Performance of Tomato Hybrids Arka Abhed and Arka Samrat in Visakhapatnam District of Andhra Pradesh, India

ABSTRACT

The farmers of Visakhapatnam district were in a great need of best performing and high yielding tomato variety as the existing varieties are less yielders and highly succumb to pests and diseases. An On-Farm Trial (OFT) for three consecutive years (2020-21, 2021-22) was conducted by ICAR-ANGRAU, Krishi Vigyan Kendra, Kondempudi directly in the farmers' fields of five selected villages viz. Bangurumeta, Adduru, Thotakurapalem, Pottidorapalem, Jaithavaram and Chedikada in Visakhapatnam district of Andhra Pradesh to evaluate the performance of two very promising tomato hybrids viz. Arka Abhed and Arka Samrat with regard to yield and economic analysis *vis a vis* the farmers' practice variety Laxmi. A total of twenty-five farmers actively participated in the OFT

covering an area of 7.5 acres. As regards fruit yield, the tomato hybrid Arka Abhed proved to be the best followed by Arka Samrat and Laxmi hybrid for all the three years of the study with fruit yields of 587.32, 569.13 and 409.14 q/ha, respectively. During the years of the trial, the fruit yields of Arka Abhed and Arka Samrat improved from 27.44 to 30.33% and 24.57 to 28.11%, respectively. Average cost-benefit ratios for three years for Arka Abhed, Arka Samrat and Laxmi hybrid were 1:2.30, 1:2.16 and 1:1.58, respectively. The Extension gap was between 111.18 to 183.86 and 129.08 to 202.83 q/ha for Arka Samrat and Arka Abhed, respectively. Results on Technology Index viz. 15.25, 19.47 and 28.83% for Laxmi (farmers' practice), Arka Abhed and Arka Samrat, respectively, revealed that for both the tomato hybrids, there is viability of the demonstrated technology in the area of the OFT viz. Visakhapatnam district and the surrounding areas of north coastal Andhra Pradesh.

Keywords: Extension gap; on farm trials and promising variety.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.), a member of the Solanaceae family and it is an important source of lipid-soluble antioxidants in the human diet because of their relatively high content of carotenoids. Lycopene presence in plasma in tomato is valued for its anti-cancer property (Bose et al. 2002). At present India ranks second in area next to China by producing 19.37 million tonnes of tomato from an area of 0.78 million ha. However, in terms of productivity, India (25 t ha-1) stands in tenth position (FAOSTAT, 2020). Whereas India is the fourth largest tomato producer in the world after China, USA and Turkey, accounting for about 6.5% of the world tomato production (Bose et al. 2002). Tomato is grown extensively throughout India including Andhra Pradesh, where the total area under the crop is 8.31 lakh ha (NHB, 2021-22). Among the Indian states, Andhra Pradesh with a total and per ha average yield of 203.12 tones and 24.42 q is the third largest producer of tomato, behind only Madhya Pradesh and Karnataka.

The fruits of the crop are in high demand for both fresh market needs and post-harvest processing by the food processing industries. Tomato regarded as a 'protective food' is a significant source of antioxidants, lycopene, vitamin C, and vitamin A. Though tomato is primarily a warm season crop, it is grown in cool climate too (10^0 C to 30^0 C, optimum being 21-24^0 C). Frost and high levels of humidity prove damaging for the crop. The intensity of the light affects fruit colour, fruit set, and pigmentation. There is thus much to modulate these factors for a higher yield and larger profit [1] and [2].

