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Evaluation of tomato hybrid Arka Abhed against multiple disease resistance in Nizamabad District

¹Bandaru Venkata Rajkumar, ²P Vijay Kumar, ³M Swetha, ⁴M Suresh and ⁵S Naveen Kumar

¹Scientist (Crop Production), Telangana Rythu Vigyan Kendra, Warangal, Telangana, India

²Subject Matter Specialist (Plant Protection), KVK, Nizamabad (Rudrur), Telangana, India

³Assistant Professor (Agril. Extension), Dr. BJR Agricultural College, Siricilla, Telangana, India

⁴Dr. M. Suresh, Subject Matter Specialist (Soil Science), KVK, Adilabad, Telangana, India

⁵Associate Dean, Agricultural College, Nizamabad, Telangana, India

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Corresponding Author: Bandaru Venkata Rajkumar

Abstract

Tomato (*Solanum lycopersicum* L.) cultivation during the Vanakalam (Rainy) season in the region is severely constrained by biotic stresses, primarily Early Blight and Tomato Leaf Curl Disease (ToLCD), leading to increased input costs from repeated chemical applications. An On-Farm Trial (OFT) was conducted across two consecutive years (2022 and 2023) to assess the performance of the multiple disease-resistant hybrid Arka Abhed against popular commercial private hybrids (Shivam, US-440). Results indicated that Arka Abhed recorded an average yield of 702.50 q/ha, marginally higher than the check hybrids at 678.59 q/ha (a 3.52% increase). Crucially, Arka Abhed exhibited significant economic superiority. Its disease resistance resulted in a (-) 9.89% reduction in the cost of cultivation due to fewer pesticide sprays, leading to Net Returns of Rs.2,27,175 per ha, a (+) 14.06% increase over the check. The hybrid demonstrated a superior Benefit-Cost (B:C) ratio of 2.60:1 compared to 2.26:1 for the farmer's practice. Furthermore, the low Technology Index (6.33%) confirms the high feasibility of technology adoption. This study concludes that Arka Abhed is a stable, high-yielding, and environmentally prudent alternative for profitable rainy season tomato cultivation.

Keywords: Tomato, early blight disease, resistant hybrid, Arka Abhed

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetable crops grown almost throughout the world including tropical and temperate regions. It is cultivated both in the green houses under protective structures as well as under natural conditions. It is consumed fresh as salad, used in culinary preparations and processed in to various forms viz. Ketchup sauces, puree, paste, powder, juice, soup, chutney etc. It is inseparable with fast foods such as pizza, burger, noodles etc. will not taste the same without addition of tomato sauces. Tomato is a rich source of vitamins A and C and is referred to as "poor man's orange". Tomato is a very good appetizer and its soup is said to be a good remedy for patients suffering from constipation. Lycopene that imparts red colour to ripe tomatoes is reported to possess anticancerous properties. It also serve as a natural antioxidant as the Beta-carotene functions to help prevent and neutralize free radical chain reaction and ascorbic acid is an effective scavenger of superoxide, hydrogen peroxide, singlet oxygen and other free radicals (Dhaliwal, 2014) [2].

Tomato cultivation in India is consistently challenged by pervasive biotic stresses, leading to substantial yield losses and necessitating intensive chemical management. Insect pests like Tuta absoluta, fungal diseases such as Early Blight

and Late Blight, and viral diseases, most notably Tomato Leaf Curl Virus Disease (ToLCVD), caused by whitefly-transmitted begomoviruses. Early and late blight diseases causing an incidence of 49-91% in conducive conditions (Azam and Shah, 2003) [1]. Traditional commercial hybrids cultivated by farmers often display high susceptibility, leading to elevated production costs due to prophylactic and curative chemical spray regimes. According to an estimate, there could be yield losses to an upward of 85- 90% (Ravuri and Kumar, 2018) [8] due early and late blight diseases with farmers relying upon repeated fungicidal sprays to control the disease. Fungicides have such adverse effects as environment pollution, and they are not able to control blights under some conditions that favour heavy disease pressure (Ko, 1994) [4]. Host resistance comes into limelight under these circumstances which reduces the disease incidence thereby reduces cost of cultivation to the farmers. Mukalazi *et al.*, (2001) [6] reported that host resistance is an important element in late blight management due to its long-term economic benefits for small-scale farmers and decreasing the likelihood of the development of fungicide resistance.

In the view of the above problem identified by the scientists of KVK, Nizamabad (Rudrur) assessed the performance of tomato hybrid Arka Abhed during Kharif Seasons of 2022 and

2023.

