



# ADVANCED FERTILIZATION EFFECTS ON YIELD AND ECONOMIC EFFICIENCY OF POTATO CULTIVARS UNDER VARIABLE CLIMATIC CONDITIONS

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**Abstract:** This 3-year experiment (2023–2025) at SCDC Târgu Secuiesc evaluated six fertilization variants (conventional, organic and advanced systems based on Nutri-Top fertilizers and stabilised urea NG) on two cultivars: Secuiana and Redsec. Three-way ANOVA on 108 plot observations revealed a dominant year effect ( $F = 12\ 048$ ;  $p < 0.001$ ), highly significant fertilization effect ( $F = 362$ ;  $p < 0.001$ ) and very strong year  $\times$  cultivar interaction ( $F = 376$ ;  $p < 0.001$ ), while the main effect of cultivar was not significant ( $F = 3.32$ ;  $p = 0.072$ ). The advanced variant **V4 (Nutri-Top + urea NG, high dose)** produced the highest 3-year mean yield (29.32 t/ha; group a), followed by V5 (28.37 t/ha) and V3 (27.88 t/ha). Linear regression of yield on NPK input was non-linear ( $R^2 = 0.65$ ), with V3 and V5 showing superior nutrient use efficiency. Economic analysis ranked V4 first by absolute profit (~20 450 RON/ha), confirming that **nutrient availability and timing are more important than absolute input levels**.

## • Introduction

Potato (*Solanum tuberosum* L.) yield and tuber quality are heavily influenced by fertilization. Conventional systems often display low nutrient use efficiency (NUE), with substantial losses through leaching and volatilization, particularly under acidic soils and irregular precipitation.

Two technological responses have emerged: (i) controlled-release fertilizers (CRF) and stabilised N products that release nutrients in synchrony with crop demand, and (ii) integration of humic substances and biostimulants. The objective of this study was to evaluate the effect of six fertilization systems on tuber yield and economic profitability of two cultivars (Secuiana, Redsec) over a 3-year period including a contrasting drought year (2025).

## • Material and method

**Site & period:** SCDC Târgu Secuiesc, 2023–2025; phaeozem/preluvosol soils.

**Plant material:** 2 cultivars — Secuiana (semi-early), Redsec (semi-late).

**Design:** randomised complete block, 3 replications, 108 plot observations.

**Statistics:** three-way ANOVA (year  $\times$  cultivar  $\times$  fertilization) + Duncan test. Linear regression of yield on NPK input. Economic analysis: producer price 1100 RON/t.

Table 1. Fertilization variants tested

Var.	Type	NPK total (kg/ha)
V1	Conv. control: NPK 9:22:22 + CAN	266
V2	Organic: Fertiplus 4-3-3	150
V3	Complex: Nutri-Top 4:12:24 + urea NG	229
V4	Intensive: Nutri-Top + urea NG (high)	315
V5	Combined: Amesal + K <sub>2</sub> SO <sub>4</sub> + CAN	288
V6	Intensive conv.: NPK 15:25:0 + K <sub>2</sub> SO <sub>4</sub> + CAN	341



## • Results and discussions

All factors and interactions were highly significant except the main effect of cultivar ( $F = 3.32$ ;  $p = 0.072$ ). The dominant source of variation was the **year factor** (mean: 36.18 t/ha in 2024 vs 18.39 t/ha in 2025).

Table 2. Three-way ANOVA for total yield (3-year)

