SEED CLASSIFICATION: INFLUENCE ON THE VIGOR EXPRESSION IN *Triticum aestivum* L.

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ABSTRACT – The objective of evaluating the response of wheat seed size from cultivars and lots, as well as the canonical interrelations of the physical and physiological characteristics of the seeds. The experimental design was a randomized block, organized in a factorial scheme, with three wheat genotypes (Quartzo, Ametista and TBIO Sinuelo) x six seed lots (A, B, C, D, E and F) x five sizes of sieves (I: standard sample used by farmers and seed producers (AO), II: seeds> 3,00 mm, III: seeds 2,5 to 2,99 mm, IV: seeds between 2,0 and 2,49 mm and V: < 2.0 mm), and the treatments were arranged in four replicates. The characters measured were: one thousand seed mass, hectoliter weight, germination, first germination count, germination speed index, field emergence, emergence speed index, seedling shoot length, seedling root length, seedling shoot dry mass, seedling root dry mass and electrical conductivity. There is variability of the physical and physiological attributes due to the dimensions of the wheat seeds, being these specific for the effects of cultivar and seed lots. Larger wheat seeds potentiate seed vigor in general for wheat cultivars.

Keywords: physiological seed quality, seed production, wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a cereal with a wide nutritional capacity, supporting in the world production in 2018 with about 747 million tons of grain (USDA, 2018), in Brazil the production was 5.7 million tons of grain, with Rio Grande do Sul being one of the largest producers with 1.6 million tons of grains (Conab, 2018). In this context, the physiological quality of the seed is one of the main attributes that reflect in the increase of productivity, influence on seedling initial performance, growth and development of the crop (Pádua et al., 2010; Szareski et al., 2018).

The wheat does not exhibit standardization of its seeds, even if in a lot it is sought length, thickness and similar width, there is variability that reflects in different germination and vigor (Vazquez et al., 2012; Pádua et al., 2010; Barbosa et al., 2010). However, few studies have shown the influence of seed size on the physical and physiological attributes of wheat, as well as the canonical relationship between these characters of agronomic interest (Carvalho et al., 2015). In this way, this work had the objective of evaluating the response of wheat seed size from cultivars and lots, as well as the canonical interrelations of the physical and physiological characteristics of the seeds.

MATERIAL AND METHODS

This work used seeds from genotypes and lots produced in the North of Rio Grande do Sul, Brazil. Subsequently, the manual fractionation of lots through a set of sieves was carried out in the Laboratory of the Seed Science and Technology Department of the Federal University of Pelotas (> 3.00 mm; 2.5 to 2.99 mm; 2.0 to 2.49 mm; and <2.0 mm) and the tests for physiological quality were performed.

The experimental design was a randomized block, organized in a factorial scheme, with three wheat genotypes (Quartzo, Ametista and TBIO Sinuelo) x six seed lots (A, B, C, D, E and F) x five sizes of sieves (I: standard sample used by farmers and seed producers (AO), II: seeds> 3,00 mm, III: seeds 2,5 to 2,99 mm, IV: seeds between 2,0 and 2,49 mm and V: <2.0 mm), and the treatments were arranged in four replicates.

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The characters measured were: one thousand seed mass (TSM, grams), hectoliter weight (HW, g cm^{-3}), germination (G, percentage), first germination count (FGC, percentage), germination speed index (GSI, index), field emergence (FE, percentage), emergence speed index (ESI, index), seedling shoot length (SL, centimeters), seedling root length (RL, centimeters), seedling shoot dry mass (SDM, milligrams), seedling root dry mass (RDM, milligrams) and and electrical conductivity (EC, µS cm^{-1} g^{-1}) based on the methodologies proposed by the Brazilian Seed test rules.

The data obtained were submitted to analysis of variance at 5% probability to verify the assumptions of the statistical model (Ramalho et al., 2012). Subsequently, the interaction between wheat cultivars x seed lots x seed size was tested at 5% probability. By identifying significance to the interactions, they were dismembered to simple effects. After that, the canonical groups were established as physical characters (group 1), being composed by the hectoliter weight (HW) and one thousand seed mass (TSM), while group 2 was composed of the physiological characteristics of the seeds, these being shoot length (SL), root length (RL), first germination count (FGC), germination (G), emergence speed index (ESI), germination speed index (GSI), electrical conductivity (EC) and seedling shoot dry mass (SDM). The analysis of canonical correlations with significance based on the Restricted Maximum Likelihood (LRT) at 5% of probability was then performed.

RESULTS AND DISCUSSION

Analysis of variance revealed significance for the interaction between wheat cultivars x seed lots x seed size at 5% probability for the first germination count, germination, seedling shoot and root length, germination speed index, emergence, one thousand seed mass, hectoliter weight, electrical conductivity and dry mass of the seedling. There was interaction between wheat cultivars x lots of seeds for field emergence at 7 days and 14 days after sowing, as well as between seed sizes x seed lots for root dry mass.

The one thousand seed mass and the hectoliter weight (Table 1) showed that the sieve V (<2.0mm) was lower for all cultivars and lots, researches indicate that the one thousand seed mass may be indicative for seed classification (Ormond et al., 2013; Gutkoski et al., 2008), being this attribute positively associated with the physiological potential of the seeds (Battisti et al., 2011), being this character highly affected during the physiological maturation of the seeds in the field (Carneiro, 2003). The one thousand seed mass in the cultivar was higher in the original sample (OS) independent of the cultivar, and there was specificity of the lots in relation to the sieves. Among genotypes, variations are imposed through the different sieve fractions and lots used.

