

Physical and physiological quality of corn seeds
Qualidade física e fisiológica de sementes de milho
Calidad física y fisiológica de las semillas de maíz

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Abstract

The aimed to evaluate the physical and physiological quality, as well the field initial performance of different maize seeds size, produced in two growing environments. It were used seeds of the Amarelo maize (*Zea mays* L.) genotype, where it were produced in two growing environments at Rio Grande do Sul, in the crops season of 2016/2017. The environment that the seeds are produced and the seeds form affect the maize plants initial growth. Flat seeds are tend to have a better performance on field in relation to the initial growth. The seedlings originated from Entre Ijuís-RS present superiority to shoot length, stem diameter, roots dry matter and shoot dry matter, while Pelotas-RS determines the sieves yield. The round and small seeds present lower sieves yield, shoot length, root length and stem diameter of maize seedlings.

Keywords: *Zea mays* L.; Cultivation environments; Field performance.

Resumo

Objetivou-se avaliar a qualidade física e fisiológica, bem como o desempenho inicial em campo de diferentes tamanhos de sementes de milho, produzidas em dois ambientes de cultivo. Foram utilizadas sementes do genótipo Milho amarelo (*Zea mays* L.), onde foram produzidas em dois ambientes de cultivo no Rio Grande do Sul, na safra 2016/2017. O ambiente em que as sementes são produzidas e as sementes se formam afetam o crescimento inicial das plantas do milho. As sementes planas tendem a ter um melhor desempenho no

campo em relação ao crescimento inicial. As plantas oriundas de Entre Ijuís-RS apresentam superioridade para comprimento da parte aérea, diâmetro do caule, matéria seca das raízes e matéria seca da parte aérea, enquanto Pelotas-RS determina a produtividade das peneiras. As sementes redondas e pequenas apresentam menor rendimento de peneiras, comprimento do caule, comprimento da raiz e diâmetro do caule das plantas de milho.

Palavras-chave: *Zea mays* L.; Ambientes de cultivo; Desempenho no campo.

Resumen

El objetivo fue evaluar la calidad física y fisiológica, así como el desempeño inicial en campo de diferentes alimentos de maíz, producidos en dos ambientes de cultivo. Se utilizaron semillas del genotipo Maíz amarillo (*Zea mays* L.), donde se produjeron en dos ambientes de cultivo en Rio Grande do Sul, en la cosecha 2016/2017. El entorno en el que se producen las semillas y se forman las semillas afecta el crecimiento inicial de las plantas de maíz. Las semillas planas tienden a funcionar mejor en el campo en comparación con el crecimiento inicial. Las plantas de Entre Ijuís-RS muestran superioridad en longitud de brote, diámetro de tallo, materia seca de raíz y materia seca de brote, mientras que Pelotas-RS determina la productividad de los tamices. Las semillas redondas y pequeñas tienen menor rendimiento de tamizado, longitud del tallo, longitud de la raíz y diámetro del tallo de las plantas de maíz.

Palabras clave: *Zea mays* L.; Ambientes en cultivo; Rendimiento de campo.

1. Introduction

In order to obtain high quality seeds, an adequate management must be realized in the production fields and the correct harvest timing. Although, it is necessary to maintain a rigorous inspection, in this manner avoiding low vigor seeds to be sown. The vigor is an attribute that defines the seed performance level in the germination and seedlings emergence (Tillmann & Menezes, 2012) and it is controlled by distinct mechanisms, at unfavorable environments (Miransari & Smith, 2014). The grain yield is influenced by abiotic and biotic factors, intrinsic characteristics of the genotype, cultivation environment, and genotype \times environment interaction (G \times E) (Carvalho et al., 2017).

The quality decrease is related to the germination low percentage, increase of abnormal seedling and seedling vigor reduction (Toledo et al., 2009). The increase in the high vigor seeds percentage, in a determined seeds lot, is favorable to the initial growth of the maize crop (Mondo et al., 2013). The low germination velocity associated to high sensibility

to the seeds tensions during germination and plants with slowly growth and low radicular development are typical from seeds with less physiologic potential (Marcos Filho, 2015).

The seeds physiologic potential emphasizes the lot quality verified through the germination test and vigor, indicating physiologic differences to lots with the same germination (Pereira et al., 2011). The seeds physiologic quality is related to the performance aspects, in relation to them, the seeds size stands out by being one of the indispensable quality components to many species (Pádua et al., 2010). The seeds size is a considerable and significant factor in the germination and initial phase of the plants growth. The difference in seeds size presents unlike reserve levels that can influence the plants growth (Ahirwar, 2012). The companies put two seeds formats at farmers' disposition, the flat, the round and various sizes, according to the seeds length and width (Schuch & Peske, 2008).

The adequate maize genotype positioning in relation to the growing environment represents the seeds final yield (Carvalho et al., 2016). In maize, bigger seeds can proportionate vigorous plants, with fast establishment on field, and it can have a positive interference in the yield components (Enayatgholizadeh et al., 2012). It is necessary to constantly keep up the production levels of maize, which can be reached by increasing the area sown, use of best management technologies and cultivation of more productive genotypes (Carvalho et al., 2017).