Tomato is grown over extensive areas in North coastal Andhra Pradesh including Visakhapatnam district where the climate and soil are ideal for the crop. However, yields are poor due to susceptibility of local hybrids with several diseases resulting in high pesticide usage [3] and also lacking knowledge among the tomato growers regarding the selection of the high yielding and multiple disease resistant varieties, proper seed treatment, nursery raising, Integrated Nutrient Management (INM), and plant protection measures. It is imperative to advise the tomato growers for high yielding cultivars and hybrids, and demonstrate the right technology for a higher yield and net money return right in their own fields and through their own hands. However, before such recommendation, it is pertinent to evaluate the cultivars with emphasis on the aspect of phenotypic and genotypic suitability and yield, more so because varietal performance of tomato varies from place to place due to varied climatic conditions. In the light of all such aspects, an on-farm trial (OFT) was undertaken in farmers' fields of selected villages by ICAR- ANGRAU, Krishi Vigyan Kendra, Kondempudi located in Viskhapatnam district of north coastal Andhra Pradesh with the principal objective of varietal assessment of high yielding tomato hybrids for ascertaining and recommending the cultivars best suited for the region. There were twenty-five participant farmers selected from six villages viz. Bangurumeta, Adduru, Thotakurapalem, Pottidorapalem, Jaithavarm and Chedikada. The field area was 7.5 acres and the tomato hybrid varieties were multiple disease resistant Arka Abhed and triple disease resistant Arka Samrat (released by IIHR, Bengaluru). The OFTs were conducted in a very systematic way for three consecutive (2020-21, 2021-22 and 2022-23) to assess the performance of the cultivars with improved practices and convince the farmers for adopting improved farming practices for enhancing their economic livelihood.

2. MATERIALS AND METHODS

Before conducting the field trial, the list of the participant farmers was prepared very meticulously. A number of group meetings were conducted and those evincing keen interest were picked up from the lot followed by imparting required specific skill training to such selected farmers. The skill training focused on the selection of quality of seeds, seed treatment, fertilizer schedule and nutrient management, irrigation schedule, plant protection measures, and fruit picking at right stage and right time. Soil pH, electrical conductivity, and available potassium were determined by following standard methods [4]. Available nitrogen and phosphorus were determined by alkaline permanganate method [5] and colorimetric method [6], respectively. Tomato hybrids of Arka Abhed and Arka Samrat, and Laxmi (farmers' practice and reference check) were selected as treatments for assessing the yield and economic analysis. Due to small seed size and high cost, the seeds were sown in pro trays for ensuring better germination and 25-day old seedlings were transplanted in the main field during the month of October of the years at a spacing of 90 x 60 cm. The spacing so used facilitated easy weeding operation with power weeder for reducing the cost of labour. Seed treatment for preventing fungal diseases was done with metalaxyl @ 3 g/kg of seed. The fields received FYM @ 6 tonnes/acre well before the sowing time. N, P and K @ 48, 24 and 24 kg/acre were applied through commercial fertilizers. Besides, 10 kg of Borax and 10 kg of Zinc sulphate/acre were applied for preventing fruit cracking. Planofix @ 1ml/4 liter was applied as a foliar spray for prevention of fruit drop. Plants were irrigated by drip system. At maturity stage, picking was done at five days interval. Performance and yields of Arka Abhed (multiple disease resistant) and Arka Samrat (triple disease resistant) were compared against Laxmi (farmers' practice and reference check). The extension parameters such as Extension Gap, Technology Gap, and Technology Index were calculated by formulae suggested by (Suthar et al. 2016) and [7] to study the impact of front-line demonstrations over the selected farmers.

Technology gap = Potential yield - Demonstrated yield

Extension gap = Demonstrated yield - Yield under existing practice

$$\text{Technology Index} = \frac{\text{Potential yield} - \text{Demonstrated yield}}{\text{Potential yield}} \times 100$$

3. RESULTS AND DISCUSSION

Chemical characteristics of the soils from the chosen OFT farmers included Soil reaction (pH) of 6.47, Electrical Conductivity (dsm-1) of 0.05, Available N (kg ha-1) 176.42, Available P (kg ha-1) 24.75, and Available K (kg ha-1) 89.72, which indicated that the soils were suitable for tomato crop cultivation. As contrast to the Available N (kg ha-1), Available P (kg ha-1), Moreover, the available P (kg ha-1) ranges were low, medium, and low, respectively.

Results on fruit yield (Table 1 and Fig. 1) revealed that the yield of all the three treatments increased steadily over the three years of study. All the three varieties recorded the highest yield in 2022-23 (409.14, 569.13 and 587.32 q/ha for Laxmi, Arka Samrat and Arka Abhed, respectively). Per cent increase in fruit yields over the farmers' practice (Laxmi) were 27.44, 26.47 and 30.33 for Arka Abhed, and 24.57, 21.93 and 28.11 during 2020-21, 2021-22 and 2022-23, respectively. Which could be the Arka samrat and Arka abhed having triple resistant (Early leaf blight, Bacterial blight and leaf curl) and multiple resistant (Early leaf blight, late leaf blight, bacterial blight and leaf curl) respectively. Similar results were reported by Mishra et al. [8], Kale et al. [7], Surendra et al. [9] and Prasanna Lakshmi et al. (2021). The results revealed the positive effects of Arka Abhed and Arka Samrat over the existing farmers' practice in Visakhapatnam district of Andhra Pradesh.

