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International Journal of Current Research
Vol. 8, Issue, 11, pp.40828-40833, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

SOWING DATE AND MULTIVARIATE ANALISYS OF YIELD AND PHYSIOLOGICAL COMPONENTS IN ELITE WHEAT GENOTYPES

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ARTICLE INFO

Article History:
Received 14th August, 2016
Received in revised form
18th September, 2016
Accepted 23rd October, 2016
Published online 30th November, 2016

Key words:

Agronomic performance,
Agricultural experimentation,
Triticum aestivum L.

ABSTRACT

The objective of this study was to evaluate the effect of sowing date on yield and physiological components aiming to identify the period that enhances the increment of the components and analyze via multivariate techniques the dissimilarity and the relative contribution of traits in elite wheat genotypes. The experiment was carried out during the 2014 agricultural year in a randomized block design (11 wheat genotypes x 2 sowing dates) with three replications. Sowing in May (date I) increases the spike weight and grain weight per spike, grain yield, thousand grain weight, first germination count, germinated seeds, and seedling dry weight. Genetic dissimilarity discriminated genotypes into two major groups, being TBIO Mestre and BRS 327 the most dissimilar genotypes. The largest relative contribution for the discrimination of genotypes was expressed by the spike insertion height, germinated seeds, number of grains per spike, and plant height, explaining 61.8% of the total variation.

Citation: Ivan Ricardo Carvalho, Maicon Nardino, Gustavo Henrique Demari *et al.*, 2016. "Sowing date and multivariate analisys of yield and physiological components in elite wheat genotypes", *International Journal of Current Research*, 8, (11), 40828-40833.

INTRODUCTION

Wheat (*Triticum aestivum* L.)is a cereal that belongs to the Poaceae family, being used as raw material in the production of bread, pasta, and biscuits. The world wheat production is approximated 700 million tonnes and the Brazilian production is six million tonnes per year. From the total Brazilian production, the states of Rio Grande do Sul and Paraná are highlighted with the greatest contribution to the national production (CONAB, 2015). In recent years, the wheat cultivation has expanded to the regions of the Brazilian Cerrado, which has contributed to the increase in the Brazilian production (Meleiro *et al.,* 2013). The wheat grain yield is a result of the conjunct action of severalagronomically important traits, which are determined by genetic and environmental factors and the genotype x environment interaction. Thereby, the cropping environment effects are the most pronounceable for wheat, influencing directly the productive performance of the genotypes, the period until flowering, the plant height, and the grain specific weight (Cargnin *et al.,* 2006). Thus, the genotype x environment interaction comes from the differential responses of each genotype facing the changes in biotic and abiotic characteristics of the environment (Yan and Holland, 2010). The strategies addressed for wheat cultivation should be supported by the choice of genotype, sowing date, cultural practices, edaphoclimaticcharacteristics of the environment, temperature, and solar radiation, influencing the crop yield (Subedi *et al.,* 2007). Researches indicate that planning and management techniques when well used can result in increments of 80% in wheat yield, especially when it is sown in suitable dates (Bassoi *et al.,* 2005; Coventry *et al,* 2011.). Whenagronomically suitable genotypes are grown in favorable environments with less insect pests and diseasespressure, they can ensure to the growerplant stand uniformity after emergence, increased yield, vigorous seeds obtainment, and elevated physiological quality (Carvalho and Nakagawa, 2000). Therefore, qualitatively superior seeds tend to generate more vigorous seedlings with appropriate plant stand and rapid establishment in the field. The seed physiological potential is assigned to the set of genetic, physical, physiological, and sanitary characteristics (Hubbard *et al.,* 2012). Sowing date, harvesting process, climatic conditions, processing and storage of seeds are highlighted among the factors that influence the obtainment of high quality seeds (Marcos Filho, 1999). In this sense, it is necessary to understand the agronomic performance of genotypes and

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determine the genetic variation among available genotypes by the Generalized Mahalanobis distance (Cruz *et al.,* 2012). Thus, the objective of this study was to evaluate the effect of sowing date onyield and physiological components aiming to identify the period that enhances the increment of the components and analyze via multivariate techniques the dissimilarity and the relative contribution of traits in elite wheat genotypes.