Materials and Methodology

Krishi Vigyan Kendra, Nizamabad (Rudrur) conducted On Farm Trial (OFT) on tomato hybrid 'Arka Abhed' during *Kharif, 2021 and 2022* at 6 locations in KVK adopted village shankora and compared against private hybrid US-440.

Arka Abhed (IIHR H-397) is a multiple disease resistance variety developed by the Indian Institute of Horticultural Research (IIHR) designed to address these combined threats by employing pyramided resistance genes, possessing resistance to ToLCV (utilizing Ty2+Ty3 genes), Bacterial Wilt, Early Blight, and Late Blight (utilizing Ph2+Ph3 genes). It is a semi-determinate hybrid yielding between 70

and 75 t/ha over a 140 to 150-day cycle, making it suitable for cultivation across the summer, *Kharif*, and *Rabi* seasons. Data on early blight incidence was collected from vegetative stage to fruiting stage in all the locations. Observations were recorded on appearance of diseases, disease severity and fruit yield per plot. The data on disease severity was recorded before spray as initial, 10 days after the spray. The severity of early blight was recorded on 10 plants were selected at randomly in each replication of the treatment. Mean severity percent was calculated based on limits depending upon visual symptoms given in the following Table.

Rating scale for assessment of early blight disease (Mayee and Datar, 1986) ^[5]

Grade	Description of the symptoms
0	No symptoms on the leaf
1	0-5 per cent leaf area infected and covered by spot on leaf
2	6-20 per cent leaf area infected and covered by spot, some spots on petiole
3	21-40 per cent leaf area infected and covered by spot, spots also seen on petiole, branches
4	41-70 per cent leaf area infected and covered by spot, spots also seen on petiole, braches, stem
5	>71 per cent leaf area infected and covered by spot, spots also seen on petiole, branch, stem, fruits

Percent disease index (PDI) was calculated by using the formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of numerical values}}{\text{Number of leaves observed}} \times \frac{100}{\text{Maximum disease rating value}}$$

A technology index was prepared to test technical feasibility due to implementation of the trial in tomato. To estimate the technology gap, extension gap and technology index the following formula was used given by Samui *et al.*, (2000) ^[11], Sagar and Chandra (2004) ^[10].

$$\text{Per cent increase in yield} = \left\{ \frac{\text{Demonstration yield} - \text{Farmers practice yield}}{\text{Farmers practice yield}} \right\} \times 100$$

$$\text{Technology Gap} = P_i (\text{Potential Yield}) - D_i (\text{Demonstration Yield})$$

$$\text{Extension Gap} = D_i (\text{Demonstration Yield}) - F_i (\text{Farmers yield})$$

$$\text{Technology index} = \left\{ \frac{\text{Potential Yield} - \text{Demonstration yield}}{\text{potential yield}} \right\} \times 100$$

Table 1: Particulars showing the details of tomato cultivation under existing farmer practices and through on-farm trails

S. No.	Particulars	Existing practices	Improved practices demonstrated through on-farm trail
1	Variety/Hybrids	F1 hybrid i.e. US-440	Arka Abedh (Multiple disease resistant) from ICAR –IIHR, Bengaluru
2	Raising of seedlings	Broadcasting of seed on Raised bed	Raised in protrays filled with media
3	Fertilizer application	Imbalanced fertilizer Application i.e. Application of Urea, DAP	Recommended Dose of Fertilizers (RDF) FYM @ 15 tonnes/ha, N:P:K@ 120:60:60 Kg/ha
4	Intercultural operations	Stalking followed	Stalking followed
5	Diseases and Pest management	4-5 times of fungicides to control early blight and 3 sprays for controlling leaf curl	Hybrid is multiple and triple disease resistant, farmers could reduce 2-3 spray applications.

Results and Discussion

A. Early blight incidence

Data on early blight incidence (Table. 2) was collected from vegetative stage to fruiting stage in both hybrid and private check in all the locations. There is significant difference among tomato hybrid Arka Abhed and private check with respect to early blight incidence during all growth stages. During vegetative stage of the crop, early blight incidence was not observed in tomato hybrid Arka Abhed whereas in private hybrid 25% of lower leaves are damaged due to early blight disease. During flowering stage, 2.5% of early blight incidence was observed in Arka Abhed whereas in private hybrid 55% early blight incidence was observed. During this stage about 75% of leaf area was blighted in private hybrid.

During fruiting stage 40% of early blight incidence was observed in private hybrid, whereas in Arka Abhed 3.5% of early blight incidence was observed. This might be attributed to high disease pressure and favourable environmental conditions for spread of the disease.