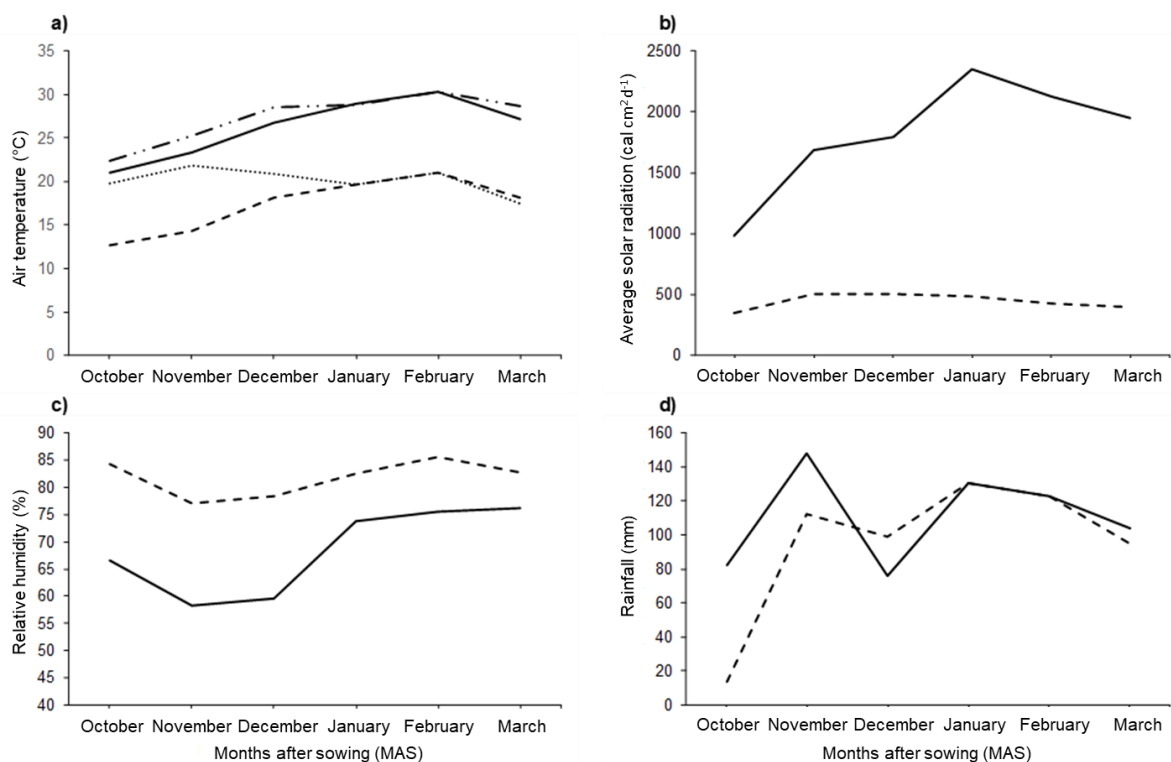
The knowledge about the plant growth permits evaluating the contribution of the different vegetal structures in the dry matter accumulation as well the crop yield, allowing the development of morphophysiologic processes on the vegetal performance (Peixoto & Peixoto, 2009). The growth analysis is an easy method, precise and designated to evaluate the vegetal reaction to the diverse environments and management conditions (Aumonde et al., 2013), allowing the inference of contribution of the different physiologic processes, being basic to the observation and primary production analysis which enables the evaluation of the competitive ability between plants (Radford, 1967). Based on the above, this work aimed to evaluate physical and physiological quality, as well the field initial performance of different maize seeds size, produced in two growing environments.

2. Materials and Methods

The experiment was conducted in the municipalities of Entre Ijuís - RS under coordinates of 28° 21' 32 "S and 54° 16' 04" O and Capão do Leão Pelotas-RS, referring to coordinates 31° 52' 00"S and 2° 21' 00", where seeds of an open-pollinated maize genotype

were produced in the 2016/2017 crop season. The seeds were sown manually in the first two weeks of October in both environments, in a previously planted area and with fertilization according to the Manual of Fertilization and Liming for the RS and SC States (CQFS RS / SC, 2004). The mean and minimum values of air, solar radiation, relative air humidity and rainfall were observed during the conduction of the experiment in the cultivation environments, and their monthly averages are presented in Figure 1.

Figure 1 – Air maximum (—) and minimum temperature (.....) Entre Ijuís-RS and air maximum (- . . -) and minimum temperature (---) Pelotas-RS (a), mean solar radiation Entre Ijuís-RS (—) and Pelotas-RS (---) (b), air relative humidity Entre Ijuís-RS (—) and Pelotas-RS (---) (c) and rainfall Entre Ijuís-RS (—) and Pelotas-RS (---) (d). Source: National Institute of Meteorology (São Luiz Gonzaga-RS) and Agroclimatological Station of Pelotas-RS (Campus Capão do Leão-RS), 2016.



Source: Authors.

Harvesting in both environments was carried out with approximately 35% moisture of the seeds (Peske et al., 2012) and sent to the Seeds Laboratory of the Graduate Program in Seed Science and Technology of the Agronomy School Eliseu Maciel, Federal University of

Pelotas for drying to a moisture content of 12%, soon after, the seeds were threshed and benefited to remove all impurities from harvest.

