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Assessment of tomato (*Solanum lycopersicon* L.*)* hybrids for performance and adoptability at Srikakulam District, Andhra Pradesh

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Abstract
Tomatoes are known for their nutritional significance and they are cultivated by the majority of farmers worldwide. Majority of the farmers in North Coastal Zone of Andhra Pradesh cultivate local varieties which are not high yielding and high prone to pests and diseases. In this contest introduction of high yielding hybrids are necessary to enhance productivity. By keeping this in view Krishi Vigyan Kendra, Srikakulam, Andhra Pradesh conducted On Farm Trial on "Assessment of Tomato Hybrids in Srikakulam district" in order to assess the performance of hybrids such as Arka Abhed and Arka Samrat with locally cultivated Lakshmi hybrid. The Average fruit weight was recorded 70.96g, 70.69g, and 68.11g and number of fruits per plant recorded 26.08, 25.01, 22.15 respectively in Arka Abhed, Arka Samrat and Lakshmi hybrids. A considerable increase in yield (54.55 t/ha) in Arka Abhed and (52.35 t/ha) in Arka Samrat was recorded where compared to farmers practice (45.33 t/ha) Lakshmi hybrid.

Keywords: tomato; yield; quality; hybrids. On farm testing (OFT), B: C ratio

Introduction
Tomato is one of the most important vegetable belongs to family Solanaceae. It is the most popular cultivated and versatile garden vegetable grown in the world (Kumar *et al*., 2013) [8]. Tomato is one of the widely consumed vegetables in the world. It is rich in compounds beneficial to health, like vitamins, carotenoids, lycopene and phenolic compounds (Palop *et et al*, 2010) [13]. It can be eaten either fresh or processed into different products. It is helpful inhealing wounds because of antibiotic properties found in ripe fruits. It is good source of Vitamins A, B and C (Baloch, A.F, 1994) [2]. It has been reported that consumption of raw tomato and tomato based products is associated with reduced risk of cancer and cardiovascular disease (Giovannucci *et al.,* 2002) [4]. Tomato is a major vegetable crops, has gained in popularity over the last century and is now grown in almost every country of the world (Robertson, L.D *et al.,* 2007) [15]. It is most important cash crop grown by both marginal farmers and commercial growers for fresh market and processing industry.

It is well adapted to wide range of soils and climates and is grown from the tropics to the temperate areas. Its fruits are used in different food preparations and also preserved in different forms. Ripe fresh tomato fruit is consumed as salad and also utilized in the preparation of processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruits. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important source of lycopene (an antioxidant), ascorbic acid and ß-carotene and valued for their colour and flavour. Lycopene is treasured for its anticancer attribute. Among tomato cultivars, hybrids have really brought the revolution in tomato cultivation. 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. (Navjot Singh Dhillon *et al.,* 2019) [12]

A huge number of high yielding hybrids of tomato varying widely in respect to their yield potential, adaptability and response to inputs have been released for cultivation in open fields (Kaddi *et al.,* 2014) [7]. Shortage of improved tomato hybrids, use of unknown seed, poor seed quality, poor soil fertility, disease and insect pest are some of the bottle necks for tomato production faced by the farmers. In Srikakulam district of Andhra Pradesh tomatoes were cultivated in around 1325 hectares and getting very low yields compared to other neighboring states mainly due to cultivating local varieties and poor management practices. In this connection, there is an immense need for popularizing suitable, high yield tomato hybrids in the district. Hence, an assessment on tomato hybrids for growth, yield and higher productivity and its suitability in Srikakulam district, Andhra Pradesh was carried out. The objective of this study was to evaluate the yield performance and other agronomic characteristics of tomato hybrids grown in Srikakulam district.

