Original Research Article

Performance evaluation of Tomato hybrids Arka Samrat and Arka Abedhin Alluri Sitarama Raju District of Andhra Pradesh, India

---

ABSTRACT

Krishi Vigyan Kendra (KVK), Pandirimamidi, DR.YSRHU conducted on farm trials from 2019-20 to 2021-22, in four selected villages involving eighteen farmers covering an area of 4.5 acres. The principal objective of this study was varietal assessment of high yielding tomato hybrids i.e. Arka Abedh (multiple disease resistant) and Arka Samrat (triple disease resistant) for ascertaining and recommending the cultivarsbestsuitedfor the region. The results showed thattomatohybrid ArkaAbhed (T_2) (528.23 q/ha, 564.65 q/ha and 589.78 q/ha) proved tobethe best in yield followedbyArkaSamrat (T_3)(501.24 q/ha, 538.67 q/ha and 558.75 q/ha) and INDAM - Rashmihybrid (T_1)(402.72 q/ha, 434.55 q/ha and 455.45 q/ha) for the three consecutive years of thestudy. The net returns increased steadily in the demonstration plots rangedfromRs.2,54,261/-to Rs. 3,38,074/-in tomato hybrid Arka Abhed, whereas tomato hybrid Arka Samrat recorded Rs. 2,35,368/- to Rs. 3,13,250/-from 2019-20 to 2021-22. AnExtensiongapo f 125.51to134.33 q/haand 98.52 to 103.30q/ha were recorded in Arka Abhed and Arka Samrat respectively. Technology Index for tomato hybrids observed as i.e. INDAM - Rashmi (13.24%), Arka Abhed (18.65%)and Arka Samrat (30.15%).

Keywords: On farm trails, Arka Abedh, Arka Samrat, Yield, Extension gap, Technology Index

1. INTRODUCTION

Tomato, scientifically known as *Solanum Lycopersicon* L., has attained the esteemed status of being the world's popular vegetable crop due to its remarkable adaptability to a wide range of agro-climatic conditions. Tomatoes are highly regarded as a protective food crop due to their rich content of essential minerals, vitamins, and organic acids. They serve as a vital source of lycopene, ascorbic acid, and carotene, all prized for their contributions to color, flavor, and antioxidant properties. Lycopene presence in plasma in tomato is valued for its anti-cancer property (1). Atpresent India rankssecondinareanexttoChinabyproducing 19.37milliontonnesoftomatofromanareaof 0.78millionha.However,intermsofproductivity, India (25 t ha^{-1}) stands in tenth position, 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 (2). Tomato is grown extensively throughout India including Andhra Pradesh, where the total area of the crop is 54160 ha with a production of 24.37 MT i.e. third largest producer of tomato, behind Madhya Pradesh and Karnataka.The hastening consumption of tomatoes has elevated its status as a high-value crop, providing a significant income source for farmers. It holds great importance from both production and industrial perspective, necessitating the need to enhance productivity per unit area in order to meet the growing

demand within limited arable land[3], [4].

Tomatois one of the most important vegetable crops cultivatinginAlluri Sitarama Raju District of Andhra Pradesh including tribal areas where the climate and soil are congenial for the crop. However, farmers are getting low yields as the cultivating varieties prone to several diseases. Farmers also lacks knowledge regarding the proper selection of high yielding, multiple disease resistant varieties, adoption of improved cultivation practices like proper seed treatment, protray nursery raising, integratednutrientmanagementandplant protection measures. It is imperative to advisethe tomato growers about high yielding cultivarsand demonstrate the right technology for getting higher yield, net returns right in their own fields and through their own hands. . In the light of all such aspects, an on-farm trial (OFT) was undertaken in farmers'fields of selected villages by Krishi Vigyan Kendra, Pandirimamidi, Dr. YSRHU inAlluri Sitarama Raju District of Andhra Pradeshwith the principal objective of varietal assessment of high yielding tomato hybrids for ascertaining and recommending the cultivarsbestsuitedfor the region. The OFTs were conducted for three consecutive years 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. MATERIALSANDMETHODS

