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STUDIES ON THE VARIABILITY OF THE CHARACTERS IDENTIFIED BASED ON THE UPOV GUIDE IN A VARIETY OF WINTER WHEAT GROWN ON THE CARACAL CHERNOZEM

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Abstract
A winter wheat assortment comprising 190 varieties of different origins was sown on the chernozem of Caracal in the fall of 2023. Based on the observations underlying the characterization of wheat plants according to the UPOV (The International Union for the Protection of New Varieties of Plants) guide, distributions were made for several characters, namely: plant habit, frequency of plants with recurved flag leaves, earing date, plant height, ear compactness (density), awn length, ear length, ear shape in profile.
For the characters determined by measured values, the coefficient of variability was calculated to highlight the presence or absence of stability. The same characters were also evaluated based on the box-plot to highlight the existence of outliers or extreme values; values that deviate significantly from all the determinations made. Also, for each score for the characters mentioned above, new examples were added to simplify subsequent determinations and to broaden the base of reference varieties. The determined variability can be the basis of the wheat breeding program for the selection of parents.

Keywords: box-plot, distributions, UPOV guide, variability, wheat.

1. INTRODUCTION

Food security is a huge challenge, as the global population is growing and needs more food. At the same time, resources such as fertile land and water are decreasing, and climate change and economic instability make it difficult for billions of people, especially in vulnerable regions, to have access to enough food (Bonciu, 2019).
Wheat (*Triticum aestivum* L.) is the most frequently cultivated crop in the world (Ișlicaru et al., 2021; Iacob et al., 2023; Paunescu et al., 2024). The grains have an exceptional nutritional value: they are rich in complex carbohydrates for energy, quality protein, essential vitamins, minerals (iron, zinc, magnesium, phosphorus), dietary fiber and antioxidants, contributing to digestive health, disease prevention (heart disease, diabetes, cancer) and general well-being (Yue et al., 2019).

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Wheat plays a vital role in global nutrition, with significant percentages of its production being used for food, thus contributing significantly to caloric intake (Sobolewska et al., 2020). New wheat varieties prioritize high yield, but this often comes at the cost of increased sensitivity to environmental stressors like heat and drought, a trend particularly evident in Europe due to climate change, with yields impacts (Schauberger et al., 2018).
The modern selection process, often using molecular tools for efficiency, aims to combine favorable wheat genes into a stable genetic line that performs well consistently (Kaiser et al., 2020). A breeder usually introgresses several characteristics into multiple backgrounds that have adapted to different environmental conditions (Glenn et al., 2017).
Member countries implement the UPOV Convention, often through national laws that incorporate the DUS (Distinct, Uniform, and Stable) criteria for examining new plant varieties, benefiting society (Yu and Chung, 2021). The genus *Triticum* include many wild relatives (diploid, tetraploid, hexaploid), extensive local collections of wheat and breeding lines from across the world, making it a vital resource for food security (Arya and Jaiswal, 2014).
Many results show a wide range of variability for wheat traits (Pal et al., 2007; Bux et al, 2012; Malik et al., 2014; Spanic et al., 2024).

2. MATERIALS AND METHODS

In the experimental field located on the chernozem of Caracal, 190 wheat varieties of different origins were tested. Most of them come from the portfolio of seed producing institutes and companies: INCDA Fundulea, Axereal, Biocrop, Donau Saat, KWS, Lidea, Limagrain, RAGT, Saaten Union, Syngenta.
Based on the observations that underlie the characterization of wheat plants according to the UPOV (The International Union for the Protection of New Varieties of Plants) guidelines, distributions were made for several characters, namely: plant habit, frequency of plants with recurved flag leaves, earing date, plant height, ear compactness (density), ear length (Table 1). For three of these (plant height, spike length, spike density), the distribution was based on value determinations performed on 15 plants/spike of each tested variety. For these, the coefficients of variability and distribution were also calculated using the box-plot method.
For each rating of the above mentioned characters, new examples of varieties were added to simplify subsequent determinations and to broaden the reference base. These were done only by classifying the varieties that were also tested in this collection (Example: the Solehio variety was tested and is listed as a reference - the varieties that behaved identically were also nominated).

