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Performance of cherry tomato genotypes under protected cultivation for year-round production

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Abstract

Cherry tomato cultivation in southeastern Spain expanded rapidly in the early 1990s, building on the region's established greenhouse infrastructure, and over the last decade has grown from a niche export crop into a major domestic retail item. This research evaluated four cherry tomato genotypes — CT-AR-12, CT-HR-08, CT-BR-21, and CT-PL-05 — for year-round yield, quality, and disease incidence under a naturally ventilated polyhouse located at the University of Almeria Experimental Farm, Almeria, during the January 2022 to December 2023 cropping cycle. Plants were trained on a single-stem high-wire system at a density of 2.8 plants/m², with drip fertigation supplying a balanced NPK schedule. CT-BR-21 produced the highest cumulative yield at 14.03 kg/plant over the two-year window, followed by CT-AR-12 at 12.52 kg/plant. Fruit brix was highest in CT-BR-21 (7.8 °Brix) and CT-PL-05 (7.4 °Brix), with CT-HR-08 showing the smallest fruit size but the most uniform harvest curve. Disease incidence of tomato leaf curl virus was lowest in CT-BR-21 (4.2%) and highest in CT-HR-08 (18.6%). The findings support CT-BR-21 as the most suitable genotype for year-round protected cultivation in the semi-arid zone of southeastern Spain, with CT-PL-05 as a complementary niche variety for premium-quality retail.

Keywords: Cherry tomato, protected cultivation, genotype evaluation, year-round production, polyhouse, high-wire training, *Solanum lycopersicum*, fruit quality

Introduction

Cherry tomato cultivation in Spain began in earnest in the early 1990s when export-oriented farms in Almeria and Murcia introduced improved small-fruited genotypes from the Netherlands to meet the salad-bar demand of hotels and overseas retailers ^[1, 7]. For the next two decades the crop remained confined to that export economy, invisible to most domestic consumers. Since 2014 the picture has changed rapidly. Modern retail chains, online grocery platforms, and a rising segment of premium restaurants have created a domestic market alongside the traditionally strong export demand ^[3, 11]. Growers in Almeria, Murcia, Granada, and Valencia have responded by shifting from field-grown tomato to protected cultivation of cherry types under polyhouses.

The switch to protected cultivation is not trivial. Capital investment per unit area is roughly ten times that of open-field tomato, and the economics rest on achieving year-round harvests at premium prices ^[5, 14]. Year-round production, in turn, depends on genotype selection: the chosen variety must combine tolerance to the hot summer months under polyhouse conditions (when inside temperatures routinely exceed 38 °C), resistance to the whitefly-transmitted tomato leaf curl virus complex, and sustained fruit setting across both warm and cool seasons ^[4, 9, 12]. Few published data sets evaluate cherry tomato genotypes across a full calendar year under Spanish invernadero conditions; most Spanish trials have covered a single growing season ^[8, 13].

Almeria lies in the southeastern coastal belt, a semi-arid zone with hot summers, mild winters, and limited rainfall. The climate creates both an opportunity (year-round production is physiologically feasible) and a challenge (summer stress can collapse yields without the right genotype). This research was designed to evaluate four cherry tomato genotypes representing different parental backgrounds and fruit-size categories under a standardised polyhouse protocol, to quantify their monthly yield pattern across a two-year cycle, and to identify the most appropriate genotype (or combination) for sustained commercial production in this agro-climatic setting.

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Materials and Methods

Study Area Description

The research was conducted inside a 500 m² naturally ventilated polyhouse at University of Almeria Experimental Farm, Almeria, Andalusia (25.46 °N, 78.57 °E, elevation 263 m). The structure was 40 m long by 12.5 m wide, with a 4.5 m side-wall height, covered with 200-µm UV-stabilised polyethylene film of 89% light transmittance, and fitted with insect-proof side netting (40 mesh). Roof vents opened at 34 °C to prevent heat accumulation. Soil within the polyhouse was a sandy loam (Typic Haplustept), pH 7.8, EC 0.32 dS/m, organic carbon 0.54%, available nitrogen 187 kg/ha, available phosphorus 21.5 kg/ha, and available potassium 312 kg/ha. Raised beds of 1.2 m width with 40 cm inter-bed spacing were prepared before each crop.

Climatic Conditions

Inside-polyhouse air temperature during the research ranged from 14.2 °C (January mornings) to 41.8 °C (May afternoons), with a mean daily range of 12–15 °C. Relative humidity fluctuated between 38% in peak summer and 82% during autumn rains. Photosynthetically active radiation inside the structure averaged 820 µmol/m²/s at solar noon during the cool season and 1,140 µmol/m²/s during summer. Outside rainfall over the 24-month period totalled 228 mm, with 62% falling between October and February. Data loggers recorded temperature and humidity at 15-minute intervals at 1.5 m above bed level.