MATERIALS AND METHODS

The experiment was carried out during the 2014 agricultural year in Tenente Portela - RS, southern Brazil. The experimental area is located at coordinates corresponding to 27°22’28’’S and 53°45’28’’W, with an altitude of 501 meters. According to Köppen climate classification, the climate is characterized as subtropical *Cfa*. The soil is classified as typical ferric aluminum red Oxisol (Streck, 2008). The experimental design was a randomized block arranged in a factorial with 11 wheat genotypes x 2 sowing dates with three replications. The following genotypes were utilized: BRS Parrudo, TBIO Sintonia, TBIO Mestre, TBIO Iguaçu, TBIO Itaipu, Mirante, TBIO Sinuelo, Quartzo, BRS 331, BRS 327, and TBIO Pioneiro. The sowing dates were: sowing date I: sowing on 01 May, 2014 and sowing date II: sowing on 01 June, 2014. The experimental units were composed by ten rows with five meters long and spacing of 0.17 m between rows. Sowing procedure was held with the aid of a tractor-seeder set in a no tillage system. The plant density was 330 viable seeds per square meter for all genotypes. The basic fertilization was supported by 350 kg ha^{-1} of N-P-K in the formulation 10-20-20. Topdressing fertilization was held with 150 kg ha^{-1} of nitrogen in amide form, applied in full tillering. In both sowing dates, weed, insect pests, and diseases control wasperformed preventively, in order to minimize the biotic effects on the experiment.

The agronomically important traits were measured in plants contained in the six central rows of the experimental unit, where one meter of each end was despised. Subsequently, ten plants representative of each experimental unit were selected. The yield traits were determined by the methodology proposed by Carvalho *et al*. (2015), beingplant height (PH, in centimeters); spike weight (SW, in grams); spike length (SL, in centimeters); number of grains per spike (NGS, in units); spike insertion height (SIH, in centimeters); grain weight per spike (GWS, in grams); hectolitre weight (HW, in kg hl^{-1}); thousand grain weight (TGW, in grams), and grain yield (GY, in kg ha^{-1}), with humidity adjusted to 13%. The physiological traits followed the methodology proposed by Seed Analysis Rules (BRAZIL, 2009), being: first germination count (FGC, in%); germinated seeds (GS, in%);shoot length (SHL, in centimeters),radicle length (RL, in centimeters), and seedling dry weight (SDW, in grams). In order to verify their assumptions, data were submitted to analysis of variance at 5% probability. Traits that revealed significant interaction between wheat genotype x sowing dates were dismembered by the simple effects. In the absence of significant interaction, traits were dismembered into the main effects and compared by Tukey test. All traits were used to compose the genetic dissimilarity analysis using Generalized Mahalanobis distance. Subsequently, the cluster analysis was performed with the unweighted pair group method with arithmetic mean (UPGMA) and the relative contribution of Singh (1981) based on the methodology proposed by Cruz *et al*. (2012). Statistical analyzes were performed using the Genes software (Cruz, 2013).

RESULTS AND DISCUSSION

Analysis of variance demonstrated a significant interaction ($p \leq 0,05$) among wheat genotypes x sowing dates for the traits: spike length (EL), spike weight (SW), number of grains per spike (NGS), grain weight per spike (GWS), thousand grain weight (TGW), grain yield (GY), first germination count (FGC), germinated seeds (GS), seedling dry weight (SDW), shoot length (SL), and radicle length (RL). Absence of significant interaction was observed for the traits plant height (PH) and spikeinsertionheight (SIH). The hectolitre weight (HW) revealed no significant differences for the variation factors. The coefficients of variation were lower with amplitude of 0.68 to 16.45%, featuring adequate experimental precision with reliable results. The traitsPH and SIH are not affected by sowing dates. In contrast, differences were obtained for genotypes, where TBIO Itaipu, Mirante, TBIO Sinuelo, Quartzo, BRS 331, and TBIO Pioneiro were greater than the other genotypes for thesametraits (Table 1).