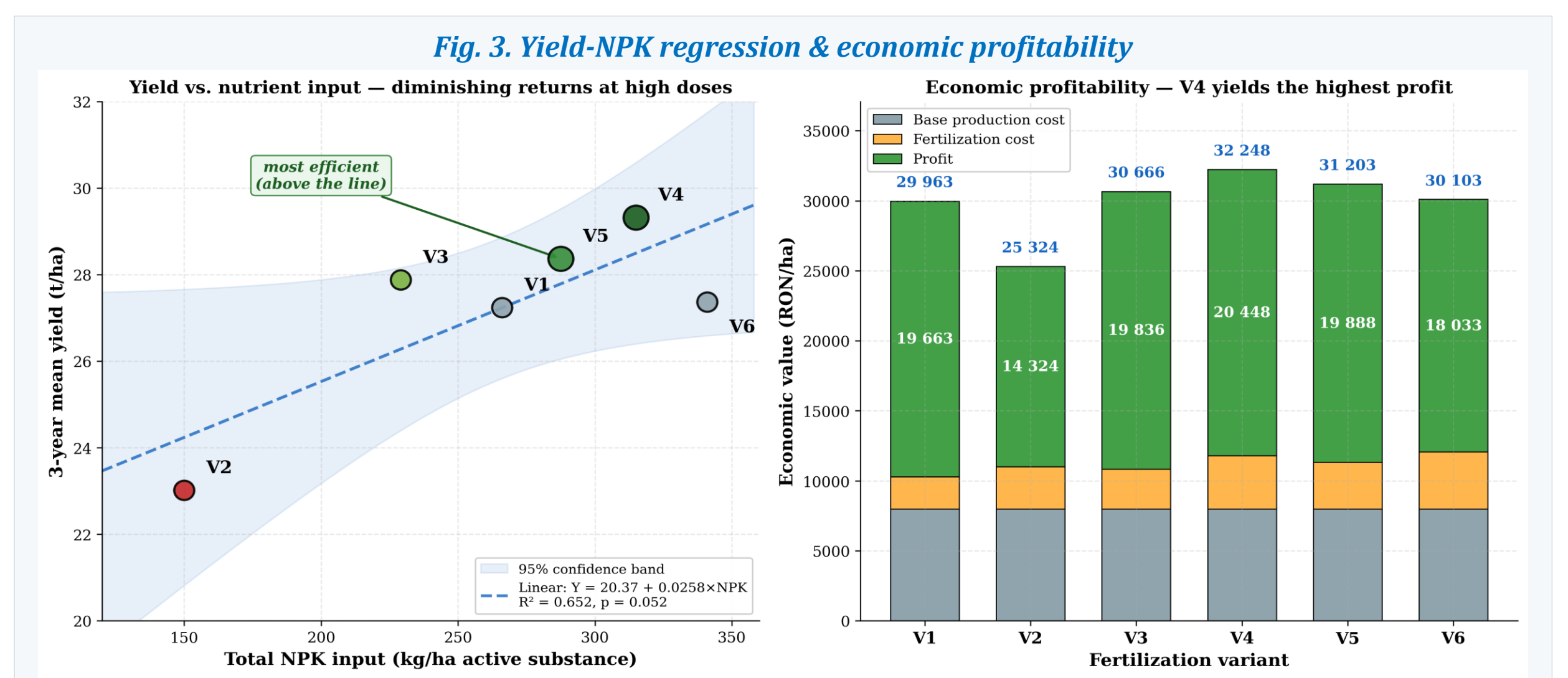
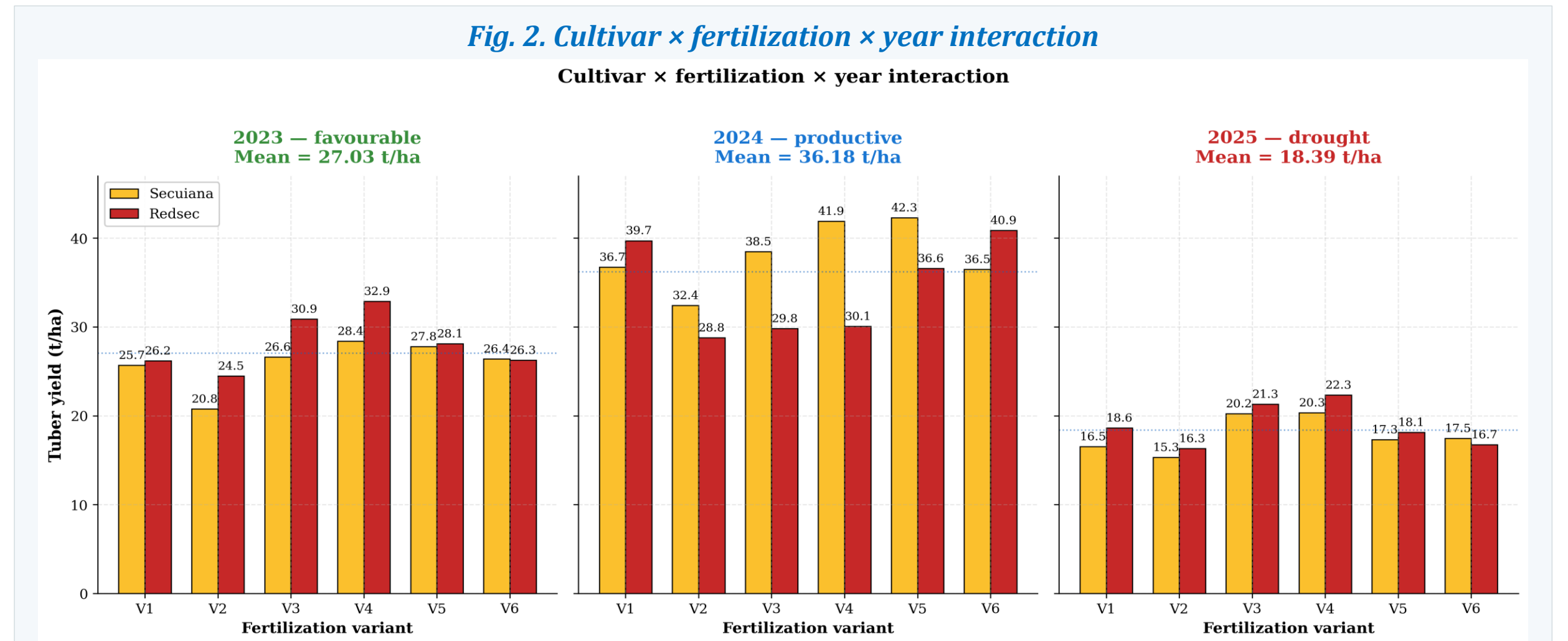
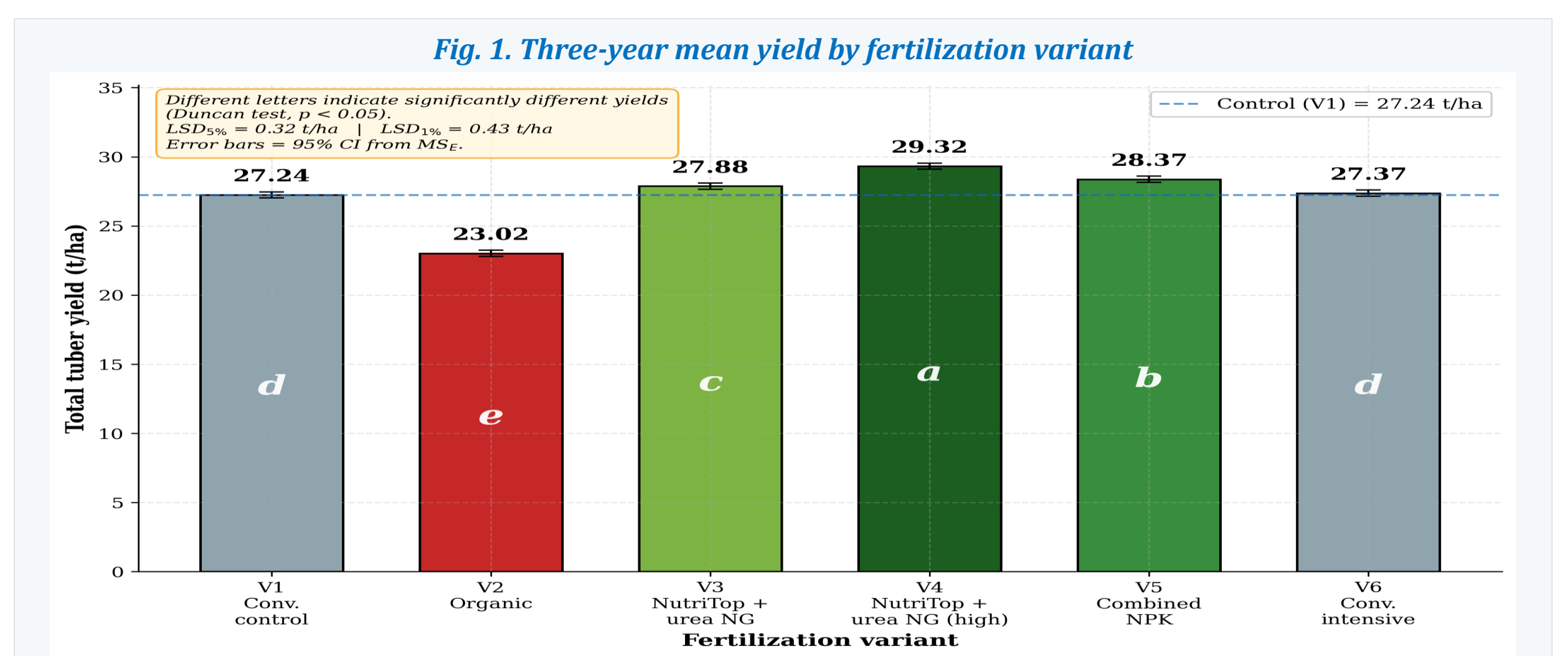
Source	df	F	Sig.
Year (Y)	2	12 048	***
Cultivar (C)	1	3.32	ns
Variant (V)	5	362.4	***
Y $\times$ C	2	376.4	***
C $\times$ V	5	43.8	***
Y $\times$ C $\times$ V	10	126.3	***