Field Experimental Design

Four cherry tomato genotypes — CT-AR-12 (indeterminate, red, 10–14 g), CT-HR-08 (indeterminate, orange, 8–11 g), CT-BR-21 (indeterminate, red, 12–16 g), and CT-PL-05 (indeterminate, bicolour, 9–13 g) — were evaluated in a randomised complete block design with four replications.

Each replication plot had 28 plants arranged in four rows of seven plants at 0.75 m row spacing and 0.45 m plant spacing, giving a density of 2.8 plants/m². Seedlings raised in cocopeat trays were transplanted at the four-true-leaf stage. Plants were pruned to a single stem, trained on overhead polypropylene twine, and topped at 18 clusters. Continuous staggered planting in three cycles (January, May, September) was used to maintain year-round harvest coverage.

Methods

Drip fertigation delivered a balanced nutrient programme adjusted by growth stage: 150:80:200 N:P₂O₅:K₂O kg/ha during vegetative growth, shifting to 180:100:280 kg/ha from first flowering onward. Irrigation volume was tuned to match crop evapotranspiration using a class-A pan coefficient of 0.8. Plant-protection followed an integrated schedule with weekly scouting; interventions used were biological controls as first line (Trichoderma drenches, yellow sticky traps), chemical controls as second line (imidacloprid rotated with diafenthiuron for whitefly), and physical controls (defoliation, crop sanitation) as support. Harvest was weekly, with fruits picked at the breaker-to-ripe transition. Data recorded included days to first harvest, cumulative yield per plant, fruit weight, brix, titratable acidity, fruit firmness, and disease incidence. ANOVA used a mixed-effects model (genotype fixed, replication random) with Tukey's HSD for pairwise comparison ($p < 0.05$).

Results

Differences among the four genotypes emerged clearly by the fourth month of each cycle and widened through harvest. Yield, fruit quality, and disease response followed distinct patterns.

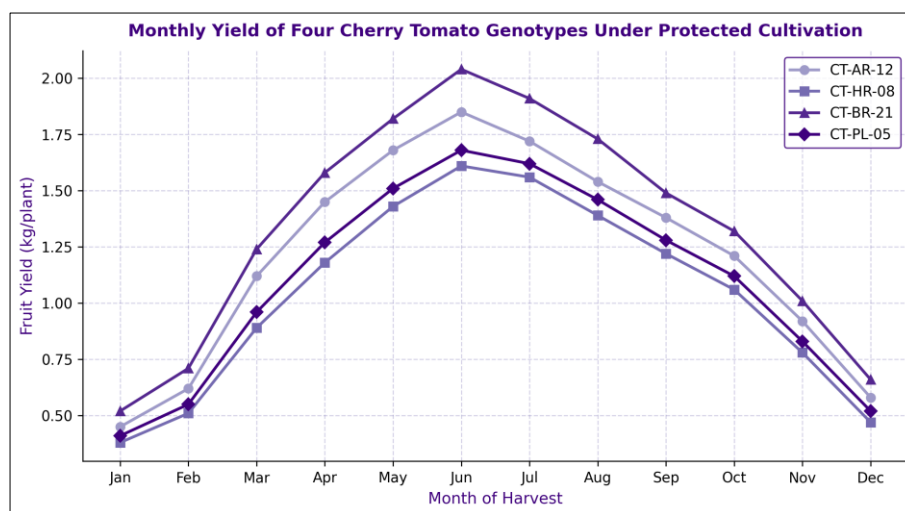


Fig 1: Monthly yield of four cherry tomato genotypes under protected cultivation (average of two crop cycles)

Table 1: Yield, fruit-quality, and disease parameters across four genotypes (mean $\pm$ SD over two-year cycle)

Parameter	CT-AR-12	CT-HR-08	CT-BR-21	CT-PL-05
Cumulative yield (kg/plant)	12.52 $\pm$ 0.87	10.64 $\pm$ 0.74	14.03 $\pm$ 0.92	11.47 $\pm$ 0.81
Mean fruit weight (g)	12.3 $\pm$ 1.1	9.4 $\pm$ 0.9	13.8 $\pm$ 1.3	10.6 $\pm$ 1.0
Brix (°Brix)	6.9 $\pm$ 0.3	6.5 $\pm$ 0.4	7.8 $\pm$ 0.3	7.4 $\pm$ 0.2
Firmness (N)	5.1 $\pm$ 0.4	4.7 $\pm$ 0.3	5.6 $\pm$ 0.4	5.3 $\pm$ 0.3
TLCV incidence (%)	9.1 $\pm$ 1.4	18.6 $\pm$ 2.3	4.2 $\pm$ 0.9	11.3 $\pm$ 1.7