Table 1. Characteristics from the UPOV Guide noted at the variety collection

Characteristics	Distribution classes	Examples varieties	note
4.Plant: growth habit	erect		1
	semi erect	(w) Callobre, (s) CH Campala	3
	intermediate	(w) Apache, (s) Sensas	5
	semi prostrate	(w) Solehio, (s) Olivart	7
	prostrate	(w) Stelarka	9
5.Plant: frequency of plants with recurved flag leaves	absent or very low	(w) Genius	1
	low	(w) Solehio, (s) Triso	3
	medium	(w) Callobre, (s) Specifik	5
	high	(w) Antonius, (s) Blini	7
	very high	(w) Atacama, (s) FD 1 24	9
7.Time of ear	very early	(w) Accor, (s) Badiel	1

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emergence	early	(w) Solehio, (s) Sensas	3
	medium	(w) Sotchy CS, (s) Granary	5
	late	(w) Rosario, (s) Triso	7
	very late	(w) Adequat	9
13.Plant: length	very short	(w) Fronton	1
	short	(w) Apache, (s) Lennox	3
	medium	(w) Solehio, (s) FD 1 24	5
	long	(w) Antonius	7
	very long	(w) Capo	9
Ear: density	very lax		1
	lax	(w) Kranich, (s) Lennox	3
	medium	(w) Solehio, (s) Granary	5
	dense	(w) Cellule, (s) Virgile	7
	very dense		9
Ear: length	very short	(s) Olivart	1
	short	(s) Granary, (w) GK Berény	3
	medium	(w) Rubisko, (s) Sensas	5
	long	(w) SY Ideo, (s) Specifik	7
	very long	(w) Edgar	9

3. RESULTS AND DISCUSSIONS

The largest share was occupied by varieties with intermediate growth habit, followed closely by varieties with semi-recumbent growth habit (Figure 1). Recumbent growth habit varieties are extremely rare. This category included the following varieties: Concret, Epilog, Gerry, Koreli, Maxence, Moschus, Omersson, Rubisko, Soliflor, Tarroca, Thalamus and Tomcat.

In the category of the Solehio variety, a reference variety that was in the collection and was marked with 7 (semi-dormant port), the following varieties were included: Absint, Anapurna, Angelica, Arnold, Asterion, Attraktion, Basmati, Bezostaia, Cevignon, Complice, Ekonom, Emblem, Euclide, Exsal, Fagur, Foxil, Foxx, GK Arato, Iris 12, Irun, Joker, Kapitol, Klima, KWS Enclum, KWS Eternel, KWS Extrem, KWS Flexum, KWS Marvel, KWS Rhum, KWS Sphere, Stroboli, KWS Ultim, KWS Usuel, Lemmy, Lennox, Lexio, Mobile, Modern, Mutic, Novic, Obiwan, Ortolan, Papillon, Perkussio, Promitor, Providence, Python, RGT Vivendo, Ruler, Somtuoso, Sothys, SY Exaltation, SY Transition, Tiberius, Tata Mata.