Materials and Methods
The present experiment was conducted at seven farmer's fields at Burja, Kurupam, Zinkibabra, Sompeta, Nandagiripeta, Vanjangipeta, Palavalasa Villages of Srikakulam district during rabi seasons of 2018-19 and 2019-2020. The area has total annual rainfall of 1313.6 mm mean maximum temperatures 33.2^{0}C mean minimum temperatures of 22.9^{0}C the farming situation is irrigated sandy loam soils. F1 hybrid seeds of Arka Abhed (H-397) are a multiple diseases resistant hybrid which is to Tomato Leaf Curl Disease, Bacterial wilt, early blight and Late blight. Plants are semi-determinate with dark green foliage. Fruits are firm, oblate round & medium large (90-100g) and Arka Samrat triple resistant High yielding F1 hybrid developed by crossing IIHR-2835 X IIHR-2832. First F1 Hybrid with triple disease resistance to ToLCV, BW and early blight. Fruits oblate to high

round, large (90-110g), deep red and firm were purchased from Indian Institute of Horticulture Research (IIHR), Bengaluru. The seeds were sown in portrays during 2nd week of September and seedlings were transplanted on 3rdweek of October 2019. Arka Abhed, Arka Samrat and local check (Lakshmi) were used for this study.

The seeds were distributed to the five identified farmers of Srikakulam district and 25-30 days old seedlings were transplanted at a spacing of 75 x 45 cm. Carbaryl dust at the rate of 2.5 – 5 g per hill is applied at the time of transplanting to protect seedlings from caterpillars or cutworm. Regular irrigations were given to the field. FYM or compost @ 25 t/ha is 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. Rest amount of nitrogen is applied in two equal splits, first at 30 days after transplanting and next dose at 50-60 days after transplanting at 10-15 cm around the plant in ring. Yellow sticky traps @ 15 numbers per ha were placed in different directions of the plot against sucking pest. Four weedings were done in the plot. Need based pest and disease control practices were followed. Trainings on protray nursery raising, nursery management, transplanting of seedlings to the main field, application of growth regulators and harvesting methods was also given to farmers before conducting the experiment. The observation on plant height (cm), days to 50 per cent flowering (days), number of fruits per plant, average fruit weight (g), average fruit diameter (cm), yield per plant (kg), estimated yield per ha (t/ha), net income (Rs.), B:C ratio and market preference were recorded. The data were analyzed with appropriate statistical method was suggested by Panse and Sukhatme (1967) [14].

Results and Discussions

The perusal of data (Table 1) revealed that among the three hybrids of tomato, Arka Abhed recorded highest values in growth, yield and cost economics characters than other hybrids. Plant height of 76.76 cm recorded the highest in Arka Abhed followed by Arka Samrat of 76.47 cm whereas Lakshmi recorded the lowest plant of 64.87 cm. In the case of days to 50 percent flowering, Arka Samrat recorded the earliest days taken for flowering (27.55) followed by Arka Abhed (28.07) whereas the longer days taken for flowering was noticed in Lakshmi (farmers practices) of (31.93). This might be due to genetic makeup of varieties.

The data demonstrated that among the hybrids for number of days taken to first harvest (Table 1) Lakshmi hybrid of tomato took maximum days (91.45) from transplanting to first harvest and Arka Abhed hybrid took maximum days (83.65). Arka Samrat was bit early and took minimum time of 82.72 days. Other studies (Abrar *et al.*, 2011 and Falak *et al.*, 2011) [1, 3] showed that the time taken from transplanting to first harvest for tomato cultivars ranged between 70 and 120 days. Pertaining to the data Arka Abhed recorded highest number of fruits per plant (26.08) followed by Arka Samrat (25.01) and farmers practice (22.15).

Number of fruits per plant is the most important component trait which is directly related to increased fruit yield per plant. Earlier researchers (Islam *et al.*, 2012; Marbhal *et al.*, 2016; Kyess *et al.*, 2017; Vijeth *et al.*, 2018) [5, 10, 16] have also reported majority of the hybrids surpassing the controls/standard check 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 bulking fruits *(Mohan Singh et al.,* 2019). Fruit weight is also another important character contributing to yield per plant directly. The Arka Abhed produced average fruit weight of 70.69 g, Arka Samrat was on par Arka Abhed having mean weight of 70.69 g. The lowest value was found in Lakshmi 68.11 g. There was a significant variation in fruit diameter across the hybrids. The data pertains to fruit diameter ranged from 3.77 to 4.47 cm (Table 1). The highest mean value for fruit diameter was recorded in Arka Abhed (4.47 cm). The least value (3.77 cm) was observed in Lakshmi 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 is evident from data presented in Table 1 that among three tomato hybrids the maximum fruit yield per plant was observed in Arka Abhed (1.85 kg), which was superior over other hybrids Arka Samrat (1.76 kg) and Lakshmi (1.53 kg). Variation in yield per plant was 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.* [16]. Regarding yield per hectare, the highest mean yield recorded in Arka Abhed 54.55t/ha followed by Arka Samrat 52.35 t/ha. The lowest yield was registered in farmers practice 45.33 t/ha.