For the hectoliter weight the cultivar Ametista presented inferiority through the original sample (OS), sieve <2,0 mm (lot B), sieve 2,0 to 2,49 mm and <2,0 mm (lot C), sieve> 3, 0 mm (lot D, E and F). The cultivars Quartzo independent of the sieve lots A, B, and F were the smaller lots of this character. Considering the cultivars used inferiority was verified in the size of sieve and lots through the cultivars Quartzo and TBIO Sinuelo for this character. The hectoliter weight is dependent on the characteristics imposed by the growing environment, cultivars used, uniformity, density and seed size (Ormond et al., 2013).

The germination of seeds from the Ametista cultivar and sieve <2.0 mm (lots A, B and C), sieve> 3.0 mm (lots C, D, E and F) were lower for this character (Table 1). The Quartzo cultivar showed that the original sample (lot B), sieve> 3.0 mm (lot A and C), sieve <2,0 mm (lot E) was inferior. For TBIO Sinuelo through the sieve> 3.0mm (lots A, C and F), 2.5 to 2,99 mm sieve (lot A), sieve 2.0 to 2.49 mm (lot D) and sieve <2,0 mm (lot E) showed lower magnitudes.

Seeds of intermediate size showed higher magnitude for germination, as they possibly showed a shorter period in the field of production and reserve degradation due to exposure to the uncontrolled environment (Carneiro et al., 2005). There is a reduction in the magnitude of starch, soluble sugars and the capacity to mobilize the reserves (Henning et al., 2010; Szareski et al., 2018). lots that presented inferior germination need previous standardization of the seeds, this could potentiate the physiological and uniform attributes of the growth and initial development of the field of grain production (Mattioni et al., 2011; Szareski et al., 2017). Research by Prando et al. (2012), show that there is great variation of the physiological attributes between wheat cultivars and lots of the same cultivar.

The first germination count evidenced that for the cultivar Ametista inferiority was conferred through the sieve <2.0mm (lot A, B, and C). Quartzo cultivar showed for the sieves >3.0 mm and <2.0 mm (lot A) and original sample (lot B), sieves> 3.0 mm (lot C), sieve 2.0 to 2.49 mm (lot E), sieve 2.5 to 2,99 mm sieve (lot F) were lower for the first germination count and possibly expressed lower vigor. For TBIO Sinuelo inferiority sinuelo was checked for the original sample (OS) (lot A, B and C), sieve 2.5 to 2,99 mm (lot A), sieve> 3.0 mm (lot C) and sieve 2, 0 to 2.49 mm (lot E).

Table 1 - Averages for interaction genotypes x seed sizes x lots, for the variables one thousand seed mass (TSM), and Hectoliter Weight (HW)

TSM						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	33,00 cBα	41,71 bAα	31,19 cCβ	26,86 dDβ	27,80 cDΓ	27,34 bDβ
II (>3,0 mm)	41,54 aCα	43,60 aAβ	42,18 aBCα	36,56 bEΓ	37,11 aDEβ	37,64 aDΓ
III (2,5 a 2,99mm)	38,32 bABα	38,00 cAα	37,84 bBα	37,57 aBα	34,76 bCΓ	35,43 cCβ
IV (2,0 a 2,49mm)	28,07 dAα	27,66 dAβ	27,04 dBα	26,99 cBα	26,89 cBβ	25,80 dCα
V (< 2,0 mm)	18,69 eAα	17,91 eAβ	16,30 eBβ	18,07 eAα	18,33 dAβ	17,58 eAα
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	29,59 cDβ	29,90 bDΓ	34,01 cBα	32,51 cCα	37,19 cAα	32,75 cCα
II (>3,0 mm)	37,64 bCΓ	37,63 aCα	42,88 aAα	40,55 aBβ	43,47 aAα	43,52 aAα
III (2,5 a 2,99mm)	38,25 aAα	37,46 aBα	36,50 bBβ	37,00 bBα	38,98 bAα	35,63 bCαβ
IV (2,0 a 2,49mm)	29,31 dAα	29,19 bAα	26,16 dCα	26,64 dCα	28,21 dBα	26,24 dCα
V (< 2,0 mm)	18,70 eABα	19,08 cAα	18,16 eBα	17,76 eBβ	19,57 eAα	17,31 eBα
SS**	TBIO Sinuelo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	30,46 dDβ	32,57 cCβ	33,71 dBα	32,92 cBCα	34,99 cAβ	25,76 cEΓ
II (>3,0 mm)	39,43 aDβ	43,88 aAβ	41,79 aBCβ	41,54 aCα	42,51 aBα	41,06 aCβ
III (2,5 a 2,99mm)	32,65 cCβ	35,41 bBβ	36,02 cAβ	35,76 bAβ	36,51 bAβ	36,58 bAα
IV (2,0 a 2,49mm)	24,53 bCβ	27,39 dAβ	26,32 bBα	25,37 dCβ	24,92 dCΓ	25,66 cBCα
V (< 2,0 mm)	18,10 eAα	18,92 eAα	17,75 eBα	15,44 eCΓ	18,30 eAβ	15,72 dCβ
CV(%)	3,19					
HW						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	78,60 aAα	74,70 cCβ	77,50 bBβ	77,55 aBα	77,70 abAα	77,25 aBα
II (>3,0 mm)	79,45 aAα	79,01 aAβ	78,58 aAβ	77,25 bBα	76,80 bBβ	76,80 aBα
III (2,5 a 2,99mm)	79,60 aAα	80,50 aAα	77,83 aBCβ	78,30 aBα	78,45 aBα	76,95 aCα
IV (2,0 a 2,49mm)	77,40 bABα	77,85 bABβ	76,95 bBβ	77,85 aABα	78,00 aAα	76,95 aBα
V (< 2,0 mm)	73,20 cCα	71,85 dDβ	71,55 cDβ	75,45 bBα	75,30 cBα	76,80 aAα
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	74,45 aDβ	73,95 cDβ	82,00 aAα	77,85 aBα	78,45 aBα	75,60 bCβ
II (>3,0 mm)	75,00 aCβ	75,15 bCΓ	81,68 aAα	77,85 aBα	78,00 aBα	75,60 bCβ
III (2,5 a 2,99mm)	74,40 aDβ	77,10 aCβ	82,00 aAα	78,45 aBα	78,00 aBCα	76,80 aCα
IV (2,0 a 2,49mm)	74,55 aCβ	73,86 cCΓ	81,00 aAα	75,75 bBβ	76,05 bBβ	74,10 cCβ
V (< 2,0 mm)	71,10 bBβ	69,90 dCΓ	78,73 bAα	70,80 cBCβ	66,00 cDβ	66,90 dDβ