The dried and cleaned seeds were initially subjected to thickness separation through sieves of oblong holes (7 x 15 mm and 8 x 15), where the retained seeds are characterized as round and the seeds that passed through the sieve are characterized as flat. After the seeds of the two portions (flat seeds and round seeds) were classified by their width. For this separation, a sieve of round holes of 8.5 mm was used, where the seeds retained in this sieve were considered large flat and large round, and the seeds that were not retained were considered small flat and small rounds for the flat and round seeds, respectively, constituted four maize seed extracts (Table 1), for each environment.

Table 1 - Different corn seed formats, separated by width and thickness.

Format	Code	Width	Thickness
Small Flat	CP	Flat (<7 x 15 mm e 8 x 15)	Small (< 8,5 mm)
Large Flat	CG	Flat (<7 x 15 mm e 8 x 15)	Large (>8,5mm)
Redonda Pequena	RP	Round (>7 x 15 mm e 8 x 15)	Small (< 8,5 mm)
Redonda Grande	RG	Round (>7 x 15 mm e 8 x 15)	Large (>8,5mm)

Source: Authors.

After being separated in different formats, the seeds from the two cultivation environments were submitted to the following:

Electrical conductivity (CE 3, 6 and 24 hours): four replicates with four subsamples of 25 seeds were used for each treatment, and their mass was previously determined. The seeds were deposited in polyethylene cups with 75 mL of deionized water, kept in a B-type germinator. the temperature of 25°C. The electrical conductivity was determined after 3, 6 and 24 hours of imbibition through a digital conductivity meter, results expressed in $\mu\text{S cm}^{-1} \text{g}^{-1}$ of seeds (Vieira & Krzyzanowski, 1999).

Field emergence: evaluated from 400 seeds, divided into eight replicates of 50 of each treatment. At 21 days after sowing the percentage of seedling emergence was determined.

Thousand seeds mass (TSM): obtained through the mass of eight samples of 100 seeds of each treatment, results expressed in grams (Brasil, 2009).

Hectolitic weight (HW): it was determined the hectoliter mass for a quarter of a liter, according to Brasil (2009), results expressed in kg hL⁻¹. Eight replicates of each treatment were used.

The experimental design used for the evaluations of sieves yield, electric conductivity, thousand seeds mass and hectolitic weight was completely randomized, organized in a factorial scheme two (production environments) x four (seeds format), being the treatments disposed in eight repetitions.

Initial growth: three successive collections (7, 14 and 21 days after emergence) were collected, with eight plants collected for each treatment. For each collection, the number of leaves per plant, shoot length and root length were measured using a ruler, these results being expressed in centimeters, stem diameter was obtained with the aid of a digital caliper and the results expressed in millimeters, leaf area was determined using the LI-3100® Liquor area meter, with results expressed in mm². For aerial dry mass and root dry mass the seedlings were collected close to the soil, separated in aerial part and root, and packed in brown paper envelopes separately. To obtain the dry matter, the material was transferred to a forced ventilation oven at 70 ± 2°C for 72 h. The total chlorophyll index was performed in conjunction with the initial growth and the readings were collected through the ClorofiLOG® apparatus.

The experimental design at the initial growth was completely randomized organized in a factorial scheme being two (growing environment) x three (harvest time) x four (formats), disposed in eight repetitions.

The obtained data was submitted to a variance analysis by the F test with 5% probability, where it was verified the statistic model presuppositions. Afterwards, it was identified the interaction between growing environments x seeds formats and growing environments x harvest time x seeds format, when significant, the simple effect was dismembered. With no interaction, it was dismembered the principle effects to each factor separately, through the Tukey complementary analysis with 5% probability.

3. Results and Discussion

The variance analysis revealed significance to the interaction growing environments x seeds formats to the electric conductivity at 24 hours, thousand seeds mass and hectolitic weight variables. To the electric conductivity variable at 3 hours there was significant effect to

the growing environments and seeds format, to the electric conductivity at 6 hours the was significance only to seeds format (Table 2).

Table 2 - Variance analysis summary with mean squares to electric conductivity 3 hours (CE3), electric conductivity 6 hours (CE6), electric conductivity 24 hours (CE24), field emergence (EC), Thousand seeds mass (TSM) and hectolitic weight (HW) in relation to the environments (Entre Ijuís-RS and Pelotas-RS) and format (large flat, small flat, large round and small round). Capão do Leão, RS, UFPel, 2017.

S. V.	G. L.	MEAN SQUARES ⁽¹⁾					
		CE3	CE6	CE24	EC	TMS	HW
Environments (A)	1	6,1*	6,5 ^{ns}	414,8*	1753,5*	34122,8*	1,7*
Formats (F)	3	31,3*	35,7*	105,2*	271,0*	50140,3*	1,1*
Repetition	7	1,2	4,3	12,4	73,7	48,6	0,04
A x F	3	2,3 ^{ns}	8,7 ^{ns}	45,0*	328,5*	3397,7*	1,42*
Residue	49	1,5	6,9	16,0	84,8	45,4	0,2
Mean	-	7,3	9,3	16,0	71,0	340,6	74,1
CV(%)	-	16,7	28,2	24,9	12,9	1,9	0,6

⁽¹⁾Mean squares: * and^{ns} – significant at 5% probability level and non-significant, respectively; CV – Coefficient of variation. Source: Authors.

