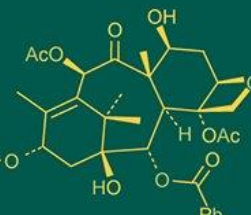
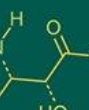
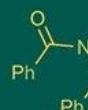


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Comparative performance of seed-propagated and side shoot cutting-propagated F₁ hybrid cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) under protected conditions

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Abstract

Vegetative propagation through side shoot cuttings is an emerging strategy to maintain hybrid vigour in F₁ hybrid vegetable crops without recurring seed costs. The present investigation was conducted to evaluate the comparative performance of side shoot cutting propagated and seed propagated F₁ hybrid cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) plants. Side shoot-propagated plants demonstrated significant earliness across all phenological parameters compared to seed-propagated plants. Yield contributing and yield parameters were statistically non-significant between the two propagation methods, indicating that vegetative propagation does not compromise with fruit yield. These results confirm that side shoot propagation is a viable, cost effective and farmer friendly strategy for sustaining F₁ hybrid vigour and ensuring early, continuous production of cherry tomatoes.

Keywords: Cherry tomato, F₁ hybrid, side shoot cutting, IBA, vegetative propagation, hybrid vigour, earliness

1. Introduction

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) has emerged as a high-value vegetable crop owing to its superior flavour, attractive appearance, high soluble solids and rich nutritional composition. The fruits are characterised by elevated levels of sugars, organic acids, vitamins, minerals and antioxidant compounds such as lycopene and β -carotene, making them increasingly popular for fresh consumption and salad preparation (Figàs *et al.*, 2015; Kabaş *et al.*, 2021) [4, 5]. Under protected cultivation, cherry tomato has gained considerable commercial importance due to its high productivity, extended harvesting period and premium market demand (Pinto and Silva, 2021) [8].

The cultivation of F₁ hybrid cherry tomato varieties has expanded rapidly because of their superior performance in vigour, earliness, and yield. These advantages arise from heterosis, wherein hybrids outperform their parental lines for economically important traits (Birchler *et al.*, 2006) [1]. However, hybrid seed production is costly and seeds harvested from F₁ plants cannot be reused for commercial cultivation due to genetic segregation in subsequent generations. Consequently, farmers must purchase fresh hybrid seed every season, substantially increasing cultivation costs.

Vegetative propagation through side shoot cuttings offers a potential alternative for maintaining the genetic uniformity and hybrid vigour of F₁ plants. In indeterminate tomato hybrids grown under protected conditions, removal of side shoots is a routine cultural practice for canopy management and improved fruit production (Ofori *et al.*, 2022) [6]. These side shoots can be utilised as propagules for raising genetically identical planting material.

Compared with seed propagation, side shoot cutting propagation may reduce seed costs, shorten nursery duration, and enable rapid multiplication of elite hybrid plants. Despite its practical significance, limited information is available regarding the comparative performance of seed-propagated and side shoot cutting-propagated F₁ hybrid cherry tomato under protected cultivation conditions. Therefore, the present investigation was undertaken to evaluate the growth, earliness and yield performance of seed propagated and side shoot cutting propagated F₁ hybrid cherry tomato plants under protected conditions.

2. Materials and Methods

The experiment was conducted at the Department of Vegetable Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, situated in the foothills of the Eastern Himalayas under humid subtropical climatic conditions favourable for protected vegetable cultivation. The experimental material comprised an F_1 hybrid cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) developed through hybridisation between two inbred parental lines, G2 and G7. The hybrid was characterised by an indeterminate growth habit, uniform red fruits borne in clusters, and suitability for extended harvesting under protected conditions. Two propagation methods were evaluated, namely seed propagation and side shoot cutting propagation.

In the seed propagation method, F_1 hybrid seeds were raised in nursery trays under standard nursery management practices and healthy seedlings were transplanted at the appropriate stage. In the side shoot cutting propagation method, healthy and disease-free side shoots measuring 12–15 cm in length were collected from stock plants of the same F_1 hybrid. Basal slant cuts were made using sterilised cutting tools to minimise pathogen contamination. The basal ends of the cuttings were treated with Indole-3-butyric acid (IBA) at 150 ppm for 30 minutes prior to planting. Treated cuttings were planted in root trainers filled with a rooting medium consisting of cocopeat and farmyard manure (1:1) and maintained under intermittent mist conditions to reduce transpiration stress and facilitate rooting. Successfully rooted cuttings with adequate root development were transplanted 28 days after planting.