The Extension Gap with Arka Abhed and Arka Samrat ranged between 129.08 to 202.05 and 111.18 to 183.86 q/ha during the three years of the study (Table 2 and Fig. 6). There is thus need to educate the farmers for the adoption of improved varieties along with modern technology through various extension methodologies viz. front-line demonstrations, cluster frontline demonstrations, field days and convergence meeting with line departments. The trend of Technology Gap gradually decreased in all the three tomato hybrids during the three years of study. The Technology Gap with Arka Abhed and Arka Samrat ranged from 254.6 to 367.68 and 382.5 to 265.87 q/ha which reflected that the OFFT farmers implemented the practices of the demonstration fields with encouraging results in all subsequent years. Similar findings were also

recorded by Kale et al. [7], Singh et al. [10] and Chapke [11].

Technologies Index results (Table 2 and Fig. 7) revealed that there was decrease in the parameter from 2020-21 to 2022-23. The lower the value of Technology Index, the more is the feasibility of the technology. As such the reduction in Technology Index with Arka Abhed was from 35.11% during 2020-21 to 18.99% during 2022-23, while with Arka Samrat, it was from 45.80% during 2020-21 to 31.84% during 2022-23. The results make it amply clear for the feasibility of the demonstrated technology in this region for improving the yield of tomato. Similar results were reported by Kale et al. [7], Katare et al. [12], Keshavareddy et al. [13] and Dayanand [14] in mustard.

The outcomes of the economic analysis and benefit-cost (B:C) ratio of Arka Abhed and Arka Samrat over the farmers' practice are shown in Table 2 and Fig. 5. Economic variables, such as the cost of cultivation, net return, and B:C ratio were calculated to determine the demonstration technologies' economic viability relative to the control (farmers' practice, check). Based on current input and output cost prices, the economic viability of upgraded technology was estimated and represented in terms of the B:C ratio. The expense of cultivation rose steadily (Fig. 3). In comparison to farmers' practice/check (Laxmi) demonstration plots, Arka Abhed and Arka Samrat had more expensive costs of cultivation which might be due to increased costs of inputs and higher labour wages. The higher costs of the demonstration plots were mostly due to the implementation of a trellis system, more vigorous and indeterminate growth characteristics, and greater harvest pickings. A similar results was reported by Sahoo et al. [15] The cost per hectare for the cultivation of Arka Abhed in the demonstration plots ranged from Rs. 1,15,462 in 2020–21 to Rs. 1,38,288 in 2022–23. For Akra Samrat, the cost of cultivation ranged from Rs 1,15,462/ha in 2020–21 to Rs 1,38,288/ha in 2022–23. The net return too increased steadily in the demonstration plots ranged from Rs 2, 60,858/ha during 2020-21 and Rs 2, 86,808/ha during 2022-23 (Arka Abhed). The net returns were substantially higher in the demonstration plots over the control with farmers' practice plots (Fig. 4). The results corroborate those Kale et al. [7], Mokidue et al. [16] and Keshava reddy et al. [13]. Cost benefit ratio was higher in the demonstration plots against farmers' practice in all the three years of study (Table 2 and Fig. 5).

Cultivation of tomato following recommended technology shall definitely bridge the Technology Gap, thus leading to increased productivity of tomato in the region which in turn shall contribute to the rise in economic condition of the tomato growers of the region. Furthermore, extension agencies in the region need to provide proper technical knowledge and knowhow and support the tomato growers of the region through different educational and extension methods to plug the Extension Gap towards reaping higher tomato production in coupled with greater net economic return from cultivation [17].