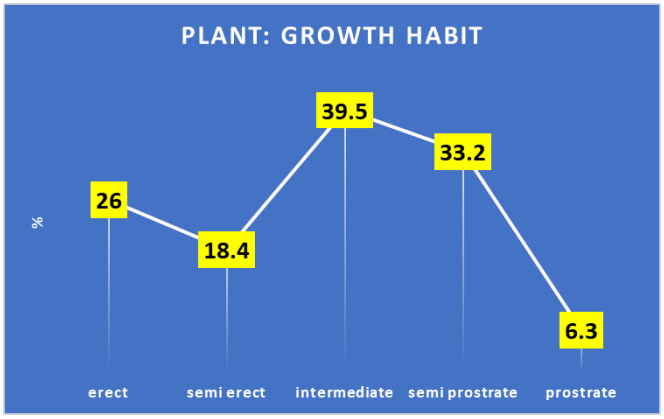

Figure 1. Distribution of plant habit according to UPOV Guide ratings

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The position of the flag leaf is a very important character for the maintenance of the crop through agricultural works that involve spraying: herbicide, fungicide, insecticide or application of biostimulants or foliar fertilizers. A high frequency of recurved flag leaves does not allow the substance to reach the base of the leaf.
The concentration of most varieties in the category of very low frequency of recurved flag leaves demonstrates the current trend in improving the architecture of the wheat plant, namely erect leaves to make treatments more efficient. The distribution ranking is continued by the medium and low frequency groups (Figure 2).
In the Solehio variety category, a reference variety marked with 3 (low frequency of recurved flag leaves), the following varieties were included: Alcantara, Amburgo, Amicus, Aurelius, Axum, Borsalino, Consecvent, Emblem, Ekonom, Emisar, Exsal, Flavor, Frenetic, Gabrio, KWS Flexum, Stromboli, Lexio, Litera, Mobile, Moisson, Mutic, Obiwan, Perkussio, PG 102, Promitor, Providence, RGT Borselino, RGT VIvendo, Sofru, Solindo, Sonathine, SY Lirico, SY Olen, SY Passion, SY Transition.

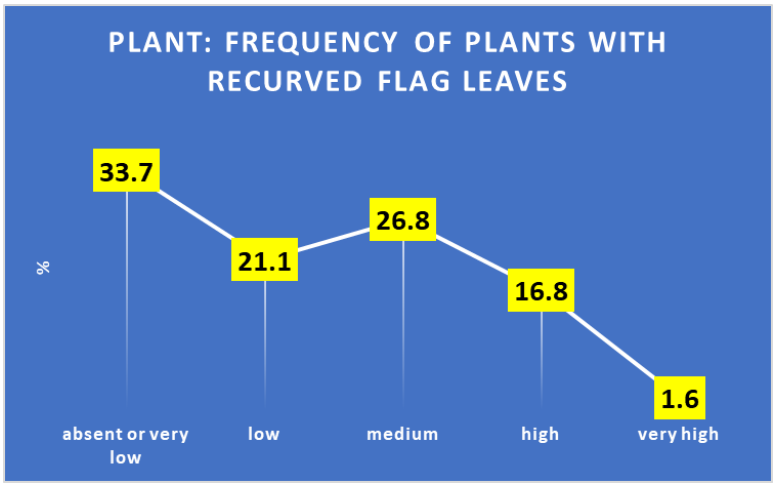

Figure 2. Frequency distribution of plants with recurved flag leaves according to UPOV Guide ratings

Given that foreign varieties are numerous in this collection, 70.5% of the varieties are included in the distribution classes with grades of 5 (medium-early), 7 (late-early) and 9 (very late-early) (Figure 3). The predominant category was the medium-early ripening period – 26.3%.
In the Solehio variety category, a reference variety graded 3 (early-early), the following varieties were included: Adelina, Alahambra, Asterion, Athlon, Basilio, Borsalino, Centurion, Darnic, Evident, Exotic, Gabrio, Ingenio, Klima, Litera, Obiwan, RGT Borsalino, SY Exception, SY Lirico, SY Starlord, Tika Taka, Tocat.
As a point of reference, it can be mentioned that the Glosa variety, the most cultivated variety in Romania, was marked with 1 – very early variety. And the Avenue variety – the most cultivated foreign variety in the area of influence is also a very early variety.
The variability of the height of wheat plants was located in the 71 cm segment for the Katarina variety and 120 cm for the Every and Tomcat varieties. The most prevalent distribution class was 91-95 am with 25.3% followed by 86-90 cm with 22.1%. Over 60% of the varieties had a height between 86 and 100 cm (Figure 4). The coefficient of variability of 9.4% places height in the category of stable characters (stability is given by the value of the coefficient below 10%).