2.1 Observations recorded

Observations were recorded on growth, earliness, yield-contributing and yield traits, which include plant height, days to first flowering, days to first fruit maturity, days to first harvest, number of clusters per plant, number of fruits

per cluster, fruit length, fruit girth, average fruit weight and fruit yield per plant. Plant height was measured from the stem base to the apical growing point at 120 days after transplanting (DAT). Fruit length and girth were measured using a digital Vernier calliper from five randomly selected fruits per plant, while average fruit weight was determined using five representative fruits. Fruit yield per plant was calculated as the cumulative marketable fruit yield recorded throughout the harvesting period.

2.2 Statistical analysis

The data obtained for all parameters were subjected to Student's t -test using R statistical software (version 4.6.0) to compare the two propagation methods. Differences between treatment means were considered statistically significant at $p \leq 0.05$, and graphical visualisation of the data was performed using box plots generated in R.

3. Results and Discussion

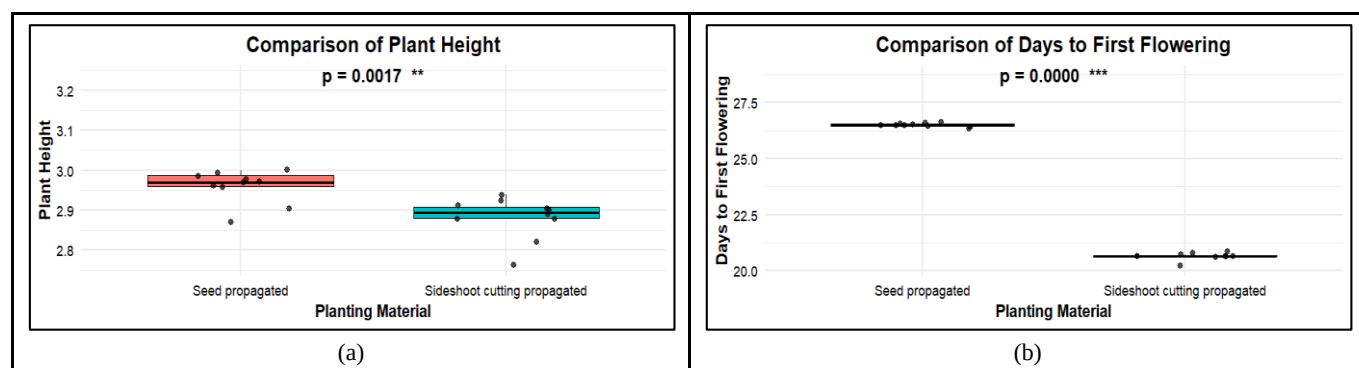
3.1 Growth parameters

Plant height at 120 DAT was 2.96 m in seed-propagated plants and 2.88 m in side shoot-propagated plants, with the difference being statistically significant (Table 1, Fig 1a). The slightly greater plant height in seed-propagated plants may be attributed to the longer juvenile growth phase, during which vegetative vigour is directed toward shoot elongation. Vegetatively propagated plants, having bypassed the seedling stage, may have initiated productive growth earlier, investing less energy in height accumulation. This is consistent with observations in other vegetatively propagated crops, where cuttings-derived plants tend to exhibit more compact yet productive plant architecture (Preece, 2003) [9]. The difference in plant height, though significant, was marginal (0.079 m) and is unlikely to have practical agronomic implications under a trained and supported growing system.

Table 1: Comparative performance of seed-propagated and side shoot cutting-propagated F_1 hybrid cherry tomato plants

Trait	Seed Propagated	Side Shoot Cutting Propagated	t-test
Plant height (m)	2.96	2.88	S
Days to first flowering	26.50	20.63	S
Days to first fruit maturity	61.50	56.25	S
Days to first harvest	68.63	63.00	S
Number of clusters per plant	18.56	21.50	NS
Fruit length (mm)	24.31	23.80	NS
Fruit girth (mm)	22.17	21.77	NS
Fruit weight (g)	11.53	11.52	NS
Number of fruits per cluster	11.49	11.60	S
Fruit yield per plant (kg)	2.47	2.49	NS