Table 1. Means of the traits plant height (PH) and spike insertion height (SIH) measured in 11 wheat genotypes

Genotypes	PH (cm)	SIH (cm)
BRS Parrudo	83.26 c*	74.83 d
TBIO Sintonia	82.93 c	74.46 d
TBIO Mestre	84.71 bc	76.40 bcd
TBIO Iguaçu	84.46 bc	76.33 cd
TBIO Itaipu	89.18 ab	81.03 abc
Mirante	90.03 ab	81.70 ab
TBIO Sinuelo	93.08 a	84.93 a
Quartzo	91.80 a	83.16 a
BRS 331	92.80 a	83.93 a
BRS 327	84.71 bc	70.00 bcd
TBIO Pioneiro	93.00 a	84.00 a
CV(%)	3.36	3.41

*Means followed by the same letter in the column do not differ statistically by Tukey test at 5% probability.

The SL for sowing date I was superior in the BRS 331, Quartzo, Mirante, and TBIO Sintonia when compared to the others. The sowing date II evidenced that the genotypes BRS Parrudo, TBIO Sinuelo, Quartzo, and BRS 331 were superior when compared to the others(Table 2). When relatingboth sowing dates, the BRS Parrudo genotype demonstrated significant and superiordifferencesfor the sowing date II and evidenced better behavior with sowing date in later periods. However, the Mirante genotype exhibited opposite behavior. Spikes with larger dimensions tend to present an increase in the number of spikelet’s and consequently provide more number of grains and yield per plant. Researchesdefined that superior SL alters the translocation of assimilates in the spike and result in fluctuations in the grain quality and weight in the spike (Andersson *et al.,* 2004; Fioreze and Rodrigues, 2014). The SWfor sowing date I exhibitedsuperiority in the genotypes TBIO Sintonia, TBIO Iguaçu, Mirante, TBIO Sinuelo, Quartzo, BRS 331, and TBIO Pioneiro. In contrast, for sowing date II, the genotypes TBIO Sintonia, Mirante, and TBIO Pioneiropresented the lower magnitudes for this trait (Table 2). Among the sowing dates, the genotypes TBIO Sintonia, TBIO Iguaçu, Mirante, TBIO Sinuelo, Quartzo, and TBIO Pioneirorevealed that greater SW when sowed during sowing date I, being indicated for earlier sowings. The differences observed between the variation factors indicate that the trait SW is influenced not only by the intrinsic characteristics of the genotype, but also by environmental conditions represented through the sowing dates. In this way, environmental conditions are decisive for the genotype performance (Yanand Holland, 2010). Studies performed by Silva *et al.* (2011) pointed that the sowing date influences the genotype behavior because of the environmental changes that occurred in that period. The NGSfor the sowing dates I and II presented superiority for the genotypesQuartzo and BRS 331 (Table 2). The results for this trait indicated that these genotypes have the greatest magnitudes for NGS, regardless of the sowing datetested. Differentiations for the trait performance were obtained for the genotype TBIO Sintonia, where sowing date I increased the NGS. However, BRS 327 genotype exhibited greater results when sown during sowing date II.

