



Suitability of Tomato (*Solanum lycopersicon* L.) having Multiple Disease Resistant

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ABSTRACT

The study was conducted for two years to assess the performance of high yielding and multiple disease resistant tomato hybrids Arka Abhed and Arka Samrat in YSR district of Andhra Pradesh. Majority of the farmers in YSR district of Andhra Pradesh cultivate commercial hybrids which were low yielding and susceptible to pests and diseases. In this situation, introduction of high yielding hybrids with resistant to pest and diseases were necessary to enhance productivity and to reduce cost of cultivation. Therefore, experiments were conducted to assess the suitability of new Tomato Hybrids namely Arka Abhed and Arka Samrat with locally cultivated Sivam hybrid. The average fruit weight was recorded 105.84 g, 113.92 g, and 100.62 g and number of average fruits per plant recorded 100.52, 90.61, 76.52 respectively in Arka Abhed, Arka Samrat and Sivam hybrids. The new hybrids showed positive results in average yield (53.20 t/ha) in Arka Abhed and (51.57 t/ha) in Arka Samrat was recorded when compared to farmers practice (38.82 t/ha) with Sivam hybrid. The total disease incidence was (4.28%) in Arka Abhed, (24.88%) in Arka Samrat and (40.51%) in farmer's practicing hybrid Sivam.

Key Words: Arka Abhed, Arka Samrat, Disease resistant, Hybrids, Tomato.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is popular and the major vegetables under cultivation after potato and belongs to family solanaceae (Kumar *et al*, 2013). India ranks second in tomato production after China with 19.75 million tonnes accounting for world's 10 % share in production (NHB, 2020). Tomato is one of the most important vegetable crops grown in the state of Andhra Pradesh and cultivated in an area of 0.61 lakh ha round the year in various agro climatic situations with an average productivity of 46 t/ha. Tomato is important commercial crop grown by both marginal farmers and commercial growers for fresh market and processing industry. Among tomato cultivars, hybrids have really brought the revolution in tomato cultivation. Tomato

hybrids excelled in yield but for the tolerance to diseases, high adaptability to adverse environment, uniformity of produce and greater plant vigour but also have shown great potential to counter the challenge of high demand of fresh and processed products. (Dhillon *et al*, 2019).

In tomato early blight, bacterial wilt (BW), tomato leaf curl virus (ToLCV) and late blight are considered as the most devastating diseases prevalent in the Andhra Pradesh. All these pathogens survive well either in soil or in collateral and alternate host plants. These diseases flare up considerably because of the cropping system used by the farmers and the prevalence of prolonged conducive environment. Various strategies have been developed for managing these diseases but

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many are limited in application, either being site specific or limited by socio-economic conditions. Although host resistance is the most effective control option, it is difficult to obtain cultivars with durable resistance across locations under the conditions of high temperature and humidity in the tropics and sub tropics. Also breeding for resistance for more than one disease is quite difficult and time consuming. However, there are varieties and hybrids in tomato which are stable in reacting as multiple resistant to the major diseases (Mishra *et al*, 2019). In this study, attempt was made to assess the performance of hybrids developed from Indian Institute of Horticultural Research (IIHR), Bangalore.

Lack of improved pest and disease resistant tomato hybrids, use of poor quality seed, poor soil fertility, disease and insect pest are some of the problems for tomato cultivation faced by the farmers. Large number of high yielding tomato hybrids has been released for cultivation in open field cultivation (Kaddi *et al*, 2014). In this connection, there is an immense need for introducing suitable, high yielding and disease resistant tomato hybrids in the district. Hence, an assessment on tomato hybrids for yield, disease resistant and its suitability in YSR district, Andhra Pradesh was carried out.

MATERIALS AND METHODS

On farm trial was conducted at five farmer's fields at Gorlapalli, Pendlimarri, Pathasangatipalli, Chinthakomma Dinne, Balupalli villages of YSR district during rabi seasons of 2020-21 and 2021-22. Total annual rainfall of 1113.6 mm received during 2020-21 and 1168.6 mm rainfall received during the year 2021-22. The YSR district rabi season maximum temperature was 31.9 ° C and minimum temperature was 21° C during 2020-21. The YSR district rabi season maximum temperature was 32.8° C and minimum temperature was 21.7° C during 2021-22. Farmers cultivated the tomato crop under irrigated conditions, the soil type was red sandy soils. Tomato F1 hybrid Arka Abhed (H-397) is a multiple diseases resistant hybrid to tomato leaf