Tomato hybrids i.e. INDAM-Rashmi (farmers' practice - Check), Arka Abhed (multiple disease resistant) and Arka Samrat(triple disease resistant) both released by ICAR- IIHR, Bengaluru were selected as treatments for assessing the yield and economic analysis in rabi season in a field area of 4.5 acres for the three consecutive years from 2019-20 to 2021-22. Eighteen participantfarmersselectedfromfourvillages viz. Rajampalem, Indukurupeta, Gangavaram and Parimithadaka.Before conducting the field trial, the list of the participant farmers was prepared very meticulously. The skill trainings focused on the selection of quality of seeds, seed treatment, nutrient management, irrigation schedule, plant protection measures and right harvesting methods.

Treatments:

$T_{1:}$ INDAM-Rashmi (farmers' practice – Check)

T_2: Arka Abhed (multiple disease resistant)

T_3: Arka Samrat(triple disease resistant)

Improved practices demonstrated through on-farm trails as mentioned in Table 2.Seed

treatment was done with carbendazim @ 2g/kg of seed [3] for preventing fungal diseases.Seeds were sown in pro trays for ensuring better germination and seedlingswere transplanted at 25 days old into the main field at a spacing of 90 x 60 cm. The spacing so used facilitated easy intercultural operations. The fields received FYM @ 15 tonnes/ha well before the sowing time. A recommended dose of fertilizers i.e. N, P and K @ 120, 60 and 60 kg/ha were applied [4] at required growth phases. Proper staking practices were followed and 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 INDAM-Rashmi(farmers' practice - check).

The parameters such as Yield (q/ha), Cost of cultivation (Rs/ha), Gross Returns (Rs/ha), Net Returns (Rs/ha), Cost Benefit ratio were recorded according to Babu et al., [4]. Other parameters like extension Gap and technology Index were calculatedbyformulaesuggestedby(Singh etal. 2016)and [6] tostudythe impact of on farm trails over the selected farmers.

- Extension gap = Demonstrated yield - Yieldunder existing practice
- TechnologyIndex= $\frac{\text{Potential Yield} - \text{Demonstrated Yield}}{\text{Potential Yield}} \mathbf{X100}$

3. RESULTSANDDISCUSSION

Results on yield (Table 3) revealed that all the three tomato hybrids recorded the highest yield in 2021-22 (455.50, 589.50 and 558.75 q/ha for INDAM-Rashmi, Arka Abhed and Arka Samrat respectively). Tomato hybrid Arka Abedh (T_2) recorded an increase of 31.16%, 29.93%and29.49% whereas Arka Samrat (T_1) recorded an increase of 18.65%, 18.43% and 17.51% in yieldoverthefarmers'practice(INDAM-Rashmi)during 2020-21, 2021-22 and 2022-23 respectively. The higher in yield per plant of tomato hybrids was due to higher fruit set and higher retention of matured fruits per plant.This could be due tomultiple disease resistance (Early leaf blight, late leaf blight, bacterial blight and leaf curl) of tomato hybrid Arka abhed and triple disease resistance (Early leaf blight, Bacterial blight and leaf curl) of Arka samrat. Similar results were reported by Babu et al., [4], Surendra et al., [2],Mishra et al., [7], Kale et al., [8] and Prasanna Lakshmi et al., (2021). The results revealed the positive effectsof Arka Abhed and Arka Samrat over the existing farmers' practice viz. INDAM- Rashmi.

The outcomes of the economic analysis of Arka Abhed and Arka Samrat over the

farmers' practice are shown in Table 3. Economic variables such as the cost of cultivation, net return and B:C ratio were calculated to determine the economic viability of demonstration relative to the control (farmers' practice - check). The cost of cultivation per hectare for the both the tomato hybrids Arka Abhed and Arka Samrat ranged from Rs. 1,15,500 /- in 2019-20 to Rs. 1,33,750 /- in 2021-22 whereas the demonstration plots ranged fromRs. 1,06,500 /- in 2019-20 to Rs. 1,23,000 /- in 2021-22.This might be due to increased costs ofinputs like seed, fertilizers,more number of labour days required for harvesting.These results were in accordance withBabu et al., [4] and Sahoo et al., [14].