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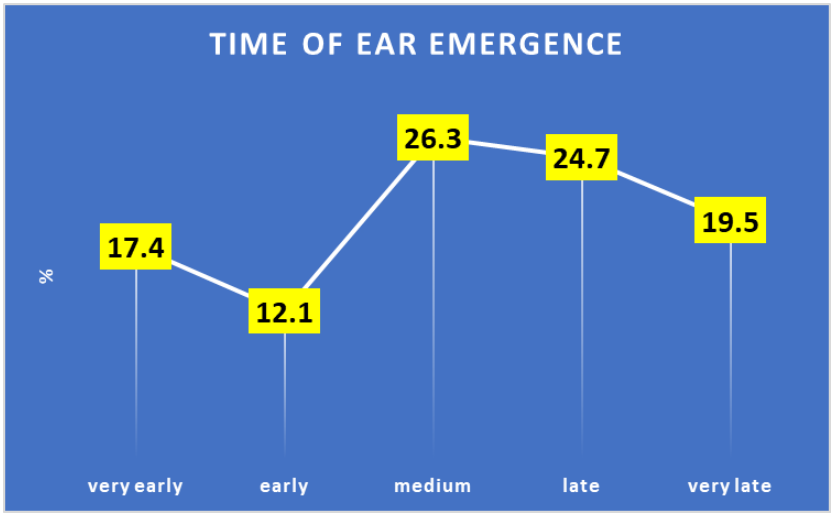

Figure 3. Distribution of the harvest season according to the UPOV Guide

The box-plot method did not reveal any waist value that deviated from the tested varieties. In the Solehio variety category, a reference variety with a waist of 90 cm, the following varieties were included: Adelina, Airbus, Amicus, Anapurna, Aurelius, Axum, Barba, Bogdana, Bologna, Dallara, Emblem, Exotic, Flavor, Gabrio, Gerry, Irun, Klima, KWS Enclum, KWS Milanum, KWS Rhum, Stromboli, KWS Usuel, Lemmy, LG Alpico, Mobile, Mutic, Mv Nador, Obiwan, Omersson, Perkussio, Pibrac, Python, RGT Cesario, RGT Vivendo, Rubisko, Sonathine, SY Milteo, SY Rocinante, Tata Mata.

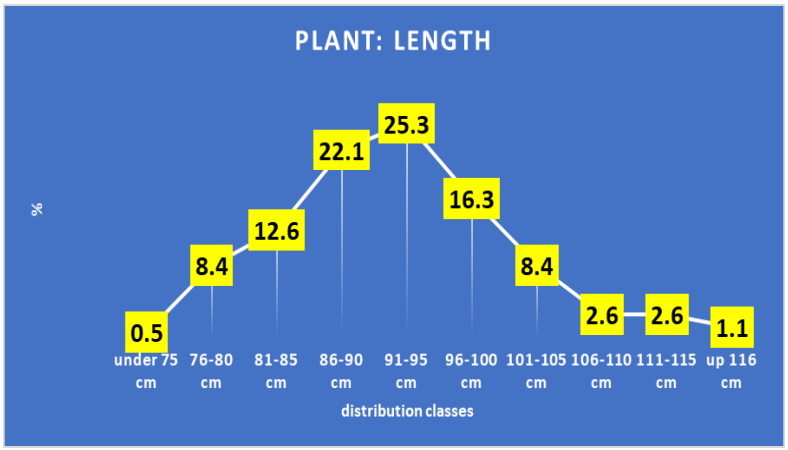

Figure 4. Waist distribution by values determined in the Caracal collection

The wheat ear density had values ranging from 9.89% in the Guido variety to 23.11% in the Emblem variety. There were small differences between two distribution classes, but the highest percentage (27.1%) was in the 18.1-19% distribution class (Figure 5).
The coefficient of variability of 9.4% places the ear density in the category of stable characters. And for this character, the box-plot method did not reveal any value that deviated from all the other tested varieties.

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In the category of the Solehio variety, a reference variety with an ear size of 17.92%, the following varieties were included:, Adelina, Amburgo, Apexus, Aurelius, Barba, Basaltic, Basmati, Bologna, Carom, Columna, Falado, Filon, Flavor, GK Arato, Ingenio, IS Agilis, Izalco, KWS Enclum, KWS Lazuli, KWS Usuel, Lennox, Modern, Moschus, Pajura, Perkussio, PG 101, PG 102, Providence, RGT Borselino, RGT Montecarlo, RGT Pacteo, , RGT Palermo, Sofru, Soliflor, Solveig, Sonathine, SY Exaltation, SY Rocinante, SY Sanluca, Tarroca, Tika Taka.