The GWS was presented as an important yield component for the wheat crop, where sowing date I allows to indicate the TBIO Sinuelo genotype as superior compared to the others. In these conditions, lower performance was found for BRS 327 genotype (Table 3). The later sowing during sowing date II resulted in greater performance with TBIO Sinuelo. Nonetheless, TBIO Sintonia obtained the lower magnitudes of this trait. Regarding sowing dates, the genotypes TBIO Sintonia, TBIO Iguaçu, Mirante, TBIO Sinuelo, Quartzo, and TBIO Pioneiroexhibited the best results for GWS when sowing was anticipated for the sowing date I. However, only the BRS 327 genotype evidenced better results when sowingwas performed delayed (sowing date II). The GYin wheat is determined by the number of spikes per unit area, number of grains per spike, and grain weight. Therefore, highly productive genotypes tend to express elevated magnitudes of these traits (Brancourt-Hulmel *et al.,* 2003). In contrast, increasing the number of grains perspike modifies thepartitioning dynamicof assimilates and the grain direction. Thereof, resulting in lighter grains and with smaller protein proportions (Ashraf Tajammal*et al.,* 2003). The GY for the sowing date I showed superiority for genotypes TBIO Sintonia, TBIO Iguaçu, Mirante, TBIO Sinuelo, BRS 331, andQuartzo. Despite, smaller GY was observed for BRS 327 genotype (Table 3). The sowing dateIIexhibited lower trait variation among genotypes and demonstrated lower magnitudes for the genotypes TBIO Sintonia and TBIO Pioneiro. When comparing the GY performance between the sowing dates, genotypes TBIO Sintonia, TBIO Iguaçu, TBIO Sinuelo, Quartzo, and TBIO Pioneirowhere more productive when sown at the sowingdate I. On the other hand, the BRS 327 genotype showed better results inthe sowing date II.

The responses obtained in this study allow inferring that greater yields can be obtained when sowing is anticipated. It allows genotypes having their initial establishment period at lower temperatures and enhancingtillering, short growing season, and long reproductive period, where the increase of fertile tillers and spikes per plant provide the increase in grain number and weight, reflecting directly in wheat grain yield. Research carried out by Coventry *et al*. (1993) and Sial *et al*. (2005) proved the obtained results where wheat sowing in later periods promoted reduced yield. The TGW can be considered an indicative traitofmore productive genotypes.Facing that, the genotypesBRS Parrudo, TBIO Sintonia, TBIO Mestre, TBIO Iguaçu, and TBIO Sinuelo presented superior performance for sowing date I. However, minor evidence of this traitare revealed by the genotypes TBIO Itaipu, Mirante, Quartzo, BRS 331, and BRS 327(Table 3). The performance of TGW for sowing date II determined superior magnitude for the genotype TBIO Sinuelo. Moreover, this genotype is characterized by an intermediate to late cycle, with greater period for the synthesis, accumulation, and remobilization of assimilates to the grain,reflecting in grains with larger dimensions and weight (Suprayogi *et al.,* 2011). Among the sowing dates, it was observed that the genotypes BRS Parrudo, TBIO Sintonia, TBIO Mestre, TBIO Iguaçu, TBIO Itaipu, and Quartzoevidenced greater TGWin sowing date I. Furthermore, researches determinedthat grain weight inwheat is directly dependent on genotype characteristics, nutritional management, water supply, and the cropping environment conditions (Simmonds *et al.,* 2014). The first germination count (FGC) allows to preliminarily inferthe seed vigor, where it was determined on sowing date I that only the TBIO Pioneiro genotype differs from the other genotypes. Moreover, it reveals that the seeds produced in these conditions appear less vigorous (Table 4). Sowing date II revealed superiority for TBIO Mestre and BRS 327genotypes. In contrast, inferiority for this trait was observed for the genotypes BRS Parrudo, TBIO Sintonia, and TBIO Sinuelo.

Regarding sowing dates, the genotypes BRS Parrudo, TBIO Sintonia, Mirante, and TBIO Sinuelo exhibited differential behavior compared to the other genotypes, which obtained more vigorous seeds when sown at the sowingdate I. The anticipation of the period designated for wheat sowing allows proper establishment, growth, and development of plants. Also, it allows the interception, absorption, and assimilation of photosynthetically active radiation, enabling greater synthesis and accumulation of assimilates in the plant tissue.Therefore, they will be directed to the seeds and propitiate the increase in physiological qualityduring the reproductive period. The seed physiological potential is dependent on cropping techniques in the field, harvest procedures, processing, and storage (Costa *et al.,* 2005). The trait GS is standard and reliable indicative of physiological seed quality, where the sowing date I indicated that genotypes TBIOSintonia, TBIO Mestre, Mirante, and BRS 327 were superior. However, low magnitudes of this traitwere evidenced in the genotypes TBIO Iguaçu and TBIO Pioneiro (Table 4). Sowing date II revealed that TBIO Mestreand BRS 327 genotypes showed the greatest values for GS. Also, poor performance was expressed by the TBIO Sintonia, TBIO Sinuelo, and TBIO Pioneiro.