The net returns too increased steadily in the demonstration plots rangedfromRs.2,54,261/-to Rs. 3,38,074/-from 2019-20 to 2022-23 in tomato hybrid Arka Abhed, whereas tomato hybrid Arka Samrat recorded Rs. 2,35,368/- to Rs. 3,13,250/-from 2019-20 to 2021-22. The net returns were substantiallyhigher in the demonstration plots over thecontrol with farmers' practice plots i.e. Rs. 1,75,404/- (2019-20) to Rs. 2,41,360/- (2021-22). The results corroboratethoseBabu et al., [4], Kaleetal.,[8],Mokidueetal., [10] and Keshava reddyet al., [11]. Cost benefit ratio was recorded higher in the Arka Abhed (1:2.20, 1:2.31, 1:2.53) and Arka Samrat(1:2.04, 1:2.15, 1:2.34) than farmers' practice – INDAM Rashmi (1:1.65, 1:1.71, 1:1.96) in the three years of study from 2019-20 to 2021-22 respectively (Table 3 and Fig 4).This finding complies with the observation of Devi et al., [3] that the wide variation in net return and benefit-cost ratio in tomato cultivation was due to high yield differences. And, also reported that a higher yield and 15% higher return was found with the tomato variety Arka Rakshak than Arka Samrat [14].

The extension gap with Arka Abhed and Arka Samratrangedbetween125.51to134.33and 98.52 to 103.00 q/ha during the years 2019-20 and 2021-22 of the study (Table 4). Thus there is aneed to educate the farmers for the adoption of improved varieties along withmodern technology through various extension methodologies viz. front-line demonstrations, cluster frontline demonstrations, field days and convergence meeting with line departments. It was evident from (Table 4 and Fig 6) that Technologies Index showed a decrease patternin both the tomato hybrids i.e. Arka Abedh (27.14% to 18.65%) and Arka Samrat (37.34% to 30.15%) respectively from 2019-20 to 2021-22. The lower the value of Technology Index, the more is the feasibility of the technology. 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 byBabu et al., [4], Kale et al., [8], Keshavareddyetal.,[11],Katare et al.[12],andDayanand& Mehta [13]inmustard.

4. CONCLUSION

Tomato hybrids Arka Abhed (multiple disease resistant) and Arka Samrat (triple disease resistant) recorded substantially higher yields than farmers' practice (INDAM - Rashmi). The net returns in demonstration plots of the hybrids were also recoreded higher over the farmers' check. The results of the on farm trials amply demonstrated the superiorityof the tomatohybrids ArkaAbhed and ArkaSamratoverthefarmers'practicein yield, net returnsand cost: benefit ratio. The participant farmers realized the superiority of hybrids over the check variety and adopted the technology. Hence, through these on-farm trails it has stated that the two tomato hybrids namely Arka Abhed and Arka Samrat have provedtobethepromising totheAlluri Sita Rama Raju district of Andhra Pradesh.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bose TK, Bose J, Kabir TK, Maity VA and Parthasarathy Som MG. Vegetable crops. Bhumani mitra publication, Calcutta, India, 2002.
2. Surendra Kaiwart, Saurabh Toppo and Sushant Sahu. Evaluation of tomato (Solanum lycopersicum L.) Hybrids for quality parameter in Allahabad agro climatic condition. Journal of Pharmacognosy and Phytochemistry. 2020;9(3): 2089-2091.
3. Bijaya Devi and Sandeep Rout. Performance of tomato varieties Arka Rakshak and Arka Samrat in naturally ventilated polyhouse and its economic returns. International Journal of Plant & Soil Science. 2023;35 (21):1037-1044.
4. Sathi Babu N, Raja Kumar N, Gouri V, Sankara Rao K, Kishore Kumar N, Babu P, Sowjanaya A and Rama Naidu P. Performance of Tomato Hybrids Arka Abhed and Arka Samrat in visakhapatnam district of Andhra Pradesh, India. International Journal of Environment and Climate Change. 2023;13(8):826-836.
5. Singh DV, Mukhi SK and Mohapatra MR. Yield Gap Analysis of Toria (Brassica campestris) through Front Line Demonstration in Kandhamal District of Odisha, Indian J. Ext. Edu, 2016; 52 (3& 4):167-17.
6. Kale SM, Barikar Umesh, Mahesh C. Popularization of Tomato Hybrid (Arka Rakshak) for Yield and Economic Analysis in Kalyan Karnatka Region. Int. J.Curr. Microbiol. App. Sci. 2020;9(6):1675-1679.
7. Mishra D, Ashis Kumar Mohanty SK, Mukhi, Singh DV. Assessing the Performance and Adoption Rate of Tomato Hybrid "Arka Rakshak" having Multiple Disease Resistance in Jagatsinghpur District of Odisha, India. Int. J. Curr.Microbiol. App. Sci. 2019;8(09):2458- 2464.
8. Kale SM, Barikar Umesh, Mahesh C. Popularization of Tomato Hybrid (Arka Rakshak) for Yield and Economic Analysis in Kalyan Karnatka Region. Int. J.Curr. Microbiol. App. Sci. 2020;9(06):1675-1679.
9. Ravuri PL, Deva S, Kumar MR. Assessment of Late Blight Resistant Tomato Hybrid Arka Abhed. Biological Forum – An International Journal. 2021;13(3):613-616.
10. Mokidue I, Mohanty AK, Sanjay K. Correlating growth yield and adoption of Urdbean technology. Indian. J. Extn. Edu. 2011;11(2): 20-24.
11. Keshavareddy G, Kamala Bai S, Nagaraj KH, Hanumantharaya BG. Integrated Crop Management - A Way for Doubling the Income of Tomato Growers in Ramanagara District of Karnataka, India. Int. J. Curr. Microbiol. App. Sci.

