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RANKS AND RANK STABILITY OF WHEAT CULTIVARS TESTED IN NATIONAL YIELD TRIALS IN ROMANIA

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Abstract. *Cultivars can play a key role in ensuring high wheat grain yields and reducing its variation under the increasing environmental variability. We used data on grain yield and coefficients of variation from sixty yield trials with Romanian winter wheat cultivars, conducted in four regions of the country, for four years (2021-2024) to analyze the ranks and rank variances of the tested cultivars. Despite the large variation of environments, we identified cultivars with better average ranks and with lower rank variances, which could contribute to higher and more stable yields in farms. Results are also useful for establishing priorities in breeding future cultivars.*

Keywords: ranks, variation, wheat, yield.

INTRODUCTION

Most farmers recognize cultivars as one of the most dynamic and economically efficient factors in wheat production, with a decisive influence on yield level and response to environmental conditions. Public breeding programs in Romania have continuously contributed to providing better cultivars to farms. As a result, from 1971 to present, Romanian wheat cultivars have occupied on about 40 to 69 % of the total certified seed produced in Romania [1], achieving a significant genetic progress in yield and other important traits [2]. To promote the best new cultivars, NARDI Fundulea has coordinated, since its foundation, a National uniform yield trial with winter wheat cultivar, at sites all over the country. The present paper analyzes average ranks and rank variance recorded in these trials conducted during 2021-2024.

MATERIAL AND METHODS

We analyzed yield trials results obtained in Romanian winter wheat cultivars released from the National Agricultural Research & Development Institute Fundulea, and from the Agricultural Research & Development Stations Turda, Lovrin – Oradea, Șimnic and Caracal, along with the historical check Bezostaya 1.

Yield trials with balanced lattice design, on 5 or 10 m^2 plots with twenty-five entries and three replications, were conducted countrywide to test winter wheat yielding ability and adaptation to various regions of Romania.

We analyzed yield results from yield trials conducted with crop management recommended for each environment, including the recommended Nitrogen fertilization, which varied from 82 to 143 kg. N/ha, at sites grouped on regions:

Southern region including: Agricultural Research & Development Station (ARDS) Valu lui Traian - Lat. 44º16' N, Long. 28º51'E; NARDI Fundulea - Lat 44°30`N, Long 26°51`E; ARDS Teleorman (Drăgăneşti-Vlaşca)– Lat. 44°07'N, Long. 25°45'E; ARDS Mărculeşti – Lat. 44°25′N, Long. 27°29′E; ARDS Brăila – Lat. 45°16′N, Long. 27°57′E; ARDS Piteşti – Lat 44º81'N, Long.24 º86'E; Craiova University - ARDS Caracal – Lat. 44º11'N. Long. 24º37'E; ARDS Șimnic -, 44°20′N 23°49′E.

Western region including: ARDS Lovrin - Lat 45°57'N, Long. 20°46'; ARDS Oradea – Lat. 47°02'N Long. - 21°54'E; ARDS Livada Lat. 47°52'N, Long. 23°08'E;

Central region including: ARDS Turda – Lat. 46º58' N, Long. 23º78'E; RDSCB Târgu-Mureş – Lat. 46°32'N, Long. 24°33'E.

Eastern region including: ARDS Secuieni – Lat. 46ºN, Long. 26º 86'E; ARDS Perieni Lat. 46°18′N, Lat. 27°37′E.

The testing sites covered a large diversity of soils, from chernozems to luvisoils with pH from 5.02 to 7.6, and humus content from 1.71 to 3.6%. Weather conditions during the period 2021-2024 at all sites reflected present climate changes and were diverse, as illustrated by rainfall, which varied from 211.2 to 613.8 mm/year.

We analyzed ranks of the cultivars tested all testing years in a two-way table with K rows (genotypes) and N columns (environments), ranking the K phenotypic values within each column (environment) separately (best value = rank of 1 and worse value = rank of K). We calculated the average rank and the variance of all ranks for each genotype. The average rank is a convenient measure of cultivar competitiveness, while the variance of ranks is a nonparametric measure of stability, a genotype being considered stable over environments if its ranks are similar over environments, i.e., maximum stability = equal ranks over environments{3].

Graphical representations of average ranks and rank variances for each

group of yield trials facilitated identification of genotypes that combine above average performance and stability, placed in the down-right quarter of the graph.