S = Significant at $p \leq 0.05$; NS = Non-significant



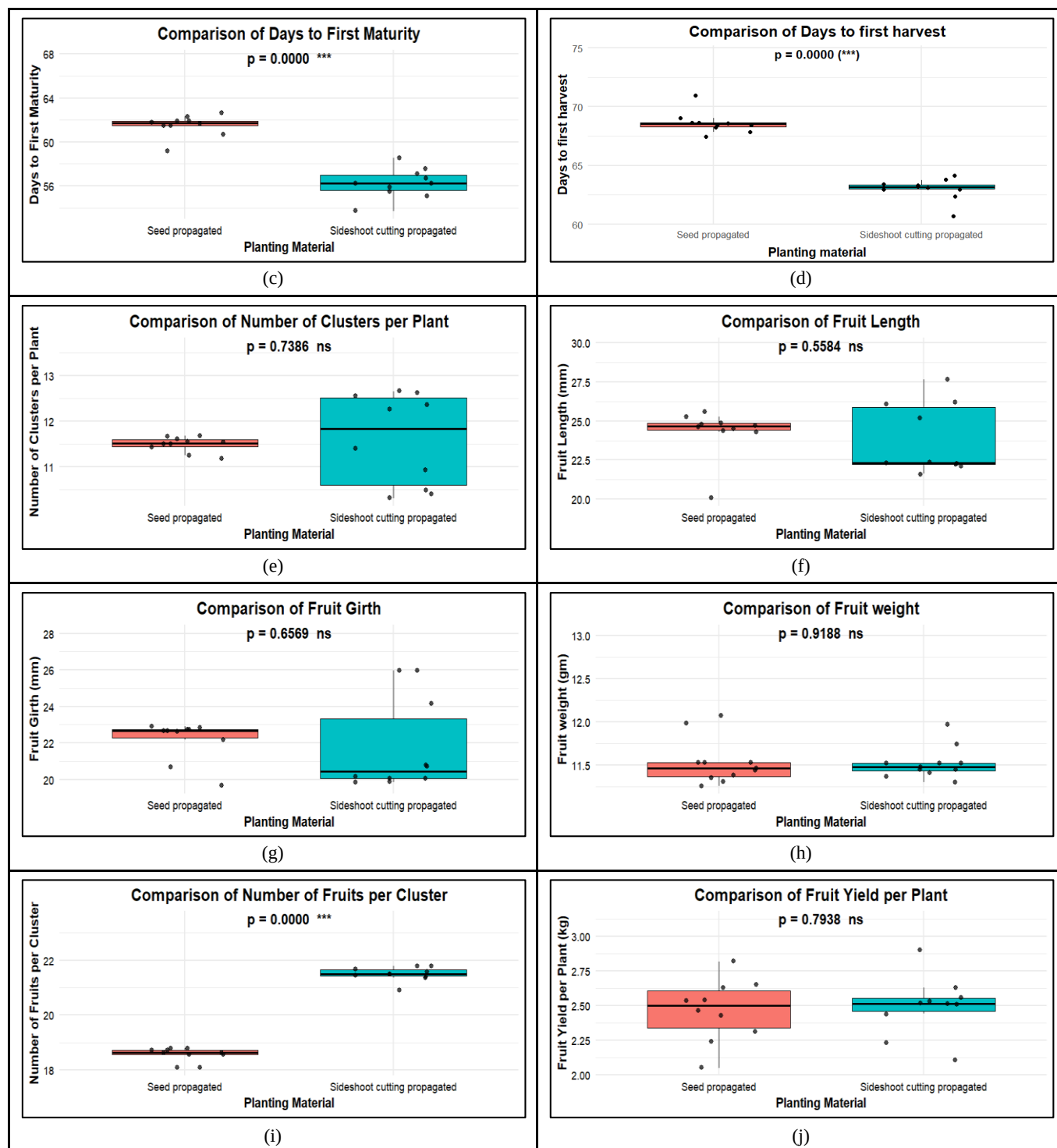


Fig 1: Boxplot showing comparative performance of seed-propagated and side shoot cutting-propagated cherry tomato plants for growth, earliness, yield contributing traits and yield per plant under protected conditions ((a) Plant height, (b) Days to first flowering, (c) Days to first fruit maturity, (d) Days to first harvest, (e) Number of clusters per plant, (f) Fruit length, (g) Fruit girth, (h) Fruit weight, (i) Number of fruits per cluster and (j) Fruit yield per plant.

3.2 Earliness Parameters

Side shoot-propagated plants exhibited significantly earlier first flowering, first fruit maturity, and first harvest compared to seed-propagated plants (Table 1) (Fig. 1b, 1c & 1d). Days to first flowering were 20.63 and 26.5 days in side shoot- and seed-propagated plants, respectively a difference of approximately 6 days. Similarly, first fruit maturity occurred at 56.251 days in side shoot-propagated plants versus 61.5 days in seed-propagated plants, and the first harvest was recorded at 63.002 days compared to 68.628 days.