2018;7(6):2161-2168.

12. Katare, Subhash, Pandey SK, Mustafa, Mohd. Yield gap analysis of rape seed mustard through front line demonstration. Agric. Update. 2011;6:5-7.
13. Dayanand VRK and Mehta SM. Boosting mustard production through front line demonstrations. Indian Res. J. Ext Edu. 2012;12(3):121-123.
14. Sahoo BB, Nayak A, Nayak, BS, Mohanty K, Mandi N, Prasad G , Das S, Khanda CM. Effect of sowing dates on growth, yield and economics of tomato (*Solanum lycopersicum* L.) hybrids in western undulating zone of Odisha. Journal of Crop and Weed. 2021;17(2): 98-105.

Table 1: Weather details of Alluri Sitarama raju district of A.P during on-farm trails from 2019-20 to 2021-22

Month	2019-20				2020-21				2021-22			
	Temp. (^{o}C)		Rainfall (mm)		Temp. (^{o}C)		Rainfall (mm)		Temp. (^{o}C)		Rainfall (mm)	
	Max.	Min.	N	A	Max.	Min.	N	A	Max.	Min.	N	A
October	34.2	24.1	206.7	259.0	34.5	23.2	206.7	350.7	34.4	25.2	206.7	119.2
November	33.9	20.2	88.4	4.7	34.1	20.3	88.4	152.7	32.2	22.4	88.4	179.2
December	30.3	19.7	10.3	1.3	30.2	18.5	10.3	0.1	31.1	19.3	10.3	2.5
January	31.1	18.9	8.7	8.3	32.4	20.2	8.7	2.0	30.7	18.9	8.7	16.3
February	34.5	22.4	11.0	6.2	34.1	19.3	11.0	1.3	32.4	20.5	11.0	0.3

N: Normal Rainfall to be received, A: Actual Rainfall received

Table 2: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	F_1 hybrid i.e. INDAM - Rashmi from market	Arka Abedh (Multiple disease resistant) and Arka Samrat (Triple

			disease resistant) from ICAR –IIHR, Bengaluru
2	Seed treatment	Improper methods were followed	carbendazim @ 2g/kg of seed
3	Raising of seedlings	Broadcasting of seed on Raised bed	Raised in protrays filled with media (Cocopeat + perlite)
4	Fertilizer application	Improper management i.e. Application of Urea, DAP	Recommended Dose of Fertilizers (RDF) FYM @ 15 tonnes/ha N:P:K@ 120:60:60 Kg/ha
5	Intercultural operations	Staking followed	Staking followed
6	Diseases and Pest management	Over doses of fungicides and pesticides used	As both the hybrids are mutilple and triple disease resistant, very limited usage of fungicides and needed pesticides.