The seed physiological characteristics were not satisfactory for some genotypes at the sowing date II, where the GS percentage was lower than the requirements of the current Brazilian legislation (Law n^{o}10, 711), which determines a minimum of GS = 80% (Brazil, 2009). Regarding sowing dates, the genotypes TBIO Sintonia, Mirante, TBIO Sinuelo, and TBIO Pioneiro revealed the best results for the physiological quality of seeds produced in sowingdate I. Research performed by Viganó *et al*. (2010) definedthat different agricultural years and wheat sowing dates directly influence the physiological quality of seeds produced regardless of genotype. As a result, earlier sowings resulted in qualitatively superior and vigorous seeds. Medina *et al*. (1997) andSá *et al*. (1997) determined that physiological quality in wheat is highly dependent on thecropping environment characteristics. The SDW has the purpose of expressing the vigor attributed to the seeds, where the sowing date Ievidenced that the genotypes BRS Parrudo, TBIO Sintonia, TBIO Mestre, TBIO Itaipu, Mirante, TBIO Sinuelo, Quartzo, BRS 331, and BRS 327 showed similar and superior responses, with more vigorous seeds than the other genotypes (Table 4).

Table 2. Means of the wheat genotypes x sowing dates interaction for the traitsspike length (SL), spike weight (SW), and number of grains per spike (NGS) measured in 11 wheat genotypes

	SL (cm)		SW (g)		NGS (uni)	
Genotypes	Sowingdates					
	I	II	I	II	I	II
BRS Parrudo	7.23 dB	8.81 Aa	1.12 cA	1.17 abA	32.46 bcA	35.70 abA
TBIO Sintonia	8.25 abcA	7.67 cdeA	1.37 abcA	0.86 cB	37.63 abA	29.60 bcB
TBIO Mestre	7.29 dA	6.97 eA	1.22 bcA	1.06 abcA	31.70 bcA	30.73 bcA
TBIO Iguaçu	8.10 bcA	7.65 cdeA	1.31 abcA	0.98 abcB	35.36 abcA	31.40 abcA
TBIO Itaipu	7.89 bcdA	7.80 bcdA	1.15 cA	0.98 abcA	37.93 abA	32.20 abcA
Mirante	8.52 abA	7.67 cdeB	1.27 abcA	0.90 bcB	37.06 abcA	31.90 abcA
TBIO Sinuelo	8.15 bcA	8.40 abcA	1.50 aA	1.22 aB	35.57 abcA	32.46 abcA
Quartzo	8.43 abA	8.18 abcdA	1.43 abA	1.14 abcB	40.90 aA	37.53 aA
BRS 331	8.93 aA	8.52 abA	1.37 abcA	1.13 abcA	39.86 aA	35.80 abA
BRS 327	7.83 bcdA	7.70 cdeA	0.70 dB	1.16 abA	19.00 dB	33.26 abcA
TBIO Pioneiro	7.66 cdA	7.46 deA	1.30 abcA	0.89 cB	31.13 cA	27.06 cA
CV (%)	0.68		14.38		11.61	

*Means followed by the same lowercase letter in the column and uppercase letter in the line do not differ statistically by Tukey test at 5% probability

Table 3. Means of the wheat genotypes x sowing dates interaction for the traits grain weight per spike (GWS), grain yield (GY), and thousand grain weight (TGW)measured in 11 wheat genotypes