This pronounced earliness in vegetatively propagated plants is a well-documented phenomenon and can be attributed to the physiological maturity of the cutting material. Side shoots collected from adult, bearing plants retain a degree of ontogenetic ageing (topophysis), possessing more advanced developmental programming than seedlings. Consequently, cuttings-derived plants transition from vegetative to reproductive phase more rapidly. Earlier flowering in vegetatively propagated plants is also attributable to the absence of a seed germination and early seedling establishment phase, during which seed-propagated plants

invest considerable time and energy. Similar findings of enhanced earliness in vegetatively propagated tomatoes have been reported, where stem cutting-propagated tomato plants flowered and fruited earlier than their seed-propagated counterparts. The practical implication of this earliness is significant: an approximately 5 to 6 day advancement in first harvest translates to earlier market entry, potentially commanding better prices, especially in remote markets such as those in Arunachal Pradesh.

3.3 Yield contributing parameters

The number of clusters per plant was 21.5 in side shoot-propagated plants compared to 18.56 in seed-propagated plants, though this difference was not statistically significant (NS). The numerical trend of higher cluster number in side shoot-propagated plants may reflect better canopy management through the four-stem training system, which promotes the development of multiple productive shoots and consequently more fruit-bearing nodes. The non-significant difference may be partly due to high variability within treatments, as cluster number in indeterminate tomatoes is influenced by the duration and conditions of the growing season.

The number of fruits per cluster was significantly higher in side shoot-propagated plants (11.60) compared to seed-propagated plants (11.49). Though the numerical difference is small, its statistical significance suggests that the physiological state of the vegetatively propagated plants particularly their retained hormonal and photosynthetic efficiency may favour better fruit set per cluster. Enhanced fruit set in vegetatively propagated plants could also be related to improved source-sink dynamics in the multi-stemmed training system employed. Similar results were reported, where higher fruit set was observed in vegetatively propagated tomato plants, an outcome attributed to better reproductive efficiency.

Fruit length (side shoot propagated vs. seed propagated) (23.80 vs. 24.31 mm), fruit girth (21.771 vs. 22.171 mm), and average fruit weight (11.521 vs. 11.531 g) were all statistically non-significant between side shoot-and seed-propagated plants (Table 1) (Fig 1f, 1g and 1h). This is a critically important finding from both commercial and scientific perspectives. Fruit quality in tomatoes is governed by genetic factors, showing genetic variation in physicochemical traits, flavor attributes, and firm texture (Causse *et al.*, 2003) [2]. Since vegetative propagation preserves the genetic integrity of the hybrid without alteration of the heterozygous genotype (Pence *et al.*, 2024) [7], the fruit quality traits remain identical between the two propagation methods. This confirms that side shoot propagation is a true-to-type propagation method that faithfully reproduces the parental hybrid characteristics, as postulated by Richharia (1962). Similar results were reported by Fernandes *et al.* (2007) [3], who found that fruit size and quality parameters were not significantly affected by propagation method in hybrid tomato.

The fruit weight of approximately 11.5 g in both treatments falls within the characteristic range for cherry tomato (<20 g) within the characteristic range for cherry tomatoes (Schouten *et al.*, 2019) [10], confirming the typical cherry tomato phenotype of the hybrid.

3.3.3 Fruit Yield Per Plant

Fruit yield per plant was 2.493 kg in side shoot-propagated plants and 2.467 kg in seed-propagated plants, with no

statistically significant difference (Fig 1j). This equivalence in yield is a key finding of the study; it demonstrates that vegetative propagation through side shoot cuttings does not compromise the yield potential of the F₁ hybrid. Given that the hybrid vigour is genetically preserved through vegetative reproduction, the comparable yield is expected. The marginal numerical superiority of side shoot-propagated plants in yield per plant, though not significant, is consistent with the slightly higher cluster number and fruits per cluster observed in these plants. These results align with those of Fernandes *et al.* (2007) [3], who found that vegetatively propagated tomato plants maintained yield parity with seed-propagated controls over successive cultivations.

4. Conclusion

The present investigation conclusively demonstrates that side shoot cutting-propagated F₁ hybrid cherry tomato plants perform comparably to, and in several parameters superior to, seed-propagated plants. Vegetative propagation through side shoot cuttings treated with IBA at 150 ppm in a cocopeat + FYM (1:1) rooting medium conferred significant advantages in earliness without any compromise in fruit yield per plant. The equivalence of fruit length, girth, weight and yield between the two propagation methods confirms that the method faithfully preserves hybrid vigour and genetic integrity. Given the high cost and seasonal unavailability of F₁ hybrid cherry tomato seeds, particularly in remote regions, side shoot propagation represents a scientifically validated, cost-effective and farmer accessible strategy for self reliant planting material production.

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