Table 3: Economic analysis of tomato hybrids Arka Abhed and Arka Samrat over farmers' practice (INDAM -Rashmi)

Particulars	Cost of cultivation (Rs/ha)				Gross Returns (Rs/ha)				Net Returns (Rs/ha)				Cost Benefit ratio			
	2019-20	2020-21	2021-22	Mean	2019-20	2020-21	2021-22	Mean	2019-20	2020-21	2021-22	Mean	2019-20	2020-21	2021-22	Mean
T_1 : Farmers practice - Check (INDAM-Rashmi)	106500	112250	123000	113917	281904	304185	364360	316816	175404	191935	241360	202900	1:1.65	1:1.71	1:1.96	1:1.77
T_2 : Arka Abedh	115500	119750	133750	123000	369761	395255	471824	412280	254261	275505	338074	289280	1:2.20	1:2.31	1:2.53	1:2.34
T_3 : Arka Samrat	115500	119750	133750	123000	350868	377069	447000	391646	235368	257319	313250	268645	1:2.04	1:2.15	1:2.34	1:2.17

Table 4: Yield, Extension Gap and Technology Index of tomato hybrids Arka Abhed, Arka Samrat over farmers' practice (INDAM - Rashmi)

Particulars	Yield (q/ha)			Potential Yield (q/ha)	% increase in yield over farmers practice			Extension gap (q/ha)			Technology Index (%)		
	2019-20	2020-21	2021-22		2019-20	2020-21	2021-22	2019-20	2020-21	2021-22	2019-20	2020-21	2021-22
T_1 : Farmers practice - Check (INDAM-Rashmi)	402.72	434.55	455.45	525	-	-	-	-	-	-	23.29	17.22	13.24
T_2 : Arka Abedh	528.23	564.65	589.78	725	31.16	29.93	29.49	125.51	130.10	134.33	27.14	22.11	18.65
T_3 : Arka Samrat	501.24	538.67	558.75	800	18.65	18.43	17.51	98.52	104.12	103.30	37.34	32.66	30.15