RESULTS

In thirty-two trials from the **Southern region**, cultivars *FDL Columna, Ursita, FDL Consecvent* and *FDL Abund* had the best average ranks, while lowest average rank was found in the historical check *Bezostaya 1*. Rank variance varied from 7.56 in *Bezostaya 1*, to more than 27 in cultivar *A4-10*. We can explain the high rank stability of *Bezostaya 1* by the fact that it was inferior to the newer, semidwarf cultivar in most trials, while the large variation observed in A4-10 was due to the fact that the region included ARDS Pitesti, where the line is very adapted, but also sites where lodging affected its yields.

We observed higher rank stability in lowest yielding cultivar *Bezostaya1*, but also in two of the cultivars with highest average ranks (*FDL Columna* and *Ursita*) (Figure 1).

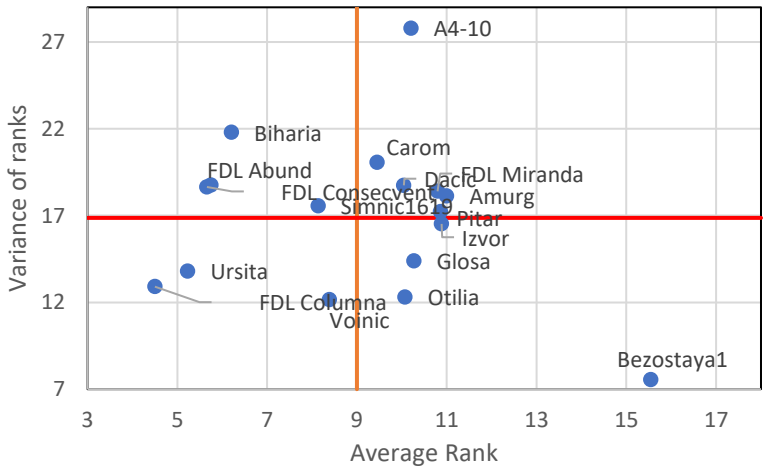


Figure 1. The relationship between cultivar average ranks and their stability in yield trials conducted in the Southern region.

In twelve trials from the **Western region** cultivars *FDL Columna, FDL Consecvent* and *Biharia* had best average ranks while *Bezostaya 1* had the lowest average rank. Highest variation in ranks was observed in cultivars *Otilia* and *Dacic*, while the lowest variation was observed again in *Bezostaya1*, but also in cultivars *Biharia* and *FDL Columna*. It is worth mentioning that cultivars *Biharia, FDL Columna* and *FDL Consecvent* proved to have at the same time the best average ranks and best rank stability caused by environmental conditions in this region (Figure 2).

Rank stability of cultivar *Biharia* was much better in the Western region than

in the Southern region. This shows better adaptation of this cultivar in West Romania and suggests that *Biharia* might be more affected by harsher weather conditions, more frequent in the Southern region.

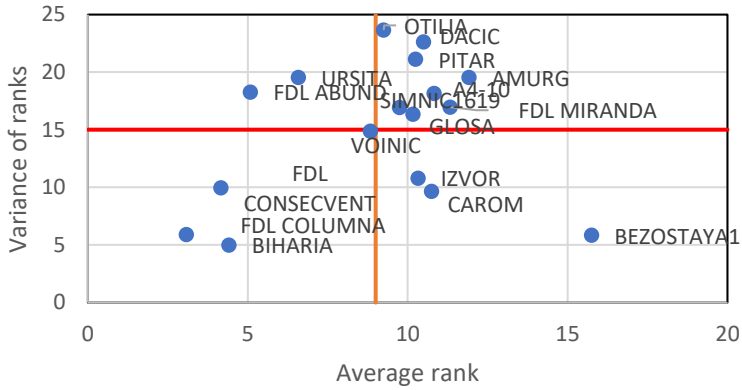


Figure 2. The relationship between cultivar average ranks and their stability in yield trials conducted in the Western region.

In the eight trials conducted in the **Central region** (Transylvania), where yields were highest of all regions, we found the best average ranks in cultivars *T75-16, FDL Consecvent, T42-17* and *Luminiţa.* Cultivars *FDL Consecvent, T42-17* and *Luminiţa*, along with *FDL Abund* and *T109-12* showed better than average performance both for average ranks and variances (Figure 3).