Continua...

Table 1 - Cont.

SS**	TBIO Sinuelo											
	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
I (OS)***	74,10	aDβ	81,25	aAα	76,05	aCΓ	77,85	aBα	78,15	abBα	68,40	bEΓ
II (>3,0 mm)	74,63	aDβ	80,95	bcAα	76,50	aCΓ	77,25	bBα	77,85	bBα	68,25	bEΓ
III (2,5 a 2,99mm)	74,81	aDβ	80,20	cAα	76,80	aCΓ	78,30	aBα	79,00	aBα	69,95	aEβ
IV (2,0 a 2,49mm)	72,75	bEΓ	80,20	cAα	75,00	bCΓ	73,50	cDΓ	76,95	cBβ	68,55	bFΓ
V (< 2,0 mm)	69,51	cBΓ	77,40	dAα	67,65	cCΓ	69,45	dBΓ	66,15	dDβ	66,00	cDβ
CV(%)	0,83											

* Means followed by the same lowercase letter in the column for sieve sizes, the same capital letter in the row for seed size between lots, and the same Greek letter between genotypes do not statistically differ for Tukey with 5% probability of error.

** SS Sieve size.

*** OS Original sample of the lot without size fractionation.

The germination speed index for the cultivar Ametista showed that seeds from the sieve> 3.0 mm (lots C, D, E and F), sieve 2.0 to 2.49 mm (lot A and B), sieve <2.0mm (lots A, B and C) showed a reduction of this character. However, for the cultivar Quartzo through the original sample (OS) without the standardization (lot B), sieve> 3.0mm (lots A, C and F), sieve <2,0mm (lots E and F), sieve 2,5 to 2.99 mm and 2.0 to 2.49 mm (lot F) presented higher germination speed index. Through TBIO Sinuelo the sieve> 3.0 mm (lots A, C and F), sieve (2.5 to 2,99 mm (lot A), sieve <2,0 mm (lots D, E and F) minimized the expression of this character (Table 2).

Plants with higher initial development present superior physiological quality, as well as, competitive capacity (Rigoli et al., 2009). Seed size and lots characteristics influence the growth and development of the plant, the magnitude of reproductive structures per unit area and the physiological quality of the seeds produced (Ohlson et al., 2010). Research has shown that smaller seeds may show less vigor and emergence speed in the field (Barbosa et al., 2010). Considering the cultivars studied, less evidence of the emergence speed was observed for the cultivar Ametista, with the TBIO Sinuelo responsible for the fastest establishment in the field.

For the seedling shoot length of the Ametista cultivar through the sieve <2.0 mm (lot A, B and C), sieve> 3.0 mm (lot E), sieve 2.5 to 2,99 mm (lot E and F). For Quartzo the original sample (lot B), sieve <2,0 mm (lots A, B, C, E and F). The cultivar TBIO Sinuelo through the sieve 2.0 to 2.49 mm (lots A and C) and sieve <2,0 mm for all lots reduced this character. Larger wheat seeds tend to increase seedling length and indirectly express high vigor (Rigoli et al., 2009).

Table 2 - Averages for interaction genotypes x seed sizes x lots, for variable First germination count (FGC), and Germination (G)

SS**	Germination											
	Ametista											
	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
I (OS)***	86	abAα	87	aAα	86	abAα	69	aBβ	58	bCΓ	66	aBβ
II (>3,0 mm)	83	abAα	86	abAα	83	bAα	45	cBβ	48	cBΓ	37	cCβ
III (2,5 a 2,99mm)	88	aAα	89	aAα	90	aAα	56	bBβ	49	cCΓ	49	bCΓ
IV (2,0 a 2,49mm)	82	abAα	83	bAβ	87	abAα	73	aBβ	65	aCβ	53	bDΓ
V (< 2,0 mm)	78	bAβ	81	bAβ	83	bAα	70	aCΓ	70	aCβ	61	aDΓ

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Table 2 - Cont.