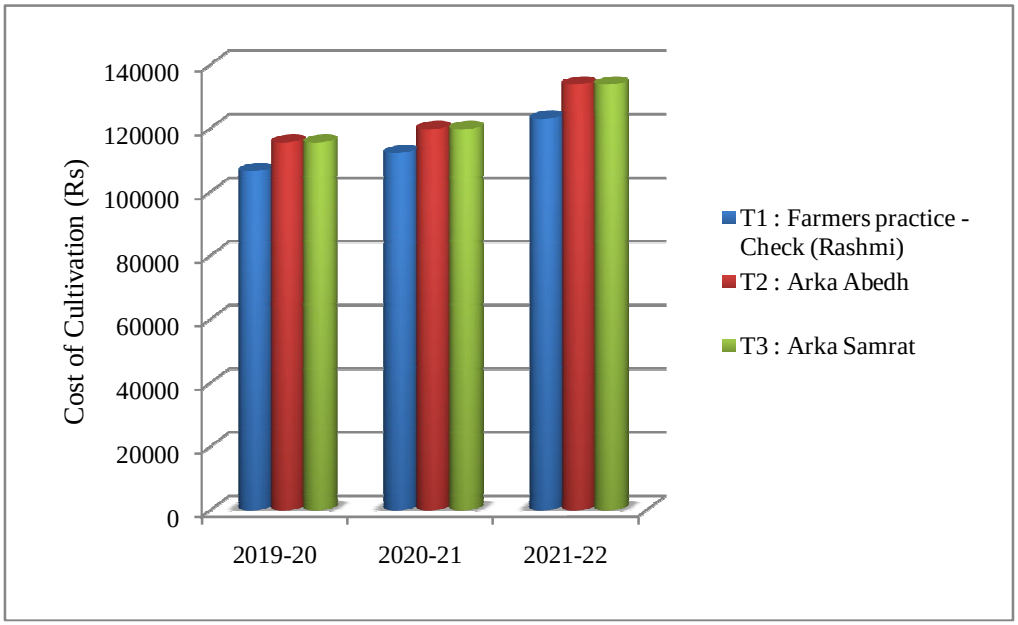


Fig 1: Cost of cultivation of tomato hybrids over farmers' practice

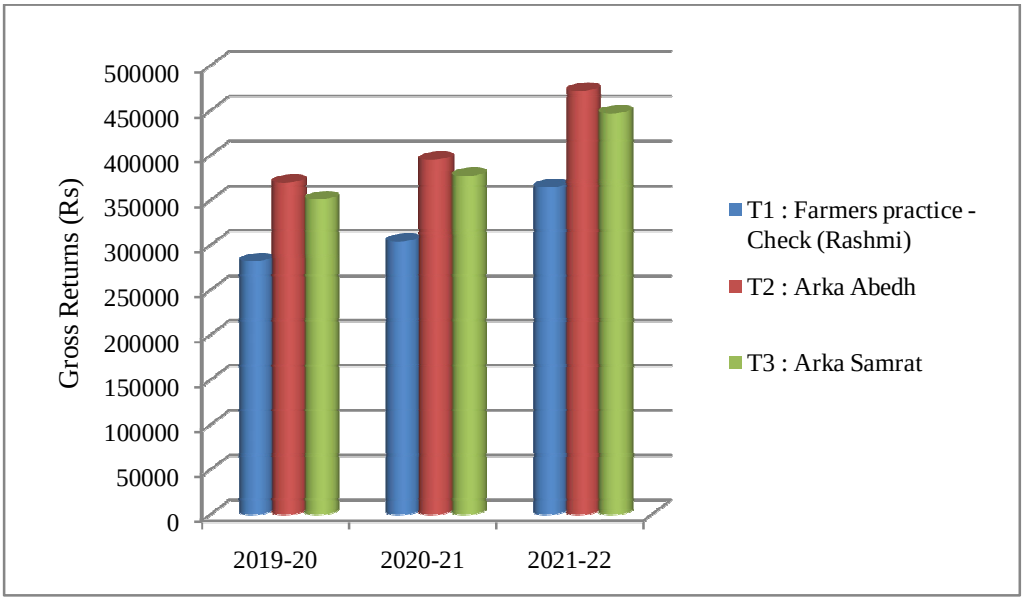


Fig 2: Gross returns of tomato hybrids over farmers' practice