	GWS (g)		GY (kg ha^{-1})		TGW (g)	
Genotypes	Sowingdates					
	I	II	I	II	I	II
BRS Parrudo	0.79bA	0.81 abA	2391.2 bA	2434.4 abA	27.47 abcA	20.80 eB
TBIO Sintonia	1.02abA	0.58 cB	3065.3 abA	1747.0 cB	27.57 abcA	24.07 bcdB
TBIO Mestre	0.93 bA	0.79 abcA	2791.8 bA	2371.0 abcA	29.41 abA	21.86 deB
TBIO Iguaçu	0.99abA	0.67 abcB	2992.0 abA	2039.0 abcB	26.75 abcA	23.30 cdeB
TBIO Itaipu	0.85 bA	0.70 abcA	2574.6 bA	2115.1 abcA	25.21 cA	23.33 cdeB
Mirante	0.96abA	0.64 bcB	2887.4 abA	1918.0 bcB	25.99 cA	20.27 eB
TBIO Sinuelo	1.16aA	0.89 aB	3490.3 aA	2671.0 aB	29.72 aA	27.59 aA
Quartzo	1.01abA	0.79 abB	3056.3 abA	2372.3 abB	25.60 cA	21.61 deB
BRS 331	1.00abA	0.81 abA	3028.4 abA	2447.7 abA	25.44 cA	24.11 bcdA
BRS 327	0.52 cB	0.82 abA	1564.5 cB	2472.4 abA	26.37 bcA	26.76 abA
TBIO Pioneiro	0.95abA	0.64 bcB	2856.8 abA	1935.6 bcB	27.26 abcA	25.61 abcA
CV%	16.44		16.45		7.58	

*Means followed by the same lowercase letter in the column and uppercase letter in the line do not differ statistically by Tukey test at 5% probability.

Table 4. Means of the wheat genotypes x sowing dates interaction for the traits first germination count (FGC), germinated seeds (GS), and seedling dry weight (SDW) measured in 11 wheat genotypes

	FGC (%)		GS (%)		SDW (g)	
Genotypes		Sowingdates				
	I	II	I	II	I	II
BRS Parrudo	88,0 abA	82,5 eB	80,0 dA	75,7 cdA	0,020 abA	0,016 deB
TBIO Sintonia	91,0 aA	83,0 deB	88,2 abA	72,0 deB	0,020 abA	0,013 fB
TBIO Mestre	92,0 aA	96,5 aA	91,0 abcA	93,2 aA	0,021 aA	0,022 aA
TBIO Iguaçu	89,0 abA	89,7 cA	81,0 dA	77,7 cA	0,018 bcA	0,015 efB
TBIO Itaipu	93,0 aA	91,0 bcA	85,0 cdA	81,0 cA	0,020 abA	0,019 bcA
Mirante	93,0 aA	87,5 cdB	87,0 abcA	77,0 cdB	0,019 abcA	0,015 efB
TBIO Sinuelo	91,0 aA	83,5 deB	84,0 cdA	68,2 eB	0,021 aA	0,018 cdB
Quartzo	92,0 aA	89,7 cA	80,2 dA	78,2 cA	0,019 abcA	0,016 deB
BRS 331	92,0 aA	90,0 cA	86,7 bcA	87,0 bA	0,019 abcA	0,018 cdA
BRS 327	91,2 aA	95,0 abA	92,2 aA	89,5 abA	0,020 abA	0,021 abA
TBIO Pioneiro	86,6 bA	90,0 cA	80,5 dA	67,5 eB	0,017 cB	0,021 abA
CV%	3,71		4,66		8,70	

*Means followed by the same lowercase letter in the column and uppercase letter in the line do not differ statistically by Tukey test at 5% probability.