curl disease (ToLCV), bacterial wilt (BW), early blight and late blight. Arka Abhed tomato plants are semi-determinate with dark green foliage. Arka Abhed tomato fruits are firm, oblate round & medium large (90-100g). Arka Samrat is a triple resistant high yielding F1 hybrid developed by crossing IIHR-2835 X IIHR-2832. Tomato hybrid Arka Samrat is first F1 Hybrid with triple disease resistance to tomato leaf curl disease (ToLCV), bacterial wilt (BW) and early blight. Tomato hybrid Arka Samrat fruits oblate to high round, large (90-110g), deep red and firm. Tomato hybrids seed was purchased from Indian Institute of Horticulture Research (IIHR), Bengaluru. Both tomato hybrids Arka Abhed and Arka Samrat were released by IIHR, Bangalore. Tomato hybrids Arka Abhed and Arka Samrat seeds were sown in pottrays during 2nd week of September in KVK, Utukur vegetable nursery unit and seedlings were transplanted on 3rd week of October 2020-21 and 2021-22 in farmer's field. Arka Abhed, Arka Samrat and local check (Sivam) were used for this on farm trial. The seedlings were 25-30 days old and were transplanted at a spacing of 75 x 45 cm. FYM @20 t/ha was incorporated in the soil during land preparation. NPK 180:100:100 kg/ha was applied, half dose of nitrogen and full dose of phosphorous and potash is applied at the time of transplanting. Remaining half amount of nitrogen was applied in two equal splits, first at 30 d after transplanting and next dose at 60 days after transplanting at 15 cm around the plant in ring. Two sprayings of micronutrient mixtures were also done at 30 and 60 d after transplanting for high yields. Yellow and Blue sticky traps each 20 numbers per ha were placed in different locations of field against sucking pest. Four regular weeding were done in the field. There were no plant protection measures taken for both check and trial plots to observe the diseases incidence in both check and trials tomato hybrids.

The disease incidences for early blight, bacterial wilt (BW), Tomato leaf curl virus (ToLCV) and late blight were observed and recorded. The yield in the check and trial plots was taken from 5 places

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each of 10 m² area for 4 times i.e., from 4 pickings and converted the data into per ha basis. The fruit weight, number of fruits per plant, days to 1st harvest and shape of the fruit were also recorded. Quality parameters of the harvested produce were also assessed by visual observation as well as collection of opinions from the farmers and the consumers. The market preferences of the produce for different parameters were assessed by collecting the opinion of the consumers from local markets and scoring was given by using 0 – 5 scale. Economic parameters like gross cost, net return and B:C ratio were also calculated from each check and trial plots for comparison.

The observations like plant height (cm), days taken for 50 % flowering, number of fruits per plant, average fruit weight (g), average fruit diameter (cm), yield per plant (kg), yield per ha (t/ha), net income (Rs./ha), B:C ratio and market preference were recorded. The data were analyzed as suggested by Panse and Sukhatme (1967). The results obtained were statistically analysed with SPSS, one way ANOVA and repeated measures mixed ANOVA was carried out for pooled analysis of two years data with three treatments.

RESULTS AND DISCUSSIONS

It was evident that tomato hybrid Arka Abhed recorded the maximum values in growth, yield and cost economic characters than other hybrids. Tomato plant height of 187.76 cm was recorded the highest in tomato hybrid Arka Abhed followed by Arka Samrat of 186.42 cm whereas Sivam recorded the lowest plant height of 176.58 cm. In the case of days to 50 % flowering after planting, Arka Samrat taken less days for flowering (27.81) followed by Arka Abhed (28.74) whereas the longer days taken for flowering was noticed in Sivam (farmers practices) of (33.15). This might be due to genetic makeup of hybrids. The two years mean results revealed that Sivam tomato hybrid took maximum days (87.85) from transplanting to first harvest and Arka Abhed hybrid took maximum days (82.99). Arka Samrat took minimum days of 82.01 d. Similar results by

(Abrar *et al*, 2011 and Falak *et al*, 2011) showed that the time taken from transplanting to first harvest for tomato cultivars ranged between 70 and 120 d. Arka Abhed recorded highest number of fruits per plant (100.52) followed by Arka Samrat (90.61) and farmers' practice (76.52). Earlier researchers (Islam *et al*, 2012; Marbhal *et al*, 2016; Kyess *et al*, 2017; Vijeth *et al*, 2018) have also reported that most of hybrids surpassing the controls for total number of fruits per plant in their studies. The fruit weight which is a function of fruit size (fruit length and diameter) may be subject of consumer's or market choice but fruit number is independent of the purpose of end use. Therefore, preference should be given to the hybrids with higher number of fruits per plant rather than those having big and bulk fruits (Mohan Singh *et al*, 2019).