SS**	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
	Quartzo					
I (OS)***	86 aBα	62 bDβ	84 aBCα	94 aAα	78 abCβ	84 aBCα
II (>3,0 mm)	78 bBα	73 aBβ	74 bBβ	92 aA	75 bcBβ	77 bBα
III (2,5 a 2,99mm)	83 abBαβ	69 aDβ	81 aBβ	94 aAα	81 aBβ	76 bCβ
IV (2,0 a 2,49mm)	84 abBα	67 abCΓ	85 aABα	91 aAα	70 cCβ	71 bCβ
V (< 2,0 mm)	87 aBα	68 abDΓ	86 aBα	94 aAα	60 dEΓ	75 bCβ
	TBIO Sinuelo					
SS**	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	85 abCα	87 aCα	88 aBCα	98 aAα	93 aABα	89 aABCα
II (>3,0 mm)	81 bBα	86 aBα	70 bCβ	95 abA	95 aAα	80 bBα
III (2,5 a 2,99mm)	79 bCβ	86 aBα	85 aBCαβ	94 abAα	94 aAα	90 aABα
IV (2,0 a 2,49mm)	86 abAα	90 aAα	86 aAα	89 bAα	90 aAα	92 aAα
V (< 2,0 mm)	88 aAα	89 aAα	82 aABα	80 cBβ	80 bBα	88 aAα
CV(%)	7,83					
First germination count						
	Ametista					
SS**	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	78 abAα	83 aAα	81 abAα	60 aBβ	44 bCΓ	57 aBΓ
II (>3,0 mm)	78 abAα	81 aAα	81 abAα	37 cBβ	37 bBΓ	28 dCΓ
III (2,5 a 2,99mm)	80 aAα	84 aAα	86 aAα	49 bBβ	39 bCΓ	37 cCΓ
IV (2,0 a 2,49mm)	73 bBβ	78 aAβ	80 abAα	63 aCβ	52 aDβ	42 cEΓ
V (< 2,0 mm)	66 cBΓ	67 bBΓ	77 bAΓα	58 aCΓ	58 aCβ	49 bDΓ
	Quartzo					
SS**	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	83 aBα	51 bEβ	82 aBα	92 aAα	67 bDβ	74 aCβ
II (>3,0 mm)	74 bBα	61 aDβ	68 bCβ	91 aAα	65 bCβ	66 bCβ
III (2,5 a 2,99mm)	78 aBα	62 aCβ	77 aBβ	93 aAα	74 aBβ	59 cCβ
IV (2,0 a 2,49mm)	80 aBα	58 aCΓ	82 aAα	88 aAα	57 cCβ	63 bcCβ
V (< 2,0 mm)	76 bBβ	57 abDβ	79 aBα	91 aAα	52 cDβ	65 bcCβ
	TBIO Sinuelo					
SS**	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	84 aCα	82 abCα	84 aCα	95 aAα	92 aABα	87 aBCα
II (>3,0 mm)	80 aBα	80 bBα	62 bCβ	90 abAα	94 aAα	77 bBα
III (2,5 a 2,99mm)	78 aCα	86 abBα	82 aBCα	92 abAα	94 aAα	89 aAα
IV (2,0 a 2,49mm)	85 aABα	87 aABα	82 aBα	85 bABα	89 aAα	89 aAα
V (< 2,0 mm)	84 aABα	86 abAα	78 aBα	76 cBβ	67 bCα	87 aAα
CV(%)	9,74					

* Means followed by the same lowercase letter in the column for sieve sizes, the same capital letter in the row for seed size between lots, and the same Greek letter between genotypes do not statistically differ for Tukey with 5% probability of error.

** SS Sieve size.

*** OS Original sample of the lot without size fractionation.

The seedling root length showed for the cultivars Quartzo and TBIO Sinuelo that the sieve <2,0 mm reduces the length of the root (Table 3). Larger wheat seeds tend to enhance the emission and leaf area of the seedlings (Rigoli et al., 2009). For the cultivar Quartzo original sample (lots B, E and F), sieve> 3.0mm (lots A, B, E and F), sieves 2.5 to 2,99 mm and 2.0 to 2.49 mm (lot F), sieve <2.0mm (lots C, E and F) presented less evidence for the length of the wheat seedling root. Wheat seedlings that exhibit faster root growth provide greater competitive potential and vary depending on the characteristics of the genotype (RIGOLI et al., 2009).

Table 3 - Averages for interaction genotypes x seed sizes x lots, for variable Germination Speed Index (GSI), and Emergence Speed Index (ESI)