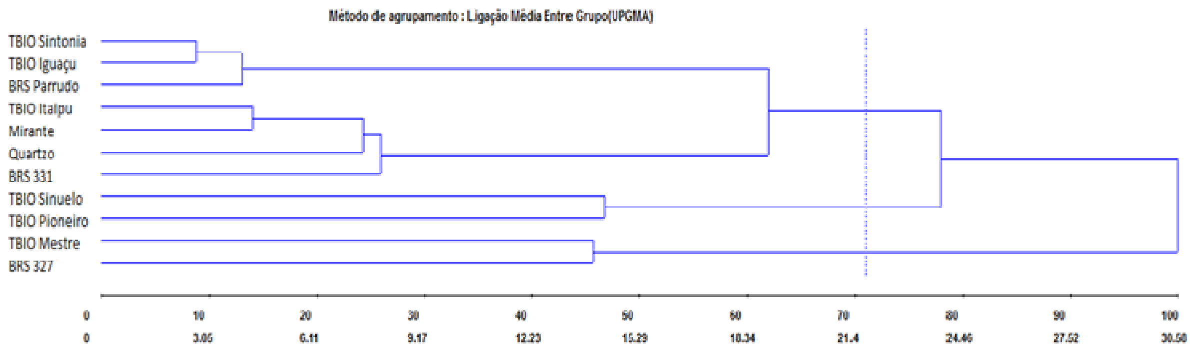

Figure 1. Dendrogram with genetic dissimilarity in 11 wheat genotypes using the Generalized Mahalanobis distance obtained by the unweighted pair group method with arithmetic mean (UPGMA). The dashed line indicates the average distances (21.705)

However, the sowing date II revealed that only the genotypes TBIO Mestre, BRS 327, and TBIO Pioneiro were the most vigorous. The magnitudes obtained for SDW indicated that the vigor attributed to wheat seeds is more related to the sowing or growing environment than for genotype characteristics. It is justified by the superiority of the sowing date I for the genotypes BRS Parrudo, TBIO Sintonia, TBIO Iguaçu, Mirante, TBIO Sinuelo, andQuartzo. The differences found between the sowing dates may result from adverse weather conditions, high rainfall, high relative humidity and temperature during flowering, physiological maturity, and harvest (Viganó *et al.,* 2010). The SHL enables understanding the initial growth of seedlings, where the sowing date I indicated that the genotypes TBIO Iguaçu, TBIO Sinuelo, BRS 327, and TBIO Pioneiroexhibitedsuperior performances. These results may be related to genotypes besides being vigorous, have fast initial growing and establishment of seedlings in the field and they can be more competitive in an inter-specific way. The sowing date II revealed that the genotypes BRS Parrudo, TBIO Sintonia, TBIO Mestre, and TBIO Pioneirostand out when cultivated in late sowing date (Table 5). Only the TBIO Iguaçu genotype presented differentiations for SHL due to the sowing date.

Table 5. Means of the wheat genotypes x sowing dates interaction for the traits shoot length (SHL) and radicle length (RL) measured in 11 wheat genotypes

	SHL (cm)		RL (cm)	
Genotypes	Sowingdates			
	I	II	I	II
BRS Parrudo	7.09 bcdA	7.37 abcA	9.05 bA	7.34 cdB
TBIO Sintonia	7.25 abcdA	7.82 abA	7.61 cde A	7.38 cA
TBIO Mestre	6.83 cdA	7.26 abcdA	10.34 aA	9.08 aB
TBIO Iguaçu	7.67 abA	6.82 cdefB	7.25 eA	6.99 cdeA
TBIO Itaipu	6.26 efA	6.83 cdefA	8.01 bcdeB	9.19 aA
Mirante	6.68 deA	6.32 fA	7.43 deA	6.32 deB
TBIO Sinuelo	7.22 abcdA	6.49 efA	8.53 bcA	6.30 eB
Quartzo	6.00 fA	6.61 defA	7.32 deA	7.58 bcA
BRS 331	7.06 bcdA	6.95 cdefA	7.50 cdeA	6.20 eB
BRS 327	7.92 aA	7.20 bcdeA	8.32 bcdA	8.50 abA
TBIO Pioneiro	7.56 abcA	7.99 aA	7.02 eA	6.66 cdeA
CV%	7.41		9.53	

*Means followed by the same lowercase letter in the column and uppercase letter in the line do not differ statistically by Tukey test at 5% probability.