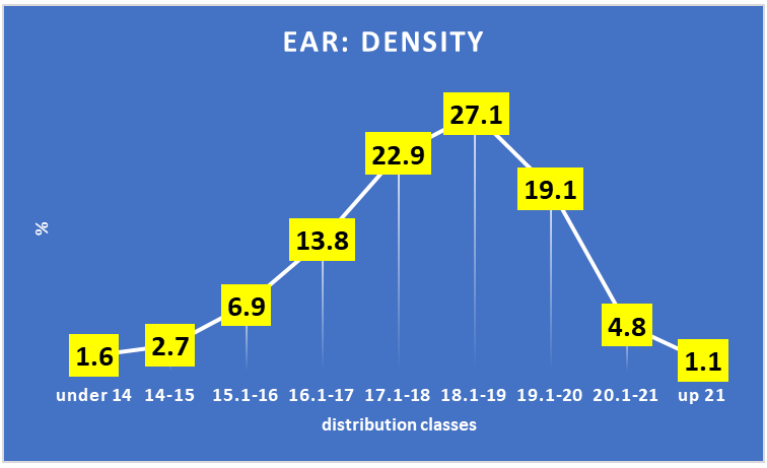

Figure 5. Spike density distribution expressed by values determined in the Caracal collection

The extreme limits of spike length were between 6.4 cm for KWS Criterium and 14.5 cm for the Activus variety. The most prevalent distribution class was 8.6-9 cm (21.8%). Over 50% of the varieties had spike lengths between 8.1-9.5 cm (Figure 6).
The coefficient of variability of 12.8% places spike length in the category of medium-stable characters (medium stability is given by the coefficient value between 10 and 20%).
The box-plot method did not reveal any value of the studied character that deviated from the tested varieties.

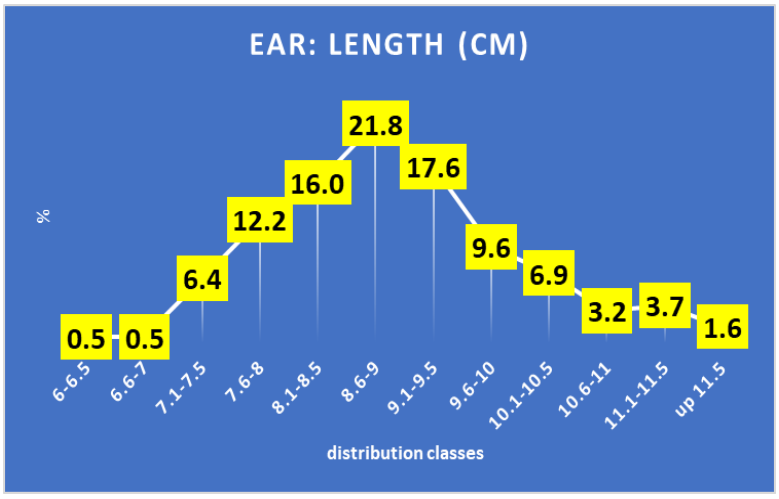

Figure 6. Spike length distribution expressed by values determined in the Caracal collection

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In the category of the Rubisko variety, a reference variety with an ear length of 8.6 cm, the following varieties were included: Abund, Amburgo, Ascona, Aspekt, Athlon, Dallara, Darnic, Ekonom, Emisar, Every, Felix, Filon, Foxil, Foxx, Gk Arato, Glosa, Iris 2, Is Agilis, Klima, KWS Marvel, KWS Rhum, Maxence, Miranda, Moisson, Obiwan, Otilia, Perkussio, RGT Borselino, RGT Letsgo, RGT Palmeo, Silverio, Solehio, Soliflor, Somtuoso, SY Lirico, SY Milteo, SY Rocinante, SY Sanluca.

4. CONCLUSIONS

Predominantly, most of the varieties tested on the Caracal chernozem were varieties with intermediate plant habit, with a very low frequency of plants with a recurved flag leaf, with a medium to late earing period, with a height of 86-100 cm, with a spike density of 17-19% and a length of 8-9.5 cm.

Spike height and density are stable characters while spike length is a character with medium stability. At the level of the Solehio variety, which was a reference variety for 5 of the 6 characters, many other varieties were recorded, thus allowing the identification of autochthonous or foreign germplasm for the analyzed characters.

All the varieties mentioned and characterized in this paper can constitute an important basis in the wheat breeding process.

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