It is important to note that for the tests analyzed in the experiment, the values for the mass of a thousand seeds and for the hectolitic weight were lower for the coefficient of variation. This indicates that the data became more homogeneous for these tests, that is, the dispersion around the analyzed average was low.

To the electric conductivity with the readings realized three hours after soaking, the round seeds released higher amounts of electrolytes to the solution (Table 3), which means that the reorganization capacity of the cellular membranes system was low, resulting in lower seeds vigor (Tillmann & Menezes, 2012).

Table 3 - Mean results to electric conductivity 3 hours and 6 hours in relation to seed format.

Formats	CE 3h	CE 6h
LF ⁽¹⁾	6,04 b*	8,44 b
SF	7,00 b	8,93 b
LR	6,98 b	8,38 b
SR	9,32 a	11,53 a
CV(%)	16,70	28,22

*Means followed by the same uppercase letter in the environment line inside each format and lowercase letter to formats inside each environment do not differ statistically at 5% of probability by the Tukey test. ⁽¹⁾ LF - large flat; SF - small flat; LR - large round; SR - small round; CV - coefficient of variation. Source: Authors.

In relation to the growing environments to this character, Pelotas – RS obtained higher liberation of electrolytes in the solution and evidenced that the seeds produced in these conditions express lower vigor, when compared to the ones originated in Entre Ijuís – RS (Table 4).

Table 4 - Mean results to electric conductivity 3 hours in relation to environments.

Environments	CE 3h
Entre-Ijuís-RS	7,03 b
Pelotas-RS	7,64 a
CV(%)	16,70

* Means followed by the same lowercase letter in the column do not differ statistically at 5% of probability by the Tukey test. CV- coefficient of variation. Source: Authors.

At the reading realized six hours after the seeds soaking, the tendencies presented similar (Table 3). However, to the conductivity measured 24 hours after seeds soaking, the Entre Ijuís – RS environment evidenced that small round seeds obtained lower vigor due to the high magnitude of electrolytes release in the solution. In this reading, the flat seeds expressed lower electrolyte liberation in the solution, what indicates higher potentiality from them to the vigor (Table 5).

Table 5 - Interaction formats x environments to electric conductivity 24 hours, field emergence, Thousand seeds mass and hectolitic weight.

Electric conductivity 24h ($\mu\text{S cm}^{-1} \text{g}^{-1}$)		
Formats	Environments	
	Entre Ijuís-RS	Pelotas-RS
CG ⁽¹⁾	13,93 bA*	13,47 aA
CP	18,2 bA	12,37 aB
RG	18,28 bA	12,69 aB
RP	23,94 aA	15,45 aB
CV (%)	24,95	
Field emergence (%)		
Formats	Environments	
	Entre Ijuís-RS	Pelotas-RS
LF ⁽¹⁾	69 abB	80 aA
SF	74 aA	73 aA
LR	59 bB	71 aA
SR	59 bB	80 aA
CV (%)	12,9	
Thousand Seed Mass (g)		
Formats	Environments	
	Entre Ijuís-RS	Pelotas-RS
LF ⁽¹⁾	385,22 bA*	363,79 aB
SF	306,29 dA	278,79 bB
LR	444,71 aA	358,87 aB
SR	318,70 cA	268,73 cB
CV (%)	1,97	
Hectolitic weight (kg hL ⁻¹)		
Formats	Environments	
	Entre Ijuís-RS	Pelotas-RS
LF	74,34 aA*	74,17 aA
SF	74,53 aA	74,12 aA
LR	74,68 aA	73,59 aB
SR	73,92 bA	73,56 aA
CV (%)	0,63	

*Means followed by the uppercase letter in the environment line inside each format and lowercase letter to formats inside each environment do not differ statistically at 5% of probability by the Tukey test. ⁽¹⁾ LF – larg flat; SF – small flat; LR – large round; SR – small round; CV – coefficient of variation. Source: Authors.

Between growing environments, Entre Ijuís – RS evidenced lower vigor associated to the seeds with small flat, small round and large round formats, in relation to the growing environment Pelotas – RS. To Ribeiro et al. (2009), the electric conductivity seed test

maintain relation to its vigor, because this test is based in the evaluation of integrity of the cellular membranes and it correspond to the seeds deterioration degree. As higher the membrane integrity the lower will be the electrolyte liberation to the solution, and lower will be the electric conductivity value indicating higher seeds vigor.

The field emergence demonstrated that the seeds produced at Entre Ijuís – RS revealed that the small flat and large formats indicated higher vigor. Although it was the Pelotas – RS growing environment that expressed higher field seedlings emergence through the round flat, large round and small round seeds (Table 5). Generally, the flat format seeds vigor, both large and small, were superior to the round formats. Researches showed that small seeds normally have a tendency to present germination and vigor lower when compared to the large and medium seeds (Biruel et al., 2010). The higher aggregated seeds vigor and measured by the electric conductivity and field emergence, is determined by higher size and flat seeds, where these are more nourished at its formation and increment of its reserve structures. Researches from Martinelli-Senem et al. (2001), verified that the flat seeds have a tendency to present higher field emergence when compared to the round seeds.