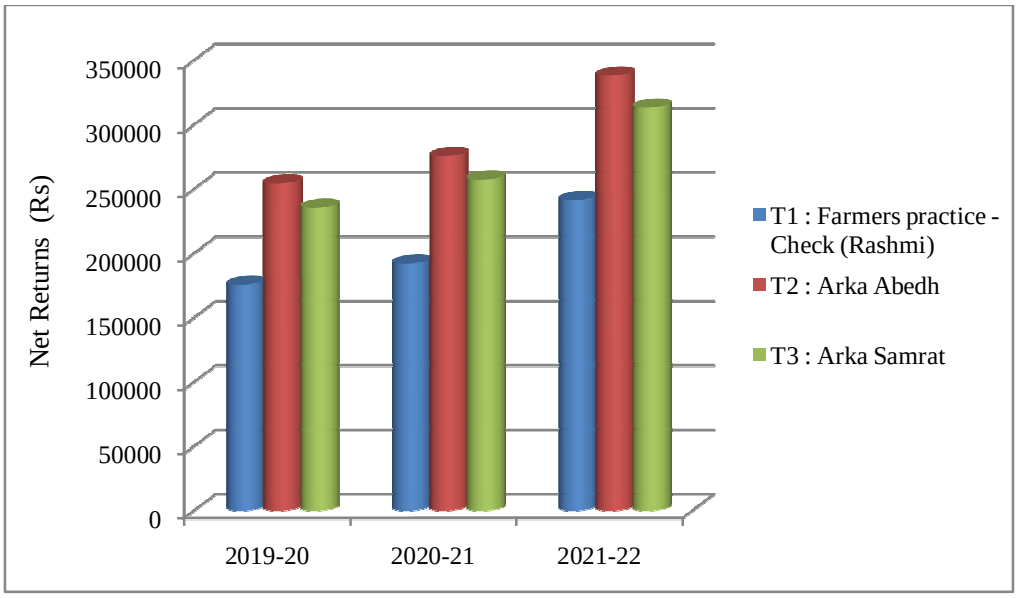


Fig 3: Net returns of tomato hybrids over farmers' practice

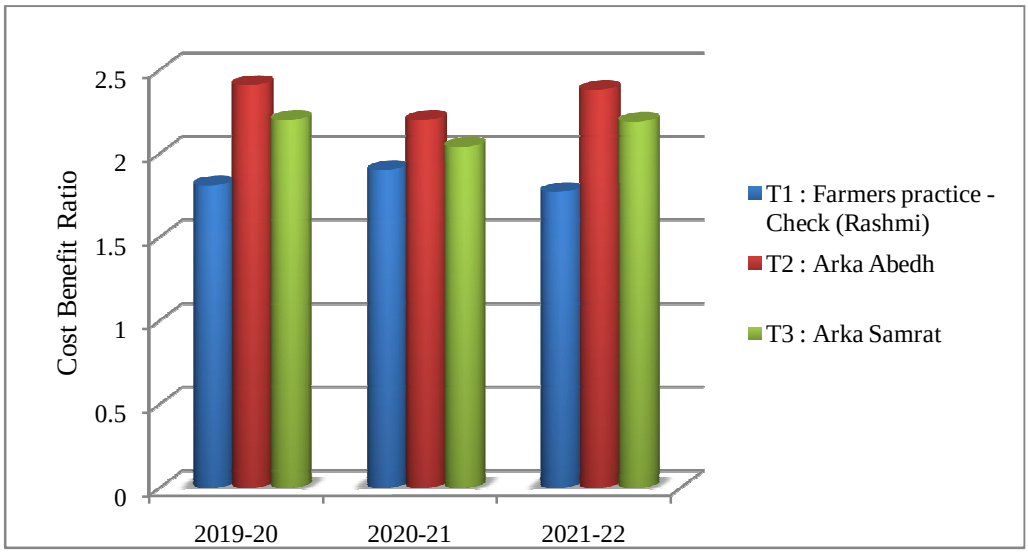
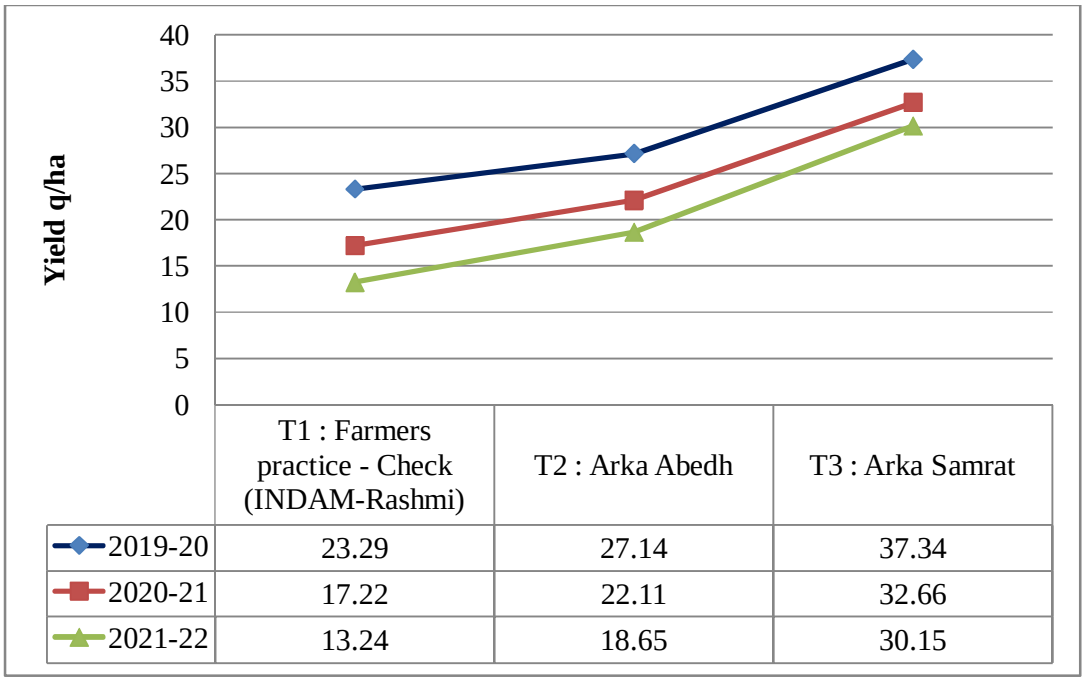