The RL was superior to the TBIO Mestre genotype at the sowing date I. In contrast, better results for the sowing date II were obtained with the genotypes TBIO Itaipu and BRS 327 (Table 5). The RL evidenced elevated influence of growing conditions because the genotypes BRS Parrudo, TBIOMestre, Mirante, TBIO Sinuelo, and BRS 331 expressed the best results when planted at the sowing date I. On the other hand, only TBIO Itaipu indicatedsuperior RL in the sowing date II. This trait can also be considered as anindicative parameter of seed vigor, where seeds tend to be stronger and have more reserves in the endosperm, enhancing the root primordial emission. Thus, superior genotypes for this trait have greater ability to form a root system with better conditions to explore the soil, absorb water and nutrients, and support plant fixation. In order to determine the genetic dissimilarity among tested wheat genotypes, the Generalized Mahalanobis distance by UPGMA grouping method was used.Fourteen measured traits were utilized to compose the matrix of distances (Figure 1). As a group separation criterion in the dendrogram, the average of genetic distances (21.705) obtained by traits measurement was used and represented by dashed line. In this way, there was obtained the formation of two major groups of genotypes.

The G I group was formed by only two genotypes, the TBIO Mestre and BRS 327 cultivars, which are more distant from the others. The G II group was formed by the other genotypes but the overall average of the distances allowed to subdivide it in a small subgroup composed by the genotypes TBIO Sinuelo and TBIO Pioneiro and the other sub-group consists of the following seven genotypes: TBIO Sintonia, TBIO Iguaçu, BRS Parrudo, TBIO Itaipu, Mirante, Quartzo, and BRS 331. The differential results obtained in this study regarding the genotype responses are justified by the dissimilarity existent between genotypes, which can be observed due to the formation of three groups. The relative contribution of the traits was obtained by the method of Singh (1981) and can reveal which traits are essential to distinguish the tested genotypes in 14 traits measured in 11 wheat genotypes (Table 6). It was observed that the genotype distinction is supported by four traits that together contribute with 61.8%. In an isolated way, the spikeinsertion height (SIH) accounts for 28.07%, germinated seeds (GS) for12.36%, number of grains per spike (NGS) for 10.59%, and plant height (PH) for 10.15% of the relative contribution.

Table 6. Results of the relative contribution by the method of Singh (1981) of agronomic and physiological traits for 11 wheat genotypes

Traits	S.j	Relative Contribution (%)
Plantheight (PH)	163.06	10.15
Spike insertionheight (SIH)	450.80	28.07
Spike length (SL)	109.79	6.83
Spike weight (SW)	96.81	6.03
Number of grains per spike (NGS)	170.07	10.59
Grain weight per spike (GWS)	28.53	1.77
Grainyield (GY)	45.28	2.82
Thousand grainweight (TGW)	52.66	3.28
Hectolitreweight (HW)	12.68	0.78
Firstgerminationcount (FGC)	26.25	1.63
Germinatedseeds (GS)	198.56	12.36
Seedlingdryweight (SDW)	33.03	2.05
Shootlength (SHL)	91.65	5.70
Radiclelength (RL)	126.32	7.86

The use of relative contribution enabled defining that the SIH, GS, NGS, and PH are essential traits to be measured in the wheat crop in order to enable discrimination of the tested wheat genotypes.

Conclusion

Sowing of wheat in May (sowing date I) favors the incrementof spike weight, grain weight per spike, grain yield, thousand grain weight, first germination count, germinatedseeds, and seedling dry matter when compared to the genotypes tested with sowing in June (sowing date II). The dissimilarity by the Generalized Mahalanobis distance allows to discriminate the genotypes into two major groups, being TBIO Mestre and BRS 327 the most dissimilar genotypes. The traits withmore relative contribution in the discrimination of wheat genotypes are spikeinsertion height, germinated seeds, number of grains per spike, and plant height, which explain 61.8% of the total variation.

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