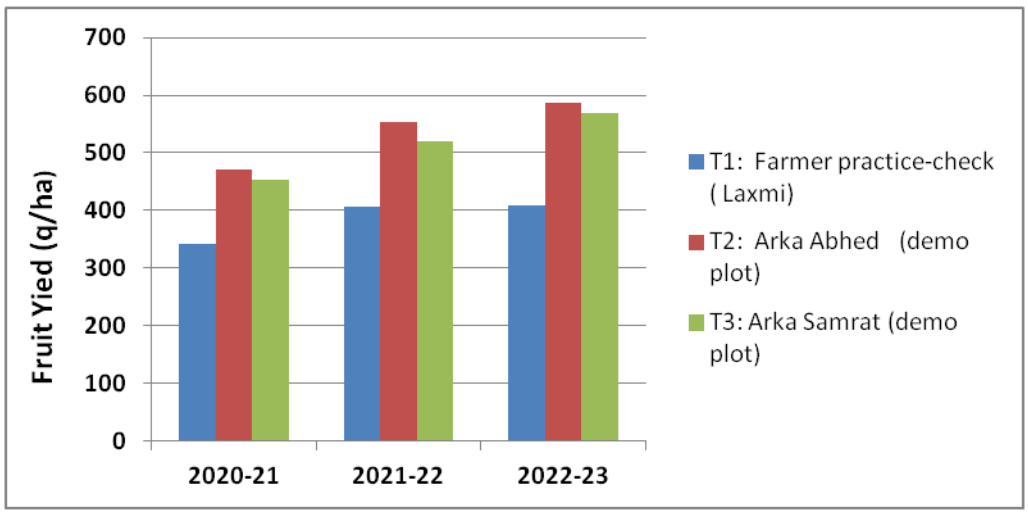


Fig. 1. Yield of tomato hybrids

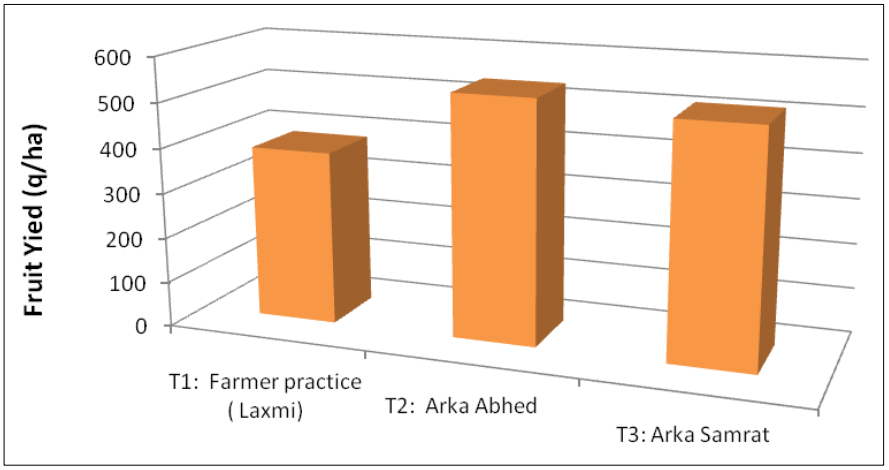


Fig. 2. Pooled yield of tomato hybrids

Fig. 3. Cost of cultivation of tomato hybrids over farmers' practice

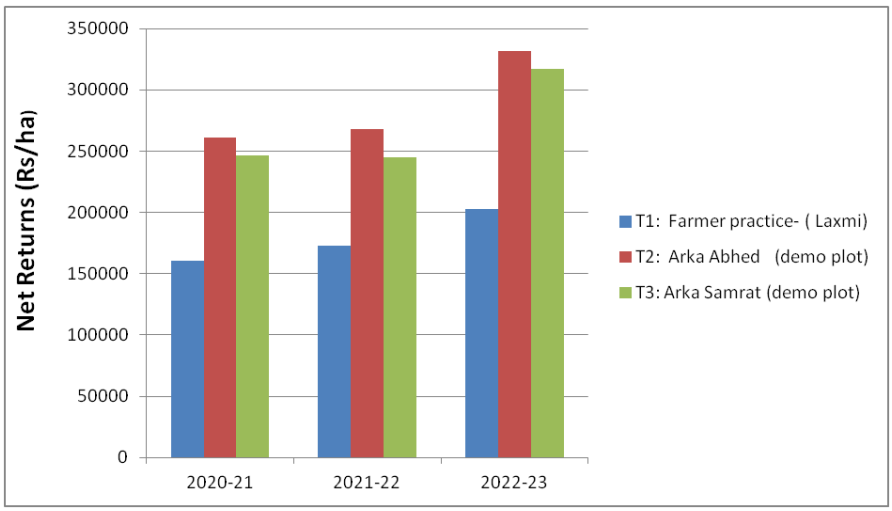


Fig. 4. Net returns of tomato hybrids over farmers' practice

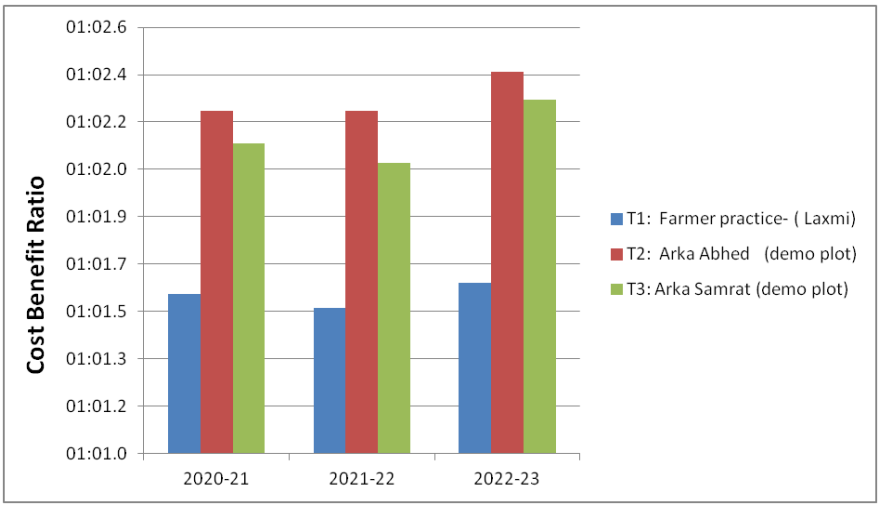


Fig.5. Cost benefit ratio of tomato hybrids over farmers' practice

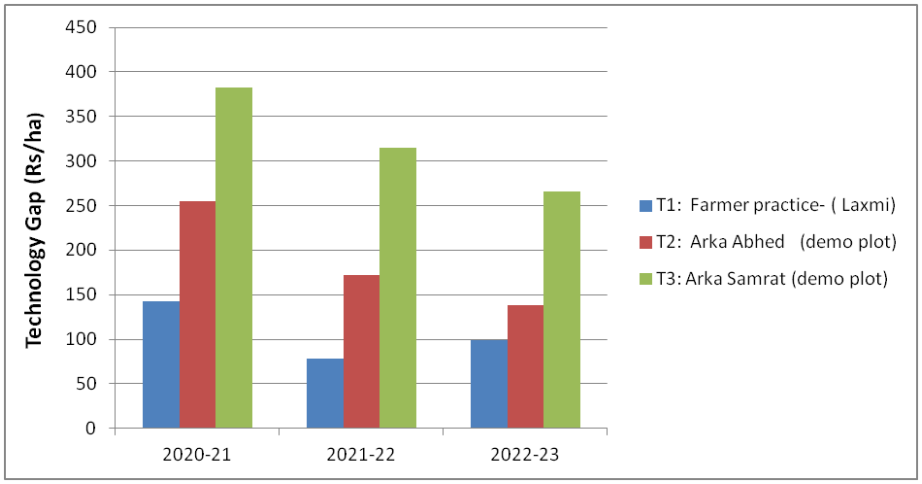


Fig. 6. Technology gap of tomato hybrids over farmers' practice

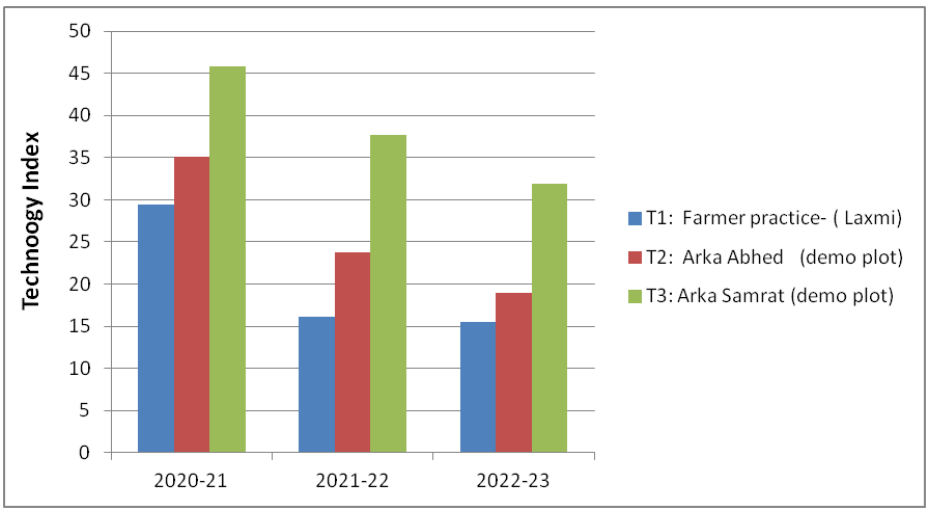


Fig. 7. Technology Index of tomato hybrids over farmers' practice

Table 1. Yield, Technology Gap, Extension Gap and Technology Index of tomato hybrids Arka Abhed, Arka Samrat over farmers' practice (Laxmi)

Particulars	Fruit yield (q/ha)			Potential yield (q/ha)	% Increase in fruit yield over farmers' practice			Technology Gap (q/ha)			Extension Gap (q/ha)			Technology Index (%)		
	2020-21	2021-22	2022-23		2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23
T1: Farmers' practice-check (Laxmi)	341.32	406.25	409.14	484	---	-----	---	142.68	77.75	98.73	---	-----	----	29.47	16.06	15.46
