



ULST Timisoara
Multidisciplinary Conference on Sustainable Development
 21-22 May 2026



YIELD STABILITY, AGRONOMIC PERFORMANCE AND SELECTION RESPONSE OF POTATO BREEDING LINES UNDER MULTI-YEAR CONDITIONS OF TÂRGU SECUIESC

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Abstract: This study evaluated the agronomic performance and yield stability of 42 potato breeding lines (TS series) and two control cultivars (Redsec, Riviera) in comparative field trials at Târgu Secuiesc during 2023–2025. Two-way ANOVA revealed highly significant effects of year ($F = 93.09$; $p < 0.001$), genotype ($F = 9.20$; $p < 0.001$) and year \times genotype interaction ($F = 4.97$; $p < 0.001$). Mean yield decreased from 30.26 t/ha in 2023 to 16.04 t/ha in 2025, the latter acting as a restrictive selection environment due to severe summer drought. Stability analysis based on CV% and the Finlay–Wilkinson regression coefficient (b_i) identified TS 22-1537-1968 as the most stable line of the trial ($CV = 9.7\%$; $b_i = 0.36$; mean = 29.81 t/ha), together with TS 22-1572-1968, TS 12-1540-1968 and TS 22-1573-18.

Introduction

Potato (*Solanum tuberosum* L.) yield is shaped by a complex interaction between genetic potential, climatic conditions and crop technology. Recent climate variability — especially the increasing frequency of summer droughts in Eastern Europe — has reinforced the need for breeding programmes targeting not only yield potential, but also yield stability across contrasting environments.

The intramontane Târgu Secuiesc Depression provides an ideal testing site, alternating between favourable seasons and stressful drought years. The objective of this study was to evaluate newly developed TS-series breeding lines under multi-year field conditions, in order to identify genotypes combining high productivity, stability and resilience to climatic stress.

Material and method

Plant material: 42 TS-series breeding lines + 2 control cultivars (Redsec, Riviera).

Site & period: PRDS Târgu Secuiesc, 2023–2025.

Design: randomised complete block design with 3 replications; uniform agrotechnology.

Assessments: phenology (emergence, flowering, maturity), morphology (tuber shape, eye depth, skin/flesh colour), agronomy (stems/plant, uniformity), virus incidence and total yield.

Statistics: two-way ANOVA (year \times genotype) + Duncan's test using POLIFACT software. Stability assessed with CV% and Finlay–Wilkinson b_i regression coefficient.

Results and discussions

All three sources of variation were highly significant ($p < 0.001$). The relative weight of the genotype effect decreased markedly when 2025 was included ($F: 27.41 \rightarrow 9.20$), while the year effect dominated. This shows that environmental stress compresses phenotypic differences and confirms that **multi-year evaluation is essential** for reliable selection.

Table 1. Two-way ANOVA for total yield (3-year)

Source	df	MS	F	Sig.
Year (A)	2	6834.53	93.09	***
Genotype (L)	41	154.99	9.20	***
A \times L	82	83.71	4.97	***
Error	246	16.86	—	—

***: significant at $p < 0.001$

Table 2. Top genotypes — yield & stability

Genotype	Mean (t/ha)	CV%	b_i
Redsec (Mt.)	38.30	14.7	0.74
TS 22-1537-1968	29.81	9.7	0.36
TS 22-1572-1968	28.32	22.7	0.85
TS 12-1540-1968	27.83	23.4	0.85
TS 22-1573-18	26.68	23.9	0.85
TS 12-1556-1955	29.83	30.5	1.13
TS 22-1545-15	31.03	44.6	1.88
TS 12-1541-15	29.01	56.9	2.02

● control ● stable & productive ● productive but unstable ● very unstable

Mean yield 2023–2025: 30.26 \rightarrow 26.46 \rightarrow 16.04 t/ha (Duncan groups C, B, A). The 2025 drought reduced yield by 47% relative to 2023.