The thousand seeds mass to Entre Ijuís – RS was superior to the large round seeds. At Pelotas – RS, the large flat and large round seeds obtained superiority to the small round seeds. To compare the environments, Entre Ijuís – RS was superior to this character independently of its seeds format (Table 5). Some differentiations of the thousand seeds mass, at these conditions, can be due to the genotypes (varieties) genetic variability (Schoninger et al., 2012). To Vazquez et al. (2012), there is the size and form influence in the thousand seeds mass of maize seeds.

The hectolitic weight revealed a similar tendency to the seeds formats and analyzed environments, because at Entre Ijuís – RS the round and small seeds format obtained a lower hectolitic weight in relation to large flat, small flat and large round formats. During the seeds formation, the cellular structures work properly and result in the reserve deposition and cellular membranes adjust, but this dynamic is directly influenced by the seeds growing environment effects (Peske et al., 2012). The differentiations observed in the hectolitic weight can be dependent of the different periods of maize seeds formation and the space designated to the expansion of each seed in the cob, as well, the number of rows and seeds per row in the cob (Mondo & Cícero, 2005).

To the initial growth evaluations, the variance analysis revealed significance to the interaction growing environments x harvest time to the shoot dry matter and total chlorophyll index variables. The significant effect of the growing environment was observed to shoot

length, stem diameter and root dry matter. The significant effect to harvest time was verified to leaves number, shoot length, root length, stem diameter, leaves area and root dry matter. To the seeds format the significant effect was noted in shoot length, root length, stem diameter, leaves area and shoot dry matter (Table 6).

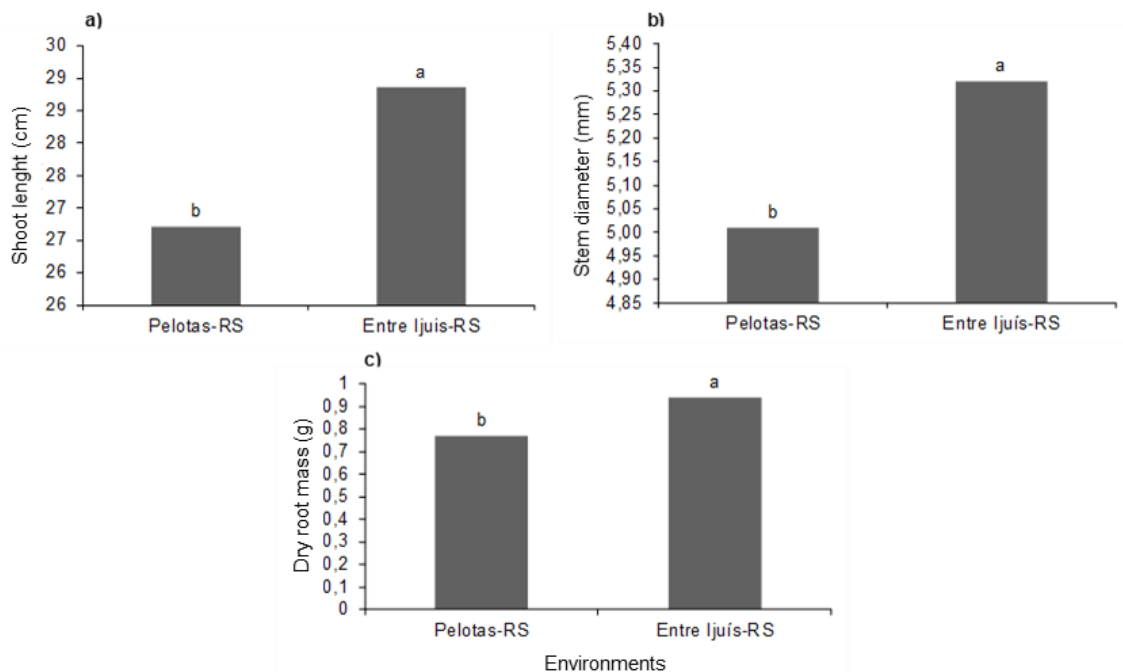
Table 6 - Variance analysis summary with the mean squares to leafe number (Ln), shoot length (Sl), root lenght (Rl), stem diameter (Sd), leaves area (La), shoot dry matter (Sdm), root dry matter (Rdm) and total chlorophyll of maize plants originated from seeds produced in different environments (Entre Ijuís; Pelotas), with different formats (large flat; small flat; large round; and small round) and harvested in different times (7;14; e 21 DAE).