Fruit weight

Fruit weight is also another important character contributing to yield per plant directly. The Arka Abhed produced average fruit weight of 105.84 g, Arka Samrat was on par with Arka Abhed having mean weight of 113.92 g. The lowest value was found in Sivam 100.62 g. There was a significant variation in fruit diameter across the hybrids. The highest mean value for fruit diameter was recorded in Arka Abhed (4.59 cm). The least value (3.70 cm) was observed in Sivam hybrid. The variation in fruit diameter in different tomato hybrids might be due to the genetic makeup of cultivars and governed by the cell size and intercellular space of the flesh (Singh *et al*, 2019). Regarding yield characters it was evident (Table 1) that among three tomato hybrids the maximum fruit yield per plant was observed in Arka Abhed (10.63 kg), which was superior over other hybrids Arka Samrat (10.32 kg) and Sivam (7.69 kg). Variation in yield per plant might be due to genetic makeup of the plant, more number of flowers and more fruit set percent because of vigorous and healthy plants. Such kind of genetic differences for marketable fruit yield and other plant characters in different tomato hybrids had also been reported by Jindal *et al* (2018). Regarding yield per

Table 1. Mean growth, yield attributes and yield of tomato hybrids in YSR district, Andhra Pradesh

Particular	Arka Abhed			Arka Samrat			Sivam (Farmers' Practice)			SD			F-value			p-value	
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22
Year																	
Plant height (cm)	188.2	187.32	187.76	187.36	185.46	186.42	177.38	175.42	176.58	7.35	8.66	7.35	5.49*	3.84*	5.49*	0.020	0.051
Days to 50 % flowering	28.02	29.48	28.74	27.54	28.78	27.81	32.42	33.86	33.15	3.75	3.31	3.75	3.46*	5.81*	3.46*	0.065	0.017
Days to first harvest	83.16	83.44	82.99	81.45	82.58	82.01	87.5	88.2	87.85	3.39	3.56	3.39	9.02*	6.33*	9.02*	0.004	0.013
No. of fruits per plant	104.34	96.82	100.52	93.44	87.84	90.61	79.60	74.84	76.52	11.41	10.21	11.41	32.33*	30.51*	32.33*	0.000	0.000
Average fruit weight (g)	104.52	107.24	105.84	109.52	118.44	113.92	98.44	102.92	100.62	7.8	8.01	7.8	3.38*	14.94*	3.38*	0.068	0.001
Average fruit diameter (cm)	4.56	4.62	4.59	4.36	4.47	4.41	3.64	3.76	3.70	0.49	0.46	0.49	12.98*	14.13*	12.98*	0.001	0.001
Yield per plant(kg)	10.90	10.38	10.63	10.23	10.40	10.32	7.83	7.70	7.69	1.09	1.16	1.09	62.51*	170.97*	62.51*	0.000	0.000
Yield per ha(t ha ⁻¹)	54.50	51.90	53.20	51.15	52.00	51.57	39.15	38.50	38.82	4.82	4.15	4.82	64.47*	118.23*	64.47*	0.000	0.000
Market preference	Very Good			Very Good			Good										

*Significant at 5% level

hectare, the highest mean yield recorded in Arka Abhed 53.20 t/ha followed by Arka Samrat 51.57 t/ha. The lowest yield was registered in farmers practice 38.82 t/ha.

Disease resistance

The observations showed that, early blight incidence was 5.65 % in Arka Abhed, 6.9 % in Arka Samrat and 51.75 % in farmer's practicing hybrid Sivam and was encountered at the time of flowering and fruit setting. Late blight was as low as only 4.75 % in Arka Abhed as compared to a high disease severity of 84.5 % in Arka Samrat and 85.95 % in Sivam i.e farmer's hybrid. Similarly bacterial wilt incidence was (2.8%) in Arka Abhed, 3.65 % in Arka Samrat and 8.75 % in Sivam. The TLCV incidence was negligible and found to be just 3.45 % in Arka Abhed as compared to a high degree of disease incidence up to 15.6 % in farmer practicing hybrid Sivam.