Germination Speed Index						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	8,24 aAα	8,57 aAα	8,40 abAα	6,58 aBβ	5,24 bCΓ	6,24 aBΓ
II (>3,0 mm)	8,10 aAα	8,39 aAα	8,17 bAα	4,20 cBβ	4,36 cBΓ	3,37 dCβ
III (2,5 a 2,99mm)	8,49 aAα	8,69 aAα	8,80 aAα	5,36 bBβ	4,54 cCΓ	4,44 cCΓ
IV (2,0 a 2,49mm)	7,84 bAβ	8,08 bAα	8,42 abAα	6,91 aBβ	5,99 aCβ	4,88 cDΓ
V (< 2,0 mm)	7,33 bBβ	7,55 bABβ	8,07 bAα	6,54 aCΓ	6,52 aCβ	5,65 bDΓ
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	8,49 aBα	5,77 bDα	8,35 aBα	9,33 aAα	7,36 abCβ	7,98 aBβ
II (>3,0 mm)	7,67 bBCα	6,82 aDβ	7,18 bCDβ	9,15 aAα	7,09 bCDβ	7,27 bCDα
III (2,5 a 2,99mm)	8,08 abBαβ	6,64 aCβ	7,95 aBβ	9,37 aAα	7,81 aBβ	6,94 bCβ
IV (2,0 a 2,49mm)	8,25 abBαβ	6,33 abCα	8,40 aABα	8,99 aAα	6,48 cCβ	6,77 bCβ
V (< 2,0 mm)	8,28 abBα	6,36 abDΓ	8,32 aBα	9,26 aAα	5,66 dEΓ	7,13 bCβ
SS**	TBIO Sinuelo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	8,43 aBα	8,47 aBα	8,64 aBα	9,46 aAα	9,24 aAα	8,80 aBα
II (>3,0 mm)	8,01 bBα	8,35 aBα	6,67 bDβ	9,14 abAα	9,48 aAα	7,86 bCα
III (2,5 a 2,99mm)	7,87 bCβ	8,60 aBα	8,36 aBCαβ	9,27 abAα	9,42 aAα	8,92 aABα
IV (2,0 a 2,49mm)	8,51 aAα	8,90 aAα	8,46 aAα	8,75 bAα	8,97 aAα	9,05 aAα
V (< 2,0 mm)	8,65 aAα	8,73 aAα	8,06 aBα	7,85 cBβ	7,47 bBα	8,75 bAα
CV(%)	8,11					
Emergence Speed Index						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	1,99 aABα	3,23 aAα	2,12 aABα	0,64 bBCβ	0,09 aCΓ	0,58 aBCβ
II (>3,0 mm)	2,94 aAα	2,21 abABα	2,83 aAα	0,51 bCβ	0,44 aCβ	0,92 aBCβ
III (2,5 a 2,99mm)	1,78 aABβ	2,83 aAα	2,50 aAαβ	3,35 aAα	0,50 aBβ	0,59 aBβ
IV (2,0 a 2,49mm)	1,62 aBCαβ	3,26 aAα	2,92 aABα	1,17 bCα	0,80 aCβ	0,87 aCβ
V (< 2,0 mm)	1,75 aABαβ	0,83 bABα	2,10 aAα	1,33 bABα	0,51 aBα	0,82 aABβ

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Tabela 3 - Cont.

SS**	Quartzo											
	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
I (OS)***	2,35	aAα	1,21	aAβ	2,48	aAα	2,37	aAα	1,73	abAβ	1,73	abAαβ
II (>3,0 mm)	2,23	aABα	0,67	aCβ	1,48	aBCα	3,44	aAα	2,42	abABα	1,96	aABαβ
III (2,5 a 2,99mm)	1,66	aABβ	0,30	aBβ	1,35	aABβ	2,66	aAα	2,76	aAα	1,44	abABβ
IV (2,0 a 2,49mm)	1,33	aABβ	0,92	aBβ	1,80	aABα	2,68	aAα	1,71	abABαβ	1,51	abABβ
V (< 2,0 mm)	1,17	aABβ	1,37	aABα	1,12	aABα	2,12	aAα	1,07	bABα	0,18	bBβ
SS**	TBIO Sinuelo											
	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
I (OS)***	3,09	aAα	3,39	abAα	2,56	aAα	3,82	aAα	3,75	aAα	2,96	bAα
II (>3,0 mm)	3,16	aABα	3,51	aABα	2,06	aBα	3,75	aAα	3,37	aABα	2,94	bABα
III (2,5 a 2,99mm)	3,98	aABα	2,10	abBα	2,87	aBα	2,50	abBα	3,53	aBα	5,21	aAα
IV (2,0 a 2,49mm)	2,94	aBα	3,25	abBα	2,21	aBα	2,45	abBα	2,69	abBα	5,55	aAα
V (< 2,0 mm)	3,04	aABα	2,01	bABα	2,16	aABα	1,62	bBα	1,67	bBα	3,28	bAα
CV(%)	48,24											

* Means followed by the same lowercase letter in the column for sieve sizes, the same capital letter in the row for seed size between lots, and the same Greek letter between genotypes do not statistically differ for Tukey with 5% probability of error.

** SS Sieve size.

*** OS Original sample of the lot without size fractionation.

The electrical conductivity was higher in seeds from the sieve <2.0 mm independent of the lot and cultivar analyzed (Table 4). However, the cultivars Ametista and Quartzo, even when coming from different lots, show similar magnitudes for this character. For all cultivars the seedling shoot dry mass was lower for the sieves <2.0 mm. In contrast, the sieve> 3.0 mm (lot D and F) was superior for the cultivar Ametista, and for the sieve 2.0 to 2.49 mm (lot B) superiority was conferred to TBIO Sinuelo (Table 4). Among the cultivars TBIO Sinuelo was superior to the others in most sieve sizes and lots. Research has shown that the greater dry mass of the seedlings potentiates the competitive ability of wheat (RIGOLI, et al., 2009), with the initial establishment being attributed to seed vigor (Oliveira et al., 2016; Koch et al., 2018).