Table 1: Mean growth, yield attributes and yield of tomato hybrids in Srikakulam district, Andhra Pradesh

S. No	Particular	ArkaAbhed	ArkaSamrat	Laxmi (Farmers practice)	SEd	CD (P=0.05%)
1	Plant height (cm)	76.76	76.47	64.87	1.825	3.976
2	Days to 50 percent flowering	28.07	27.55	31.93	0.939	2.046
3	Days to first harvest	83.65	82.72	91.45	1.141	2.485
4	No.of fruits per plant	26.08	25.01	22.15	0.861	1.876
5	Average fruit weight (g)	70.96	70.69	68.11	0.698	1.520
6	Average fruit diameter (cm)	4.47	4.33	3.77	0.188	0.410
7	Yield per plant(kg)	1.85	1.76	1.53	0.049	0.106
8	Yield per ha(t/ha)	54.55	52.35	45.33	1.489	3.244
9	Market preference	Very good	Very good	Good		

Economics

Table 2: Cost economics of Tomato hybrids in Srikakulam district, Andhra Pradesh

S. No	Particulars	Arka Abhed	Arka Samrat	Farmers practice- Lakshmi
1	Yield per ha(t/ha)	54.55	52.35	45.33
2	Gross cost (Rs./ha)	1,00,450	1,01,500	1,14,000
3	Gross income(Rs./ha)	4,36,400 @ 8/- per kg	4,18,800 @8/- per kg	2,71,980 @6/- per kg
4	Net income(Rs./ha)	3,35,950	3,17,300	1,57,980
5	Benefit : Cost ratio	4.34	4.13	2.38

Performance of tomato hybrids Arka Abhed and Arka Samrat is superior over Lakshmi hybrid in respect of no. of pickings, average fruit weight, yield and price per kg. Data pertaining to table 2, Arka Abhed cost of cultivation for per hectare is Rs. 1, 00,450/- and recorded average yield of 54.55 tonnes per hectare. Farmers sold tomato at average price of Rs. 8/- per kg and obtained gross returns as Rs. 4,36,400/- per hectare and high net returns of Rs. 3,35,950 /- with B: C ratio of 1:4.34. Arka Samrat cost of cultivation for per hectare is Rs. 1, 01,500 /- and recorded average yield of 52.35tonnes per hectare. Obtained gross returns as Rs. 4, 18,800/- per hectare @ Rs. 8/- per kg and net returns of Rs. 3, 17,300/- with B: C ratio of 1: 4.13. Regarding Lakshmi, Cost of Cultivation for per hectare is Rs. 1, 14,000/- and recorded average yield of 45.33tonnes per hectare. Farmers sold tomato at average price of Rs. 6/- per kg based on the quality of the fruit and shelf life the unit price of Lakshmi hybrid was decreased compared to Arka Abhed and Arka Samrat and obtained gross returns as Rs. 2,71,980 /-per hectare with net returns of Rs. 1,57,980/- with B: C ratio of 1: 2.38. Arka Abhed showed 20% increased yield and Arka Samrat 15% increased yield with good market preference over farmers practice Lakshmi hybrid.

Conclusion

Present study concluded that cultivating Arka Abhed and Arka Samrat in Srikakulam district, Andhra Pradesh was beneficial due to their traits. On the basis of results obtained it may be concluded 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 were realized to achieve maximization of marketable crop yield by cultivating Arka Abhed and Arka Samrat in srikakulam district.

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