\*\*\*:  $p < 0.001$ ; ns: not significant;  $MS_e = 0.236$ ;  $df_e = 72$ .

Table 3. Yield by variant — 3-year mean & Duncan groups

Var.	Mean (t/ha)	$\Delta$ vs V1	% V1	Group
V4	29.32	+2.08	107.6%	a
V5	28.37	+1.13	104.1%	b
V3	27.88	+0.64	102.3%	c
V6	27.37	+0.13	100.5%	d
V1 (Mt.)	27.24	0	100.0%	d
V2	23.02	-4.22	84.5%	e

$LSD_{0.05} = 0.32$  t/ha;  $LSD_{0.01} = 0.43$  t/ha.



**Economic ranking (3-year mean)**

- ★ V4 — 20 448 RON/ha (highest profit)
- ★ V5 — 19 888 RON/ha
- ★ V3 — 19 836 RON/ha
- V1 — 19 663 RON/ha (control)
- V6 — 18 033 RON/ha (high cost)
- ↓ V2 — 14 324 RON/ha (organic, lowest)

## • Conclusions

- Year was the dominant source of variation ( $F = 12\ 048$ ;  $p < 0.001$ ); 2024 produced 36.18 t/ha vs 18.39 t/ha in 2025 (drought).
- V4 (Nutri-Top + urea NG, high) was best on the 3-year mean (29.32 t/ha; group a), followed by V5 and V3. The organic V2 was significantly inferior (–15.5%).
- Cultivar main effect was NOT significant ( $p = 0.072$ ), but  $Y \times C$  interaction was extremely strong ( $F = 376$ ) — Redsec dominated in 2023, Secuiana in 2024.
- Yield-NPK regression was non-linear ( $R^2 = 0.65$ ). V3 and V5 above the line (high NUE); V6 below (diminishing returns).
- Practical: stabilised urea (urea NG) + Nutri-Top fertilizers (V3, V4) provide best balance of productivity, NUE & profitability.