Field emergence at 7 and 14 days after sowing (DAS) revealed that the TBIO Sinuelo cultivar was superior to the others. At 14 DAS the cultivar Ametista (lots E and F) was inferior to the other cultivars analyzed. In general, seed from the sieve <2,0 mm minimizes field emergence. In addition, the seed size determines the vigor, establishment and initial growth of wheat (Rigoli et al., 2009, Aisenberg et al., 2016, Pedo et al., 2016) because smaller seeds reduce the emergence speed in the field (Barbosa et al., 2010; Ferrari et al., 2016; Carvalho et al., 2017; Kavalco et al., 2017).

Table 4 - Averages for interaction genotypes x seed sizes x lots, for variable Seedling Shoot Length (SL), and Seedling Root Length (RL)

Seedling Shoot Length (cm)						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	7,02 bAβ	6,37 bBβ	6,96 abAαβ	6,00 aBCΓ	5,46 bCΓ	6,57 bABβ
II (>3,0 mm)	8,66 aAβ	7,06 aBβ	7,10 abBα	5,85 abCΓ	5,40 bCΓ	7,66 aBβ
III (2,5 a 2,99mm)	6,58 bBβ	7,21 aAβ	7,43 aAβ	5,29 bCΓ	6,24 aBΓ	5,63 cCβ
IV (2,0 a 2,49mm)	5,22 cDβ	7,53 aAα	6,64 bcBα	5,91 abCΓ	5,78 abDβ	7,42 aAβ
V (< 2,0 mm)	4,95 cCβ	5,32 cBΓ	6,19 cAα	6,27 aAΓ	6,00 abABβ	5,93 bcBCβ
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	7,62 aAαβ	6,28 bBβ	7,38 bAα	6,69 aBβ	6,34 bcBβ	6,59 aBβ
II (>3,0 mm)	7,71 aAΓ	7,55 aAβ	7,42 bABα	7,19 aABβ	6,85 bcBCβ	6,51 aCΓ
III (2,5 a 2,99mm)	7,04 abCDβ	7,44 aBCβ	8,47 aAα	6,76 aDβ	8,02 aABβ	5,53 bEβ
IV (2,0 a 2,49mm)	7,34 abAα	7,38 aAα	6,06 cBα	7,05 aAβ	6,21 cBβ	5,01 bcCΓ
V (< 2,0 mm)	6,74 bAα	6,47 bAβ	4,82 dBCΓ	6,64 aAβ	5,13 dBΓ	4,36 cCΓ
SS**	TBIO Sinuelo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	7,97 bBα	8,86 aAα	6,45 bCβ	7,92 bBα	9,16 aAα	8,70 bAα
II (>3,0 mm)	9,38 aAα	9,00 aA	7,20 aBα	8,80 aAα	8,83 aAα	9,32 aAα
III (2,5 a 2,99mm)	8,36 bBCα	8,06 bCα	6,96 abDβ	8,92 aAα	9,10 aAα	8,87 abABα
IV (2,0 a 2,49mm)	7,33 cCα	7,72 bcBCα	5,14 cDβ	7,93 bBCα	8,17 bBα	9,05 abAα
V (< 2,0 mm)	7,11 cABα	7,42 cAα	5,70 cCβ	7,26 cAα	7,14 cABα	6,64 cBα
CV(%)	20,83					
Seedling Root Length (cm)						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	10,74 bABβ	9,86 bBCβ	11,17 aAβ	8,81 aCβ	7,11 cDΓ	9,53 bCβ
II (>3,0 mm)	14,70 aAα	10,89 abBβ	11,40 aBα	7,50 bCΓ	7,70 bcCΓ	10,55 abBβ
III (2,5 a 2,99mm)	9,79 bcBΓ	11,22 aAα	9,90 bBΓ	7,49 bCΓ	8,78 abBCΓ	8,09 cCβ
IV (2,0 a 2,49mm)	8,25 dCβ	11,70 aAα	10,50 abBα	8,49 abCΓ	8,89 abCΓ	11,71 aAβ
V (< 2,0 mm)	9,43 cAβ	9,90 bAα	9,54 bAα	9,55 aAΓ	9,86 aAΓ	9,52 bAβ
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	13,11 aAα	9,86 bcCβ	12,27 aABα	12,04 aBα	9,28 bCβ	9,57 aCβ
II (>3,0 mm)	10,11 cBβ	10,99 abBβ	12,20 aAα	11,99 aAβ	11,08 aBβ	10,47 aBβ
III (2,5 a 2,99mm)	11,42 bBβ	10,89 abBα	13,11 aAα	11,73 aBβ	11,15 aBβ	8,18 bCβ
IV (2,0 a 2,49mm)	13,7 aAα	11,81 aBα	10,48 bCα	11,54 aBβ	9,23 bcDβ	7,73 bEΓ
V (< 2,0 mm)	11,48 bAα	9,46 cBα	8,21 cCβ	11,05 aAβ	8,04 cCβ	7,62 bCΓ

Continua...

Table 4 - Cont.