T2: Arka Abhed (demo plot)	470.4	552.5	587.32	725	27.44 %	26.47 %	30.33 %	254.6	172.5	137.68	129.08	146.25	202.05	35.11	23.79	18.99
T3: Arka Samrat (demo plot)	452.5	520.4	569.13	835	24.57 %	21.93 %	28.11 %	382.5	314.6	265.87	111.18	114.15	183.86	45.80	37.67	31.84

Table 2. Economic analysis of tomato hybrids Arka Abhed and Arka Samrat over farmers' practice (Laxmi)

Particulars	Cost of Cultivation (Rs/ha)				Gross Returns (Rs/ha)				Net Returns (Rs/ha)				Cost Benefit Ratio		
	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23	Pooled	2020-21	2021-22	2022-23
T1: Farmers' practice-check (Laxmi)	105462	111425	124758	113881	273040	284375	327312	294909	160858	172950	202554	215454	1:1.58	1:1.53	1:1.62
T2: Arka Abhed (demo plot)	115462	118750	138288	124166	376320	386750	469856	410975	260858	268000	331568	286808	1:2.25	1:2.25	1:2.39
T3: Arka Samrat (demo plot)	115462	118750	138288	124166	362000	364000	455304	393768	246538	245250	317016	269601	1:2.13	1:2.06	1: 2.29

Picture 1. Arka Abhed seedlings

Picture 2. Arka Samrat seedlings

Picture 3. Laxmi seedlings

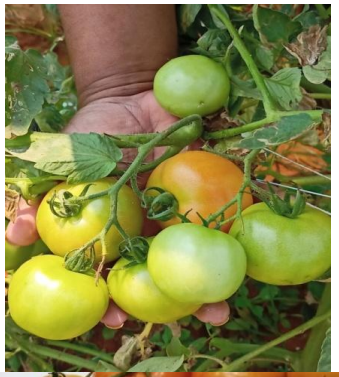
Picture 4. Main field view of tomato

Picture 5. Erection of pheromone traps

Picture 6. Staking of Tomato

Picture 7. Field days

Picture 8. TO1: Farmer practice: Laxmi



Picture 9. TO2: Arka Abhed

Picture 10. T03: Arka samrat

4. CONCLUSION

Tomato hybrids Arka Abhed (multiple disease resistant) and Arka Samrat (triple disease resistant) recorded substantially higher yields than farmers' practice (Laxmi). The net returns in demonstration plots of the hybrids were also higher over the farmers' practices variety. The results of the OFT amply demonstrated the superiority of the tomato hybrids Arka Abhed and Arka Samrat over the farmers' practice (Laxmi) in yield, cost: benefit ratio and net return. The participant farmers themselves could find the superiority of the tomato hybrids Arka Abhed and Arka Samrat over the farmers' practice (Laxmi) and the adoption of technology for realizing higher fruit yield and greater net return from the cultivation of tomato. Hence, the two hybrids namely Arka Abhed and Arka Samrat were proved to be the promising to the Visakhapatnam district and North Coastal Zone of Andhra Pradesh as well.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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