Fig. 1. Mean yield variation across the three experimental years

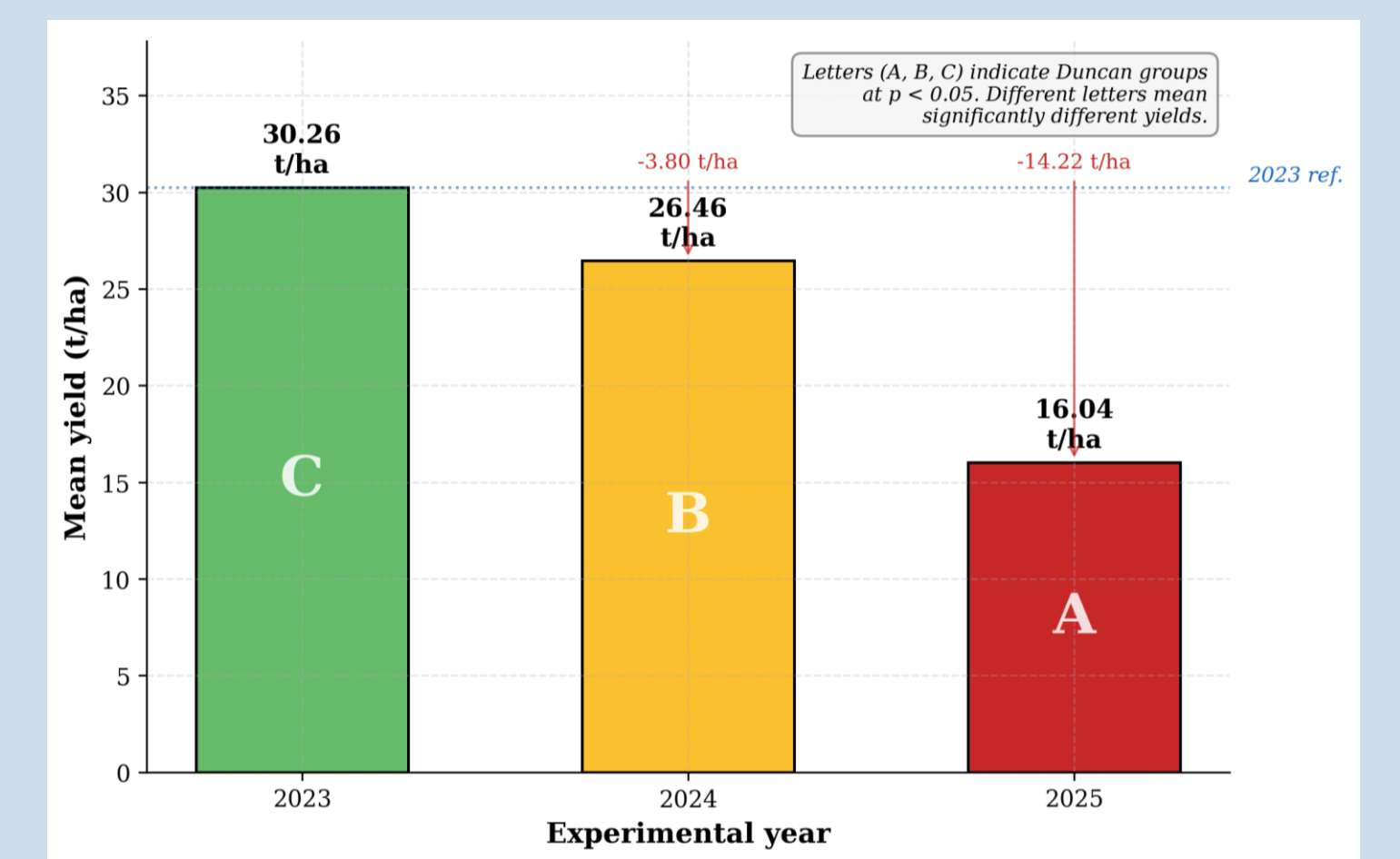


Fig. 2. Comparative yield of top genotypes across 2023–2025



Fig. 3. Mean yield vs CV% — stability quadrants for selection

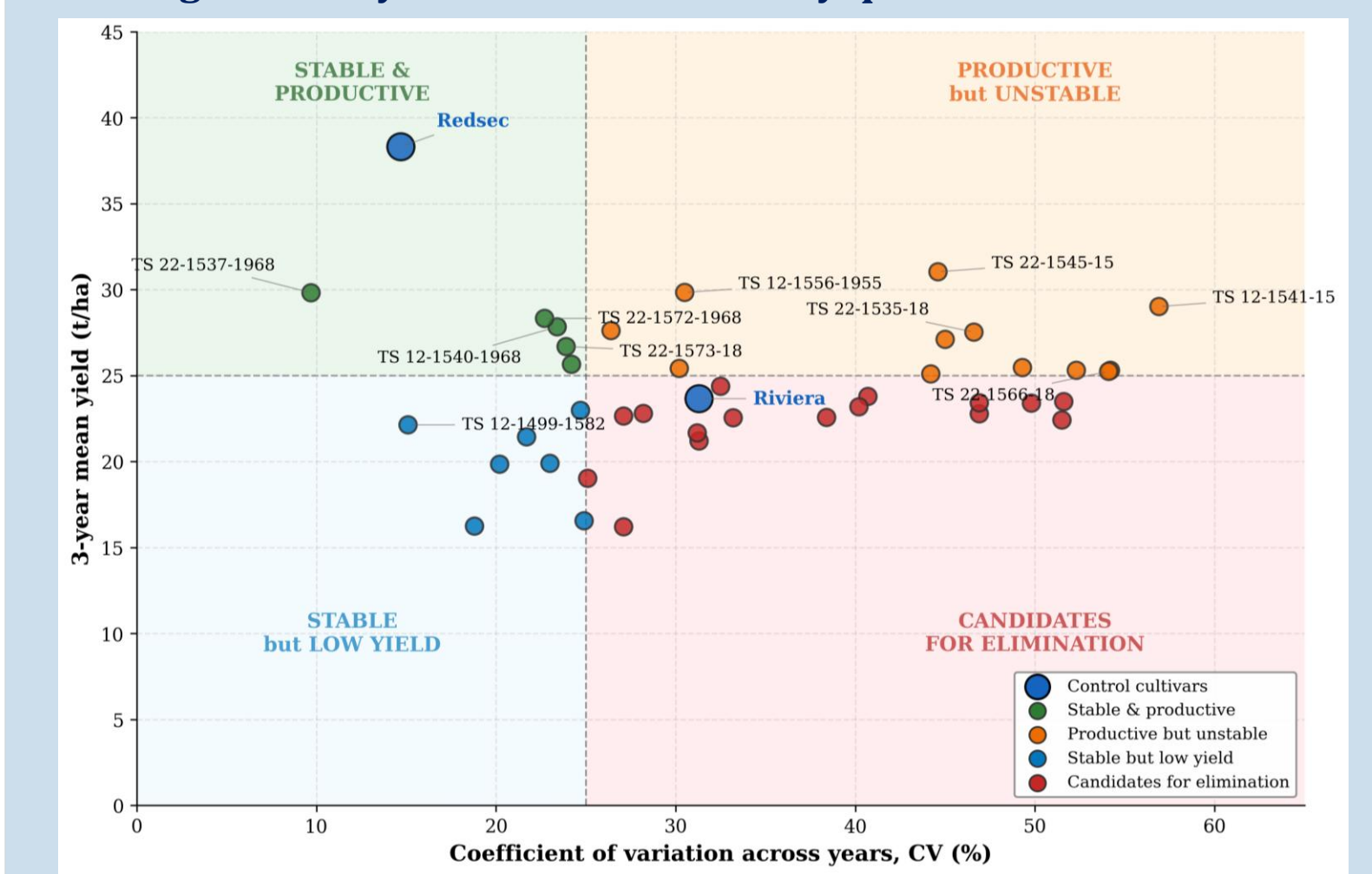
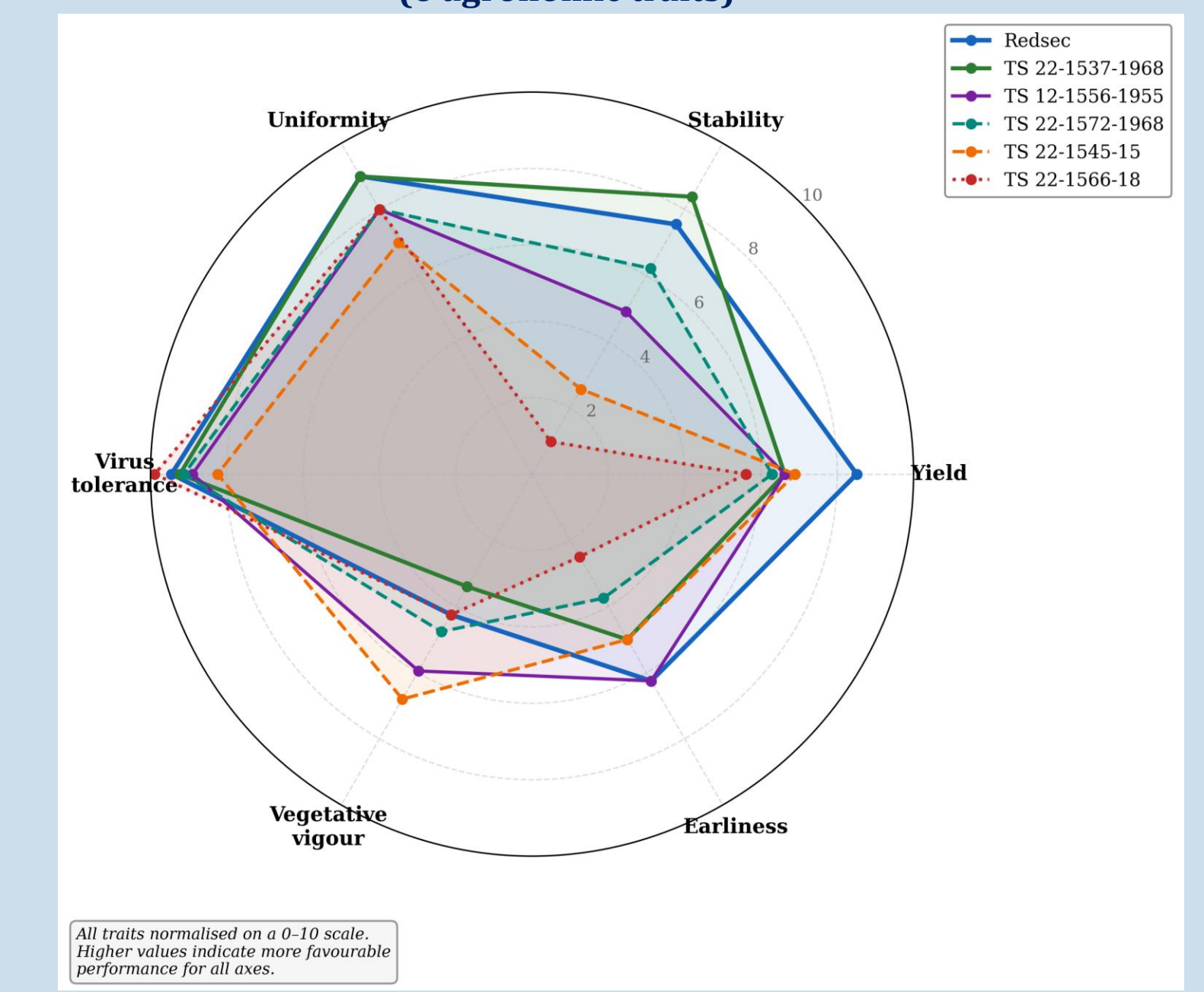


Fig. 4. Radar profile of selected genotypes (6 agronomic traits)



Conclusions

1. Year, genotype and year \times genotype interaction had highly significant effects ($p < 0.001$); 2025 acted as a drought-induced selection environment.
2. TS 22-1537-1968 was the most stable line of the trial ($CV=9.7\%$, $b_i=0.36$); together with TS 22-1572-1968, TS 12-1540-1968 and TS 22-1573-18 it forms the core stable & productive group recommended for advancement.
3. TS 22-1545-15, TS 12-1541-15 and TS 22-1535-18 reached very high yields in 2023 (>39 t/ha) but collapsed under stress ($CV > 44\%$); favourable-environment specialists, risky under climate variability.
4. Multi-year evaluation including a stress year is indispensable: single-year ranking would have misclassified TS 12-1541-15 (47.00 \rightarrow 14.55 t/ha) as the top performer.