SS**	TBIOSinuelo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	12,70 bCα	13,23 abBCα	11,24 abDαβ	13,09 bBα	14,12 aBα	15,24 aAα
II (>3,0 mm)	14,69 aABα	13,58 aCα	10,31 bcDβ	13,83 aBCα	13,86 aBCα	15,30 aAα
III (2,5 a 2,99mm)	13,98 aBα	12,44 bcCα	11,58 aCβ	14,41 aBα	13,37 abBα	15,56 aAα
IV (2,0 a 2,49mm)	12,78 bBα	11,96 cBα	8,76 dCβ	12,85 bBα	12,68 bBα	16,20 aAα
V (< 2,0 mm)	12,12 bABα	10,13 dCα	10,04 cCα	12,29 bAα	12,40 bAα	11,05 bBα
CV(%)	22,63					

* Means followed by the same lowercase letter in the column for sieve sizes, the same capital letter in the row for seed size between lots, and the same Greek letter between genotypes do not statistically differ for Tukey with 5% probability of error.

** SS Sieve size.

*** OS Original sample of the lot without size fractionation.

The root dry mass (Table 5) was increased in seeds from the 2.5 to 2,99 mm sieve (lots C and E). Seeds classified in different sizes present variability of the physiological attributes (Pádua et al., 2010; Kehl et al., 2016; Demari et al., 2016). In general, the response to the size of the wheat seed varied according to the cultivars, with the TBIO Sinuelo being superior in vigor and germination, first germination count, germination speed index and field emergence, seedling root length, shoot dry mass, in contrast, the physical attributes were superior through the cultivars Ametista and Quartzo.

Table 5 - Averages for interaction genotypes x seed sizes x lots, for variable Electrical Conductivity (EC) and Shoot Dry Mass (SDM)

Electrical ConductivityµS cm-1						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	39,69 bAα	36,92 bAα	36,80 cAβ	20,08 cBα	38,83 bcAα	20,94 cBβ
II (>3,0 mm)	13,84 cCβ	35,08 bBα	31,83 dBβ	48,11 aAα	46,30 bAα	15,89 cCβ
III (2,5 a 2,99mm)	43,70 bCα	15,33 cDΓ	42,50 cCα	56,98 aBα	67,88 aAα	16,90 cDβ
IV (2,0 a 2,49mm)	20,87 cCβ	21,16 cCβ	55,59 bBα	48,01 aBα	67,66 aAα	48,51 bBα
V (< 2,0 mm)	63,32 aABα	58,80 aBβ	65,45 aABα	41,64 bCα	33,25 cCα	70,83 aAα
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (SS)***	38,04 bBα	19,80 cDβ	55,70 aAα	17,34 cDα	26,38 cdCβ	31,78 abBCα
II (>3,0 mm)	15,09 cCβ	27,10 cBα	51,21 bAα	14,49 cCβ	46,01 aAα	30,05 abBα
III (2,5 a 2,99mm)	19,72 cBβ	40,70 bAβ	38,41 cAα	15,62 cBβ	18,30 dBΓ	23,34 bBαβ
IV (2,0 a 2,49mm)	36,09 bBα	39,69 bABα	46,90 bcAα	38,61 bABβ	31,42 bcBβ	36,20 aBβ
V (< 2,0 mm)	61,77 aAα	70,89 aAα	61,30 aBα	50,47 aCα	35,78 bDα	38,09 aDΓ

Continua...

Tabele 5 - Cont.

SS**	TBIO Sinuelo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	35,46 bcAα	42,29 bAα	20,44 bcBΓ	26,51 bBα	18,93 cBβ	34,91 bAα
II (>3,0 mm)	30,74 cABα	28,29 cABα	17,45 cCΓ	16,52 cCβ	24,43 bcBCβ	35,60 bAα
III (2,5 a 2,99mm)	40,78 bBα	56,90 aAα	18,91 bcCβ	19,29 bcCβ	32,73 abBβ	31,21 bBα
IV (2,0 a 2,49mm)	41,65 abA	42,54 bAα	28,10 bBβ	44,58 aAαβ	38,78 aAβ	43,53 abAαβ
V (< 2,0 mm)	50,78 aAβ	36,31 bcBΓ	37,90 aBβ	50,40 aAα	35,33 aBα	50,72 aAβ
CV(%)	18,27					
Shoot Dry Mass (g)						
SS**	Ametista					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	0,068 aABα	0,053 bBβ	0,070 aAα	0,045 abBCβ	0,039 aCΓ	0,050 aBCβ
II (>3,0 mm)	0,070 aAβ	0,078 aAβ	0,076 aAα	0,034 bBΓ	0,038 aBβ	0,036 bBΓ
III (2,5 a 2,99mm)	0,068 aAα	0,070 abAαβ	0,069 aAαβ	0,041 abBΓ	0,040 aBΓ	0,041 abBβ
IV (2,0 a 2,49mm)	0,054 bABα	0,061 bAα	0,056 bABα	0,054 aABα	0,046 aBβ	0,048 abABβ
V (< 2,0 mm)	0,035 cABβ	0,039 cABβ	0,047 bAα	0,045 abABα	0,033 aBβ	0,038 abABβ
SS**	Quartzo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	0,067 aAα	0,066 aABαβ	0,066 bcABα	0,063 abABα	0,053 bBβ	0,055 aABβ
II (>3,0 mm)	0,061 abAβ	0,054 aBβ	0,074 abAα	0,070 aAβ	0,075 aAα	0,047 abBβ
III (2,5 a 2,99mm)	0,054 abBβ	0,058 aBβ	0,081 aAα	0,061 aBβ	0,063 abBβ	0,047 abCβ
IV (2,0 a 2,49mm)	0,058 abABα	0,061 aAα	0,050 cABαβ	0,056 bABα	0,045 bBCβ	0,039 bCβ
V (< 2,0 mm)	0,052 bAα	0,040 bAβ	0,039 cAα	0,039 cAα	0,019 cBΓ	0,021 cBΓ
SS**	TBIO Sinuelo					
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
I (OS)***	0,071 bcAα	0,079 bAα	0,070 aAα	0,066 bAα	0,700 bcAα	0,078 bAα
II (>3,0 mm)	0,096 aAα	0,095 aAα	0,073 aBα	0,077 aBα	0,080 abBα	0,106 aAα
III (2,5 a 2,99mm)	0,076 bABα	0,073 bcBα	0,064 aBβ	0,081 abAα	0,086 aAα	0,086 bAα
IV (2,0 a 2,49mm)	0,060 cdBα	0,063 cAα	0,042 bBβ	0,054 bcBα	0,058 cdBα	0,075 bAα
V (< 2,0 mm)	0,049 dBCα	0,079 bAα	0,026 cDβ	0,043 cCα	0,048 dCα	0,061 cBα
CV(%)	13,84					