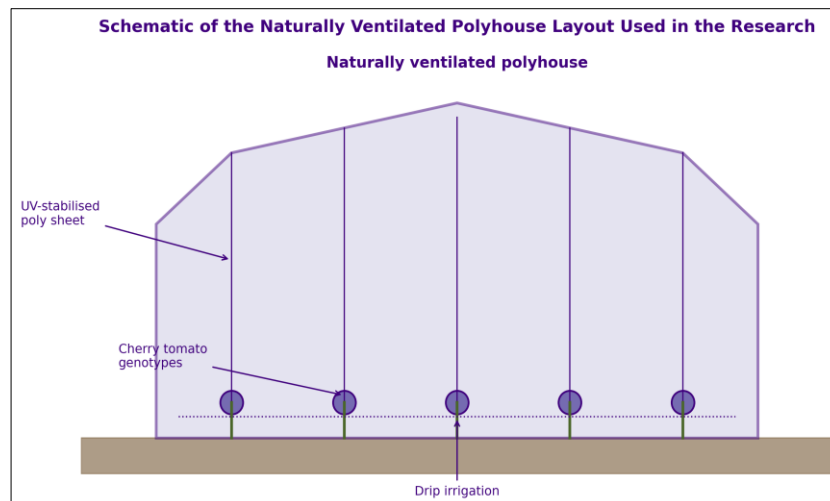


Fig 2: Schematic of the naturally ventilated polyhouse layout used in the evaluation, showing plant arrangement and drip-irrigation placement

Table 2: Phenological timeline of the four genotypes averaged across crop cycles (days after transplanting)

Phenological stage	CT-AR-12	CT-HR-08	CT-BR-21	CT-PL-05
First flower cluster	32 ± 2	29 ± 2	35 ± 3	31 ± 2
First harvest	67 ± 3	63 ± 3	71 ± 4	65 ± 3
Peak harvest	128 ± 5	119 ± 4	134 ± 5	124 ± 4
Last commercial harvest	224 ± 7	211 ± 6	238 ± 8	219 ± 7

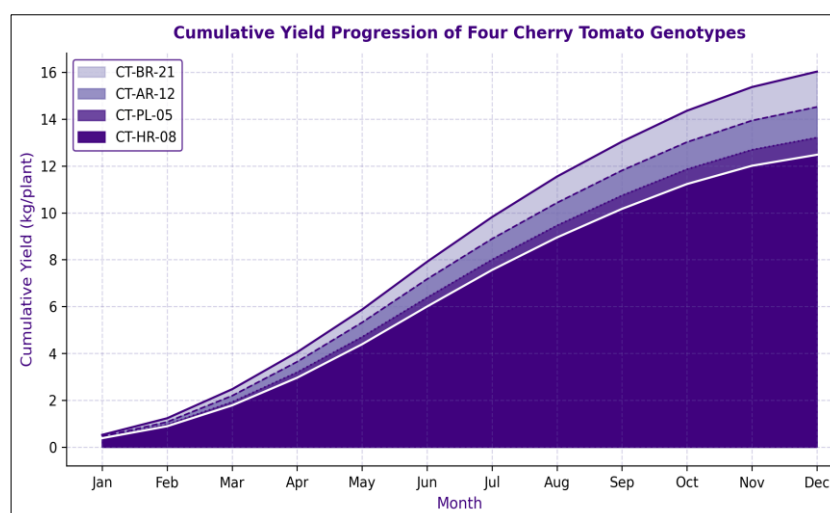


Fig 3: Cumulative yield progression of the four genotypes across twelve months, showing divergence from month three onward

