor seeds obtained the worst results at Site 1, without differing from plants grown from low vigor seeds at the Site 2. This can be related to the number of plants per square meter, which was significantly lower for the low vigor seed lot.

It is noticeable that plants grown from seeds with a low vigor seek to occupy spaces in sowing lines without plants, emitting more tillers due to less competition among plants. Consequently, the production of seeds in tillers is higher. The effects of competition between plants are decisive for the production of tillers, with direct implications on the productivity of grains and their components (Semeato, 2016). In this sense, the number of

Table 4: Number of fertile tillers (Nft), number of seeds in tillers (Nst), seed mass (g) in tillers (Smt), and grain yield.ha⁻¹ (Prod) of wheat plants grown from seeds with three vigor levels, Capão do Leão, RS

	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
	Nft		Nst		Smt (g)		Prod. (kg.ha ⁻¹)	
Cultivar								
Toruk	1.64a*	1.48a	44.15a	39.17a	1.73a	0.636b	5991.02a	4218.31a
Mestre	1.69a	1.63a	51.36a	42.63a	1.72a	0.741ab	5548.93b	4423.57a
Iguaçu	1.78a	1.71a	46.33a	46.09a	1.63a	0.815a	5321.49b	4541.80a
Vigor Level								
High	1.52b	1.60ab	38.68b	42.25ab	1.29c	0.701b	5842.27a	4744.58a
Medium	1.66b	1.46b	45.36b	38.35b	1.69b	0.658b	5858.51a	4174.58b
Low	1.94a	1.76a	57.81a	47.3a	2.09a	0.833a	5160.66b	4264.52b
Value of F								
Cultivar (C)	1.11 ^{ns}	2.32 ^{ns}	1.89 ^{ns}	1.93 ^{ns}	0.306 ^{ns}	4.29	6.13*	2.02 ^{ns}
Vigor (V)	9.29*	3.70*	12.99*	3.24*	15.714*	4.43*	8.39*	7.09*
C x V	1.06 ^{ns}	0.610 ^{ns}	0.461 ^{ns}	0.49 ^{ns}	0.803 ^{ns}	0.609 ^{ns}	2.06 ^{ns}	1.4 ^{ns}
CV (%)	14.12	16.67	19.73	20.27	20.98	20.49	8.48	9.07

* Means followed by the same lowercase letter in rows do not differ by Duncan test ($p \leq 0.05$).

Site 1: Pelotas; Capão do Leão; Site 2: Nova Boa Vista.

plants in a given area has an influence and can be decisive for the balance of yield components and, consequently, productivity. In the wheat crop, the number of plants per unit area influences the architecture of the plants and the emission of tillers (Benin *et al.*, 2012), which justifies the superior results obtained by plants from seeds with low vigor, which showed lower number of plants m².

The cultivar Tbio Toruk reached high values of grain yield at Site 1. However, no significant differences were observed in grain yield among cultivars at Site 2 (Table 4).

Productivity is significantly affected by seed vigor levels. The highest values are reached when high vigor seeds are used. There was a productivity difference of approximately 10-11%, corresponding to a productivity of 480 and 669 kg.ha⁻¹ in relation to high and low vigor seeds at Sites 2 and 1, respectively.

In relation to increased productivity, factors such as obtaining a uniform stand, higher percentage of seedling emergence, higher initial seedling growth, increased leaf area, and dry mass may explain a better use of resources by plants with a high vigor, which allows the achievement of a greater productive potential (Mielezrski *et al.*, 2008; Scheeren *et al.*, 2010; Schuch *et al.*, 1999; Schuch *et al.* 2000). In addition, it is noteworthy that for certain species, low vigor can culminate in the formation of insufficient plant populations by area, negatively altering the final production (Marcos Filho & Novembre, 2009). In this sense, there is research for crops such as rice and soy, which prove that the use of seeds with low vigor results in changes in the initial stand and consequently imply significant reductions in plant productivity (França-Neto, 2012; Mielezrski *et al.*, 2008).

Therefore, in several species, the vigor of the seeds influences the productivity of the crops. In studies on rice crops (*Oryza sativa* L.), Melo *et al.* (2006) found that plant communities grown from high vigor seeds reach yields higher than 20% in relation to plant communities grown from low vigor seeds. For soybean (*Glycine max* L. Merrill), Bagateli *et al.* (2020) observed that the use of high vigor seeds resulted in increases in productivity of up to 19% compared to the use of low vigor seeds. Other authors have found significant increases in the productivity of soybeans for the cultivation of plants grown from highly vigorous seeds: 25,2% (Rodrigues *et al.*, 2018), 20% (Tavares *et al.*, 2013). In addition, Silva *et al.* (2016) found that the increase in vigor provided an increase in the productivity of corn hybrids.

The use of high vigor seeds provides the best establishment of plant stands, resulting in a greater number of spikes per area and a higher seed productivity (up to 11%). On the other hand, there is a plasticity effect of low vigor plants due to the lack of plants in sowing lines. There is an increase in the number of fertile tillers

and in the number of seeds in tillers. However, this effect is not sufficient to compensate for the lower population of plants, adversely affecting the productivity of wheat seeds.

CONCLUSIONS

The cultivars present different performances when cultivated from seeds with different levels of vigor.

The use of low vigor seeds negatively affects the establishment of wheat plant stands.

The use of high vigor seeds provides a greater number of wheat plants and spikes per area.

Grain yield is affected significantly by seed vigor level. There is an increase of up to 11% using high vigor seeds compared to low vigor seeds.

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