Economics

Arka Abhed and Arka Samrat hybrids were superior over sivam hybrid in respect of number of pickings, average fruit weight, yield and price per kg. For Arka Abhed cost of cultivation for per hectare was Rs. 1, 58, 905/- and recorded average yield of 53.20 t/ha. Farmers sold tomato at average price of Rs. 8/ kg and obtained gross returns as Rs. 4, 25, 600/ha and high net returns of Rs. 2, 66,695/ ha with B: C ratio of 1:2.67. Arka Samrat cost of cultivation for per hectare was Rs. 1, 68, 200/- and recorded average yield of 51.57 t/ha. Obtained gross returns as Rs. 4, 12,560/ha, Rs. 8/kg and net returns of Rs. 2, 44,360 with B: C ratio 1: 2.45. Regarding Sivam, Cost of Cultivation is Rs. 1, 89, 036/ha and recorded average yield of 38.82 t/ha. Farmers sold tomato at average price of Rs. 7/kg based on the quality of the fruit and shelf life the unit price of Sivam hybrid was decreased compared to Arka Abhed and Arka Abhed showed 37.04% increased yield and Arka Samrat 32.84 % increased yield with good market preference over farmers' practice Sivam hybrid. The data about interaction effect of year and hybrid were found non significant

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Table 2. Pooled analysis of Repeated Measure Mixed ANOVA for Tomato hybrids fruit yield

Year	Variety	Mean yield (t ha ⁻¹)	Std. Deviation
2020-21	Arka Abhed	54.50	2.05
	Arka Samrat	51.15	0.68
	Sivam (Farmers practice)	39.15	1.50
2021-22	Arka Abhed	51.90	1.35
	Arka Samrat	52.00	0.83
	Sivam (Farmers practice)	38.50	0.62
Mean	Arka Abhed	53.20	1.7
	Arka Samrat	51.57	0.75
	Sivam (Farmers practice)	38.82	1.06

Table 3. Interaction of varieties over two years

Source	F-value	p-value
Years	9.404	0.010
Years * Hybrid	3.038	0.086
Hybrid	188.973*	0.000

*Significant at 5% level

Table 4. Cost economics of Tomato hybrids in YSR district, Andhra Pradesh

Particular	Arka Abhed			Arka Samrat			Sivam (Farmers' Practice)		
Year	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Yield per ha(t ha ⁻¹)	54.50	51.90	53.20	51.15	52.00	51.57	39.15	38.50	38.82
Gross cost (Rs./ha)	1,54,060	1,63,750	1,58,905	1,64,400	1,72,000	1,68,200	1,84,050	1,94,022	1,89,036
Gross income(Rs./ha)	4,36,000	4,15,200	4,25,600	4,09,200	4,16,000	4,12,560	2,74,050	2,69,500	2,71,740
Net income(Rs./ha)	2,81,940	2,51,450	2,66,695	2,44,800	2,44,000	2,44,360	90,000	75,478	82,704
Benefit : Cost ratio	2.83	2.53	2.67	2.48	2.41	2.45	1.48	1.38	1.43

Table 5. Comparison of the incidence/severity of different diseases in YSR district, Andhra Pradesh

Name of Hybrid	Early Blight (%)			TLCV (%)			Bacterial wilt (%)			Late Blight (%)		
Year	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Arka Abhed	5.5	5.8	5.65	3.2	3.7	3.45	2.3	2.8	2.8	4.6	4.9	4.75
Arka Samrat	6.7	7.1	6.9	4.2	4.8	4.5	3.5	3.8	3.65	83.6	85.4	84.5
Sivam (Farmers' practice)	51.1	52.4	51.75	15.4	15.8	15.6	8.6	8.9	8.75	85.2	86.7	85.95

which indicated that during two years three hybrids performed in the same way. Further, Arka Abhed performed well with higher fruit yield of 53.20 t/ha than other hybrids i.e Arka Samrat 51.57 t/ha and Sivam 38.82 t/ha. Similar results were reported by Sunitha *et al* (2020).

CONCLUSION

It was concluded that cultivation of Arka Abhed and Arka Samrat in YSR district, Andhra Pradesh was beneficial due to their traits. On the basis of results obtained it can be said that among the three hybrids, Arka Abhed was found superior in yield and yield attributing parameters such as number of fruits, fruit weight, fruit diameter, total yield per plant and yield per hectare followed by Arka Samrat. Hence farmers realized to achieve maximization of marketable crop yield by cultivating Arka Abhed and Arka Samrat in YSR district.

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