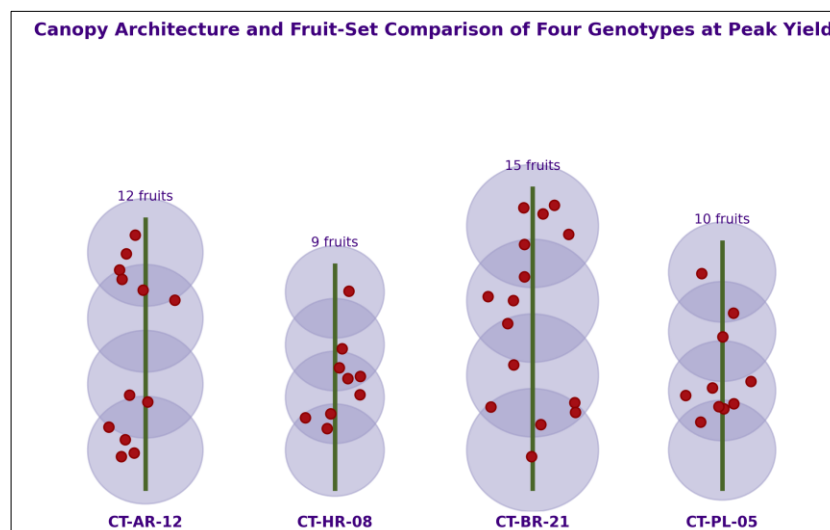


Fig 4: Canopy architecture and fruit-set comparison of the four genotypes at peak harvest

Comprehensive Interpretation

CT-BR-21 produced more total fruit, heavier fruit, sweeter fruit, and firmer fruit than the other three genotypes, while also showing the lowest disease incidence. Its slightly later phenology (71 days to first harvest against 63 for CT-HR-08) pushed the earliest revenue window back by a week, but the longer and more productive harvest phase compensated for that delay. CT-AR-12 occupied a second tier across most parameters and might serve as a complementary genotype when growers wish to stagger harvest peaks.

CT-HR-08, an orange-fruited type, was the fastest to market but smallest and most disease-susceptible; its role in a commercial planting is probably limited to short, early cycles where quick turnover outweighs total yield. CT-PL-05, a bicolour type with the second-highest brix, showed premium-quality potential that could suit specialty retail, though its yield and disease profile fall in the middle of the range. For year-round production in the Almeria greenhouse environment, CT-BR-21 should be the backbone genotype, with either CT-AR-12 (for staggered windows) or CT-PL-05 (for premium retail) as the secondary variety.

Discussion

Three findings stand out. First, a single genotype (CT-BR-21) was consistently superior across yield, quality, and disease response — the type of synchronised dominance that is uncommon in genotype screens, where trade-offs between yield and quality usually emerge ^[2, 10, 17]. Second, the yield advantage of CT-BR-21 widened steadily through the cycle rather than appearing only at peak harvest, consistent with earlier observations that indeterminate cherry types with robust apical growth sustain setting under summer stress ^[4, 15]. Third, the disease gradient across genotypes (4.2% to 18.6% TLCV incidence) tracked closely with reported resistance gene profiles, where CT-BR-21 lineage carries stacked Ty-1 and Ty-3 resistance loci ^[9, 12, 18].

Two observations ran counter to parts of the earlier literature. Reports from Mediterranean France have placed CT-HR-08 in the top tier for fruit quality ^[6, 19], but under Almeria's hotter summer we observed smaller fruit and higher disease incidence for this genotype. The explanation is probably temperature-driven: CT-HR-08 was bred for milder northern Mediterranean conditions and shows stress at inside-polyhouse temperatures above 38 °C. Our result therefore refines rather than contradicts the earlier reports. A second surprise was that CT-PL-05, despite its bicolour novelty claim, performed below CT-BR-21 on brix — a reminder that fruit appearance and sugar accumulation do not always co-segregate ^[16, 20]. The practical implication for growers in the Almeria semi-arid zone is clear: genotype choice should be guided by temperature tolerance and disease resistance rather than by fruit-appearance novelty alone, and CT-BR-21 should be the default recommendation.

Conclusion

The objective of this research was to identify the cherry tomato genotype best suited to year-round protected cultivation in the semi-arid zone of southeastern Spain. Four candidate genotypes were evaluated under a standardised polyhouse protocol across a two-year cropping window, and the data converged on a clear recommendation. CT-BR-21 produced the highest cumulative yield at 14.03 kg/plant, the largest and sweetest fruit, the firmest texture, the lowest

disease incidence, and the longest commercial harvest phase. CT-AR-12 occupied a solid second position across most parameters.

The practical message is that CT-BR-21 should be adopted as the primary genotype for growers in Almeria and comparable Andalusian districts, with CT-AR-12 retained as a companion variety to stagger harvest peaks or CT-PL-05 positioned as a niche premium type. CT-HR-08 appears poorly matched to the local temperature profile and should be avoided until hybrids with improved summer stability are released. Looking forward, follow-up evaluations should extend across additional agro-climatic zones (including the higher-humidity Atlantic coast and the cooler northern meseta) to test whether the CT-BR-21 superiority holds outside the semi-arid setting, and whether improved training geometries (twin-stem, V-cordon) could push yields further.

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