F. V.	G. L.	MEAN SQUARES ¹⁾							
		Ln	Sl	Rl	Sd	La	Sdm	Rdm	Clorofila
Environments (A)	1	0,08 ^{ns}	222,3*	0,09 ^{ns}	4,4*	53588 ^{ns}	42,4*	1,3*	0,2 ^{ns}
Periods (E)	2	74,4*	6937,6*	389,5*	71,8*	7968194*	828,3*	37,2*	6008,7*
Formats (F)	3	3,9 ^{ns}	98,3*	29,8*	3,7*	119190*	13,9*	0,6 ^{ns}	12,4 ^{ns}
Repetitions	7	3,4	45,9	4,9	1,7	76160,7	9,1	0,5	11,2
A x E	2	1,1 ^{ns}	2,9 ^{ns}	3,6 ^{ns}	0,1 ^{ns}	1394,3 ^{ns}	27,8*	0,7 ^{ns}	40,4*
F x E	6	2,0 ^{ns}	17,8 ^{ns}	2,7 ^{ns}	0,1 ^{ns}	24341,2 ^{ns}	7,3 ^{ns}	0,5 ^{ns}	11,3 ^{ns}
A x F	3	2,8 ^{ns}	29,0 ^{ns}	9,4 ^{ns}	0,2 ^{ns}	64677,4 ^{ns}	3,3 ^{ns}	0,1 ^{ns}	3,5 ^{ns}
A x F x E	6	2,5 ^{ns}	30,5 ^{ns}	4,3 ^{ns}	0,9 ^{ns}	66253,1 ^{ns}	3,3 ^{ns}	0,1 ^{ns}	5,0 ^{ns}
Residue	161	2,1	18,0	6,4	0,8	36017,4 ^{ns}	4,1	0,3	6,7
Mean	–	5,10	27,7	13,1	5,1	465,6	3,1	0,8	27,4
CV (%)	–	27,9	15,2	19,3	17,3	40,7	65,1	67,2	9,4

¹⁾ Mean square: * and^{ns} – significant with 5% of probability and non-significant, respectively; CV – variation coefficient. Source: Authors.

In relation to the environments in which the seeds were produced, the shoot length was superior in plants emerged from seeds originated from Entre Ijuís – RS, being 7% superior from those produced in Pelotas – RS. Similar responses were expressed to stem diameter, root dry matter, with 5% and 18% differences, respectively (Figure 2).

Figure 1 - Shoot length, stem diameter, root and shoot dry matter of maize plants originated from different environments. (Bars followed by the same letter do not differ among them, by the Turkey test, with 5% probability level).

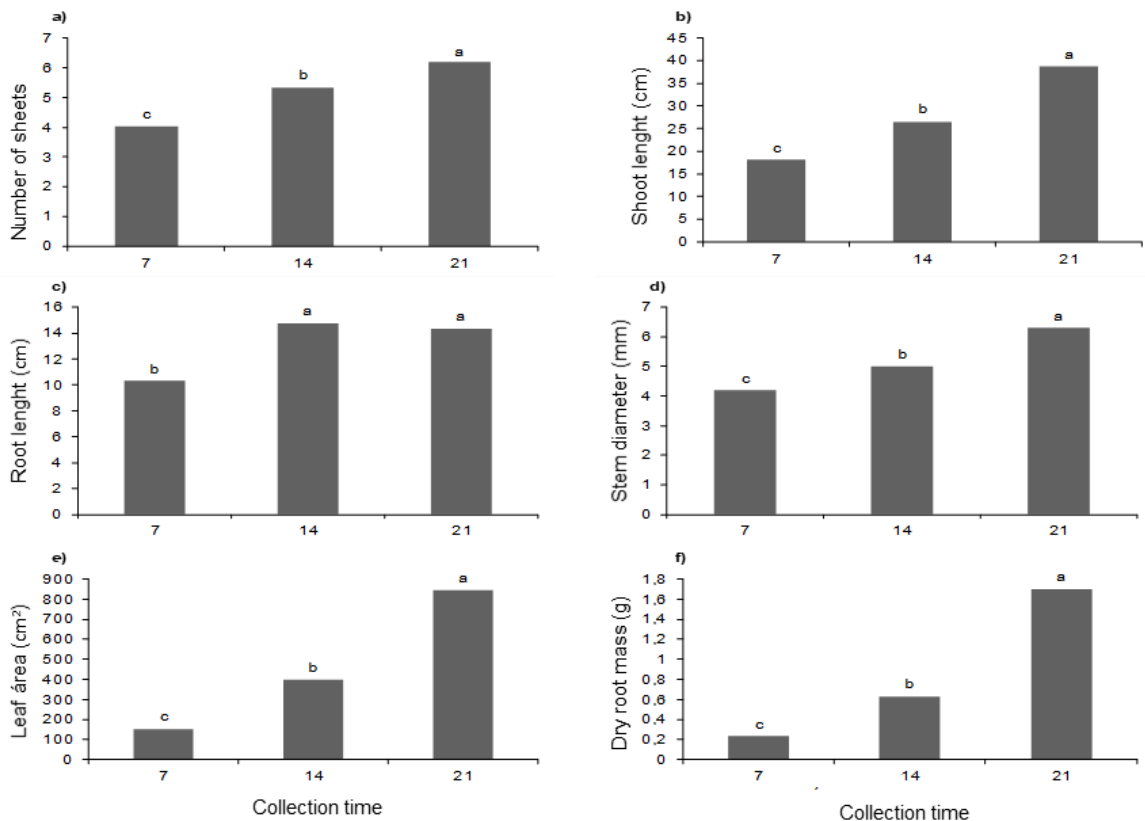


Source: Authors.