Fig 4: Cost benefit ratio of tomato hybrids over farmers' practice



	T1 : Farmers practice - Check (INDAM-Rashmi)	T2 : Arka Abedh	T3 : Arka Samrat
2019-20	23.29	27.14	37.34
2020-21	17.22	22.11	32.66
2021-22	13.24	18.65	30.15

Fig 5: Yield details of tomato hybrids over farmers' practice

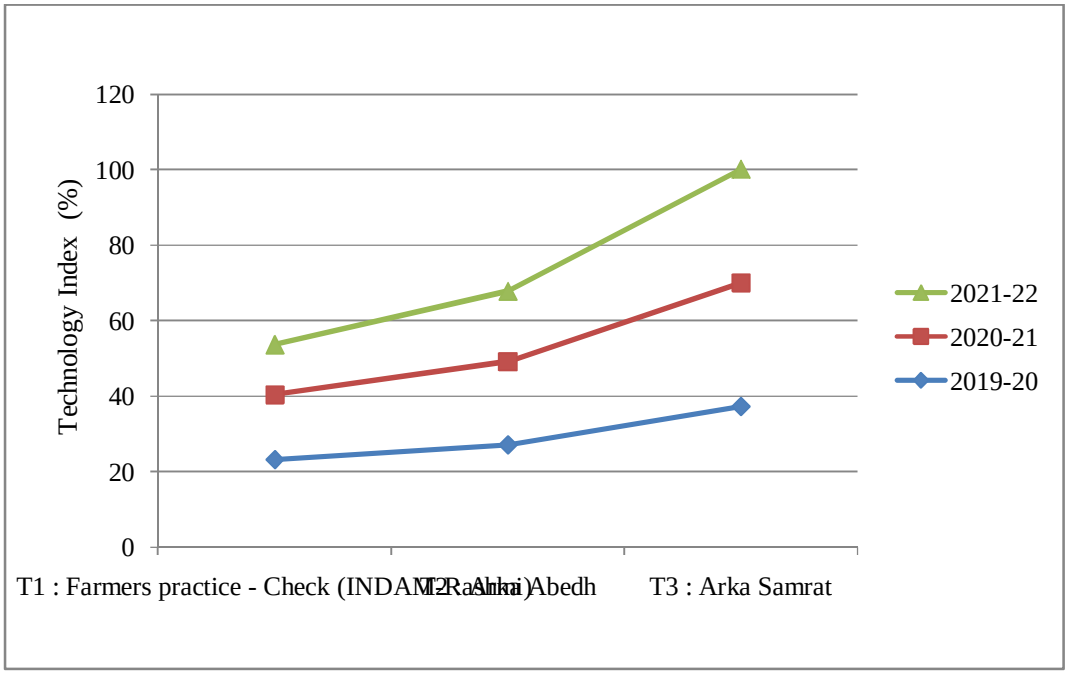


Fig 6: Technology Index (%) of tomato hybrids over farmers' practice

Inputs provided to beneficiaries

Staking operation in Tomato hybrids

Fruits ready for harvesting

Harvested Yield

T_1: Farmers Check Tomato var. INDAM - Rashmi

T_2: Tomato hybrid Arka Abedh

T_3: Tomato hybrid Arka Samrat

Plate 1: Operations from seedling raising to harvesting in Tomato hybrids