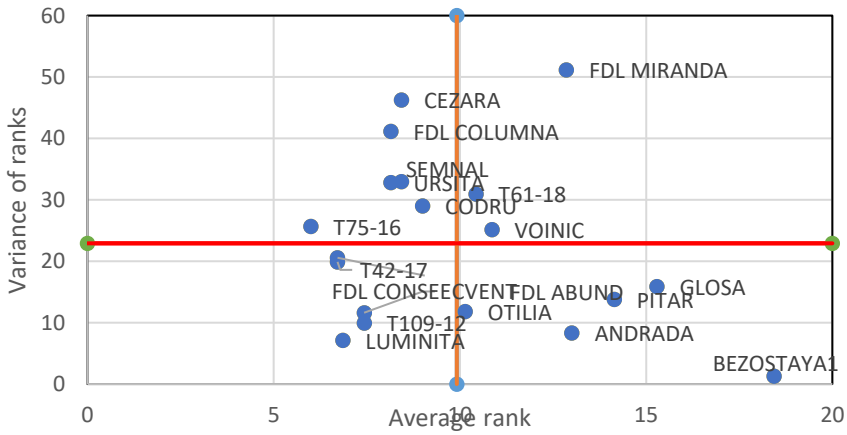


Figure 3. The relationship between cultivar average ranks and their stability in yield trials conducted in the Central region.

Cultivars *Bezostaya 1, Andrada, Glosa* and *Pitar*, showed lower rank

variances, but lower yields in this region, related to their lower yielding potential or to their earliness, which did not allow full use of the available weather resources.

Data from eight trials conducted in the **Eastern region**, showed the best average ranking in cultivars *FDL Columna* and *FDL Consecvent*, followed at considerable distance by *Voinic* and *FDL Abund*. The old non semidwarf cultivar *Bezostaya 1* had the worse ranking, as in all other regions. Cultivars *FDL Columna, Bezostaya 1* and *Andrada* had the smallest variance of ranks.

Cultivars *FDL Columna, FDL Consecvent, FDL Abund* and *Ursita* combined average ranks and variance of ranks better than the average of all studied cultivars (Figure 4).

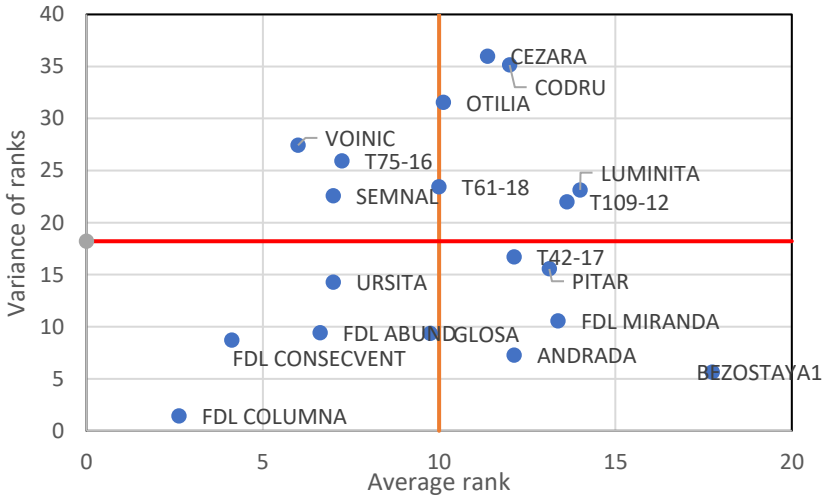


Figure 4. The relationship between cultivar average ranks and their stability in yield trials conducted in the Eastern region.

DISCUSSION

As underlined by Huehn [3] "Nonparametric measures for phenotypic stability based on ranks provide a useful alternative to parametric measures currently used, which are based on absolute data". Among the advantages of nonparametric stability statistics, he mentioned the fact that "no assumptions are needed about the distribution of the phenotypic values" and "for many applications, for example selections in breeding and testing programs, the rank orders of the genotypes are the most essential information."

Using this approach, we analyzed the results of sixty yield trials with winter wheat cultivars, conducted during four years at fifteen sites from four regions of

Romania. Both average ranks and rank variances varied much among cultivars, allowing identification of cultivars with better relative performance and with better rank stability. We did not find any correlation between ranks and their stability, the lowest rank variances being found in the historical check *Bezostaya 1,* but also in cultivars with highest performance.

The most recently released cultivars, and especially *FDL Columna*, showed the best average ranks for yield in most regions, combined with good rank stability, superior to older cultivars.

CONCLUSIONS

Testing wheat cultivars in sixty yield trials conducted for four years in diverse conditions allowed identification of cultivars able to provide higher yields, with smaller variation induced by environmental conditions, Data included in this paper can facilitate better choice of cultivars for each of the analyzed regions and this could contribute to higher and more stable wheat production in farms. Presented results can also be useful for establishing priorities in breeding future cultivars.

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