Research from Vieira and Carvalho (1994), defines that the plant parts that are noted in the vigor test must stay in absolute growth, because there is a tendency to stabilize the growth. The environment conditions in which the seeds were produced directly affects the seeds size and format, and it is directly linked to the seed physiologic quality (Mondo & Cícero, 2005), that will directly reflect in its growth when sowed on field.

The Figure 1 shows that the incident solar radiation at the Entre Ijuís – RS environment was superior than at Pelotas – RS, it defines the superiority of the shoot length, stem diameter and root dry matter originated from seeds of this environment. To Vazquez et al. (2012), the format and size of maize seeds directly interfere in the plants initial growth. At the Figure 3, the dynamics of the growing harvest are exposed, showing that there is difference in the leaves number, shoot length, root length, stem diameter, leaves area and root dry matter in relation to harvest dates. At the 21 days, it was verified higher values in all the measured variables, but at the 14 and 21 days the root length did not differ (Figure 3). The initial growth followed the normal tendency through the study days (Sousa et al., 2012).

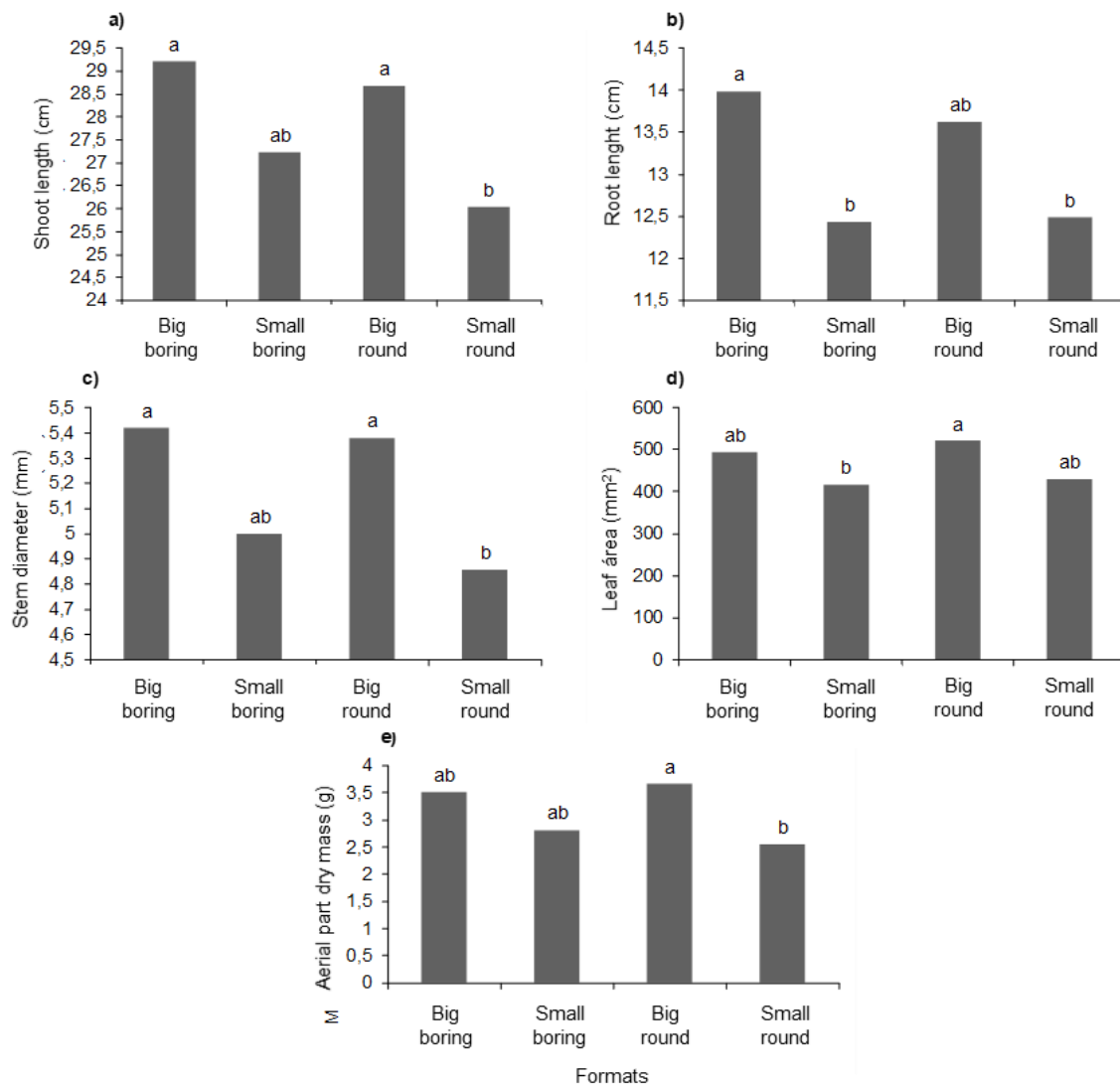
Figure 3 - Leaves number a), shoot length b), root length c), stem diameter d), leaves area e) and root dry matter f) of maize plants in relation to different harvest periods. (Bars followed by the same letter do not differ among them, by the Turkey test, with 5% probability level).