* Means followed by the same lowercase letter in the column for sieve sizes, the same capital letter in the row for seed size between lots, and the same Greek letter between genotypes do not statistically differ for Tukey with 5% probability of error.

** SS Sieve size.

*** OS Original sample of the lot without size fractionation.

Onde cita a table 6?

Table 6 - Averages for interaction genotypes x lots, for the variables Field Emergence 7 DAS (FE 7 DAS) and Field Emergence 14 DAS (FE 14 DAS), and averages for interaction seed size x lots of seeds for the variable Root Dry Mass (RDM), and seed size averages for the Field Emergency 14 DAS (FE 14 DAS) variable

Field Emergence 7 DAS												
Genotype	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
Ametista	14,90	aA	15,50	aA	14,82	aA	10,68	aAB	3,30	bB	3,76	bB
Quartzo	11,00	aA	7,52	bA	7,72	aA	13,84	aA	7,70	bA	6,36	bA
Sinuelo	19,10	aAB	18,30	aAB	12,52	aB	16,60	aAB	17,52	aAB	22,56	aA
CV(%)	92,66											
Field Emergence 14 DAS												
Genotype	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
Ametista	26,54	bB	38,84	aA	39,30	abA	18,90	bBC	9,46	cC	13,68	cC
Quartzo	26,90	bB	11,50	bC	30,52	bB	44,90	aA	35,14	bAB	26,76	bB
Sinuelo	52,30	aB	43,40	aBC	42,00	aC	46,42	aBC	47,40	aBC	71,26	aA
CV(%)	43,20											
RDM												
SS**	Lot A		Lot B		Lot C		Lot D		Lot E		Lot F	
I (OS)***	0,3003	aA	0,3017	aA	0,3060	bA	0,2920	aA	0,2786	bA	0,2857	aA
II (>3,0 mm)	0,2984	aA	0,3043	aA	0,3026	bA	0,2968	aA	0,2863	bA	0,2800	aA
III (2,5 a 2,99mm)	0,2911	aB	0,2898	aB	0,4339	aA	0,2833	aB	0,4332	aA	0,2819	aB
IV (2,0 a 2,49mm)	0,2934	aA	0,2949	aA	0,3135	bA	0,2808	aA	0,2743	bA	0,2821	aA
V (< 2,0 mm)	0,2798	aA	0,2788	aA	0,2696	bA	0,2731	aA	0,2634	bA	0,2673	aA
CV(%)	123,15											
SS**	FE14											
I (OS)***	19,32 a											
II (>3,0 mm)	18,75 a											
III (2,5 a 2,99mm)	18,72 a											
IV (2,0 a 2,49mm)	17,66 a											
V (< 2,0 mm)	13,02 b											
CV(%)	43,2											

* Means followed by the same lowercase letter in the column for sieve sizes, the same capital letter in the row for seed size between lots, and the same Greek letter between genotypes do not statistically differ for Tukey with 5% probability of error.

** SS Sieve size.

*** OS Original sample of the lot without size fractionation.

Two canonical pairs were significant, being the first one responsible for the interrelationship (r = 0.68) between physical and physiological characters (Table 7), where the largest one thousand seed mass increases the shoot and root length, first germination count, germination, germination and emergence speed index, shoot dry mass, however, reduce the electrical conductivity. The second canonical pair (r = 0.33) determines that the reduction of the hectoliter weight can increase the seedling shoot length, seedling root length, germination, germination index and field emergence.

Table 7 - Charges of physical characteristics (group I) and physiological quality of seeds (group 2) in canonical correlations (r) between groups, in three wheat genotypes, 18 seed lots and 5 seed sizes

Group I		
Character	1stCanonical Pair	2nd Canonical Pair
HW	0,347	-0,288
TSM	0,689	-0,022
Group II		
	1stCanonical Pair	2nd Canonical Pair
SL	0,311	0,048
RL	0,169	0,218
FGC	0,132	0,070
G	0,050	0,034
GSI	0,085	0,509
EC	-0,495	-0,063
ESI	0,228	0,129
SDM	0,526	-0,162
r	0,691	0,333
LRT	< 0,001	< 0,001

CONCLUSIONS

There is variability of the physical and physiological attributes due to the dimensions of the wheat seeds, being these specific for the effects of cultivar and seed lots. Larger wheat seeds potentiate seed vigor in general for wheat cultivars.

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