Table 2: Mean disease severity per cent recorded at vegetative, flowering and fruiting stage

Treatment	Per cent Disease Index		
	Vegetative stage (30 DAP)	Flowering stage (60 DAP)	Fruiting stage (90 DAP)
Arka Abhed	6	12	14
US-440 (Check)	34	46	50

Yield Performance and Stability in Biotic Stress Environments

The pooled mean yield of Arka Abhed (702.50 q/ha) showed a modest but statistically relevant 3.52% increase over the

farmer’s check (678.59 q/ha) (Table 3). However, a high-level interpretation of the year-wise data reveals yield stability.

Table 3: Productivity, technology gap, extension gap and technology index

Year	Yield (q ha ⁻¹)			% Increase in yield	Technology gap (q ha ⁻¹)	Extension gap (q ha ⁻¹)	Technology index (%)
	Potential	Arka Abhed	US-440				
2022	750	730.00	713.00	+2.38	20.00	17.00	2.67
2023	750	675.00	644.17	+4.78	75.0	30.83	10.00
Average	750	702.50	678.59	+3.52	47.50	23.91	6.33

In 2023, where overall yields were lower, more likely due to higher disease pressure or adverse weather typical of the Vanakalam season, the yield gap widened, and Arka Abhed maintained a stronger yield advantage (+4.78%) compared to 2022 (+2.38%). This difference confirms the hybrid’s role as a biotic stress buffer, translating its genetic resistance into tangible yield protection under challenging conditions, a finding consistent with other evaluations of disease-resistant

Arka hybrids (Murthy and Kameswari, 2024; Ravuri *et al.*, 2021) [7, 9].

Demonstration of Disease Resistance and Economic Returns

The core strength of the Arka Abhed technology is its economic efficiency, directly stemming from its disease resistance.

Table 4: Economic Metrics (Mean)

Parameter	Treatment Arka Abhed	Private Hybrid US-440	% Change / Deviation
Cost of Cultivation (Rs/ha)	1,42,325	1,57,950	-9.89%
Net Returns (Rs/ha)	2,27,175	1,99,167	+14.06%
B:C Ratio	2.60	2.26	-

The 9.89% reduction in cost of cultivation for Arka Abhed is the most significant finding, validating the farmer feedback that the hybrid was "less prone to disease and pest incidence, saving him the cost towards chemical sprays." This reduction is a direct demonstration of the value of the ToLCV (Ty2+Ty3) and Early Blight resistance genes, minimizing the need for expensive and frequent plant protection measures.

Technological Adoption and Feasibility (Technological Aspects)

To assess the potential for widespread adoption, the technology was evaluated using the Technology Index (TI)

(Murthy and Kameswari, 2024) [7]. The low Technology Index (6.33%) is a strong technological indicator and demonstrates that the improved technology performs close to its maximum potential under actual field conditions. This suggests minimal constraints during technology transfer, confirming Arka Abhed’s high adaptability to the micro-farming situation and high potential for successful horizontal spread. The calculated Extension Gap of 23.91 q/ha further reinforces the need for extension efforts to motivate farmers to switch to this superior, stress-resilient hybrid.

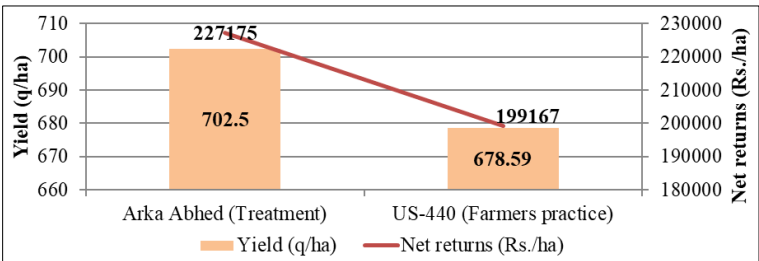


Fig 1: Bio-Economic Performance: Yield vs. Profitability (2022-2023)

While the increase in yield (represented by bars) is marginal, the increase in Net Returns (represented by the second axis line) is steep. This shows that profitability is driven by cost minimization through resistance, not just yield maximization. The resulting B:C ratio of 2.60 is highly competitive and proves the hybrid’s financial viability under high-risk rainy season conditions.

Conclusion

Arka Abhed demonstrated superior performance in farmers' fields in Nizamabad district, exhibiting excellent fruit

quality, extended crop duration, and high yield potential. The hybrid displayed strong resistance to early blight under the local field conditions of Nizamabad, which are highly conducive to early and late blight incidence during the rainy season. By effectively managing early blight from the 10th day after transplanting through the flowering stage, farmers can maximize productivity and economic returns.

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