Source: Authors.

The seed format effects revealed that the shoot length was inferior to those plants originated from seeds classified as small round. The higher length of the shoot occurred from large and flat seeds (Figure 4a). The root length was superior to the plants provided from large flat seeds, not statistically differing from large and round seeds (Figure 4b). The seedlings stem diameter was higher in the large flat and large round seeds (Figure 4c). The fertilization, reserve disposition and dehydration are processes involved in the seeds formation (Bewley & Black, 2013).

Figure 4 - Shoot length, root length, stem diameter, leaves area and shoot dry matter of maize plants originated from different format seeds. (Bars followed by the same letter do not differ among them, by the Turkey test, with 5% probability level).



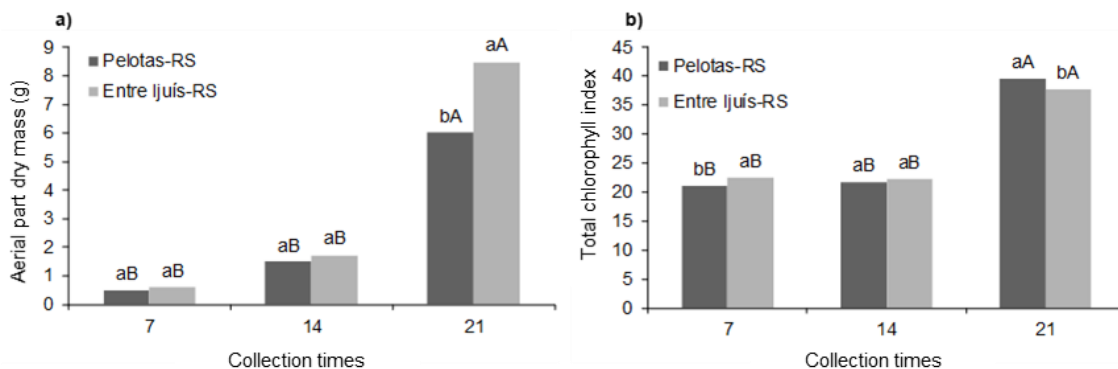
Source: Authors.

In relation to maize, the seeds that were formed in the ear base are the first in relation to the ones in the apex, then, existing a gradient of assimilates received in each cob fraction and each seed inside the same fraction (Shieh & McDonald, 1982). According to Vanzolin and Nakagawa (2007) the smaller seeds tend to germinate faster than the larger, however, the larger seeds ended up originating seeds with higher size and mass. As said by Carvalho e Nakagawa (2012), the initial growth is strongly influenced by the seeds size, decreasing the intensity as the plants develop, once that large seeds are the ones that have higher amounts of reserve. Vazquez et al. (2012), revealed that the maize seeds size and shape did not exposed effects to the stem diameter in relation to the sieves diversity.

The higher leaves area was obtained to the large round seeds format (Figure 4d). It could occur due to the higher investment on assimilates in the formation of the photosynthetic apparatus (Pedó et al., 2014). According to Kikuti et al. (2013), the round seeds situated in the cob apex showed inferior performance to the base seeds and the middle of the ear, as well large seeds present higher amounts of reserve to development in relation to the smaller (Carvalho & Nakagawa, 2012).

There was significant interaction between growing environment x harvest time to the shoot dry matter and total chlorophyll index (Figure 5). At the 21 days, it was observed the significant difference between environments to shoot dry matter, where Entre Ijuís – RS showed a increase of 29% in relation to Pelotas – RS. In the same conditions, Entre Ijuís – RS obtained higher shoot accumulation than Pelotas – RS (Figure 5a).

Figure 2 - Environment interaction (Entre Ijuís; Pelotas) x harvest periods (7;14; e 21 DAE) to shoot dry matter and total chlorophyll of maize plants. (Bars followed by the same lowercase letter to environments and same uppercase letter to periods do not differ among them, by the Turkey test, with 5% probability level).



Source: Authors.

The total chlorophyll at 7 days showed superior values in Entre Ijuís-RS at 14 and 21 days. In relation to the harvesting, the total chlorophyll index was superior to the seedlings collected at 21 days after emergence (Figure 5). Chlorophylls are pigments that reflect the green color and absorb radiant energy that are associated to the photosynthesis (Taiz & Zeiger, 2013; Vieira et al., 2014). As said by Santos (2017), the seeds size and format have a influence in the chlorophyll index *a*, *b* and *total* in maize genotypes. Generally, the initial development of plants on field revealed differences between maize seeds format and the environment in which the seeds are produced, where small round seeds presented less developed plants.

4. Final Considerations

The environment that the seeds are produced and the seeds form affect the maize plants initial growth.

Flat seeds are tend to have a better performance on field in relation to the initial growth.

The seedlings originated from Entre Ijuís-RS present superiority to shoot length, stem diameter, roots dry matter and shoot dry matter, while Pelotas-RS determines the sieves yield.

The round and small seeds present lower sieves yield, shoot length, root length and stem diameter of maize seedlings.

Due to the fact that corn seeds are uneven in the position of the ear, it is an important factor to know the quality of seeds of each format, in order to offer several options to the rural producer. In addition, to facilitate the choice at the time of harvest.

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