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Assessing the Performance and Adoption Rate of Tomato Hybrid "*Arka Rakshak*" having Multiple Disease Resistance in Jagatsinghpur District of Odisha, India

Debasis Mishra[1], Ashis Kumar Mohanty[1], S. K. Mukhi[2] and D. V. Singh[2*]

[1]*Krishi Vigyan Kendra, Jagatsinghpur, OUAT, Bhubaneswar, India*
[2]*Krishi Vigyan Kendra, Kandhamal, OUAT, Bhubaneswar, India*

*Corresponding author

A B S T R A C T

The present investigation was undertaken to assess the reaction of the hybrid "Arka Rakshak" towards three major diseases prevalent in the district and thereby find an eco-friendly and simple solution to manage all these devastating diseases for which farmers are spending lots of money and time. The results clearly revealed that 40.4 % higher fruit size, 38.8 % more numbers of fruits per plant and an average of 103.9 % more crop yield was recorded, there was no BLB incidence, the severity of ALB was as low as 10 %, TLCV incidence was negligible and found to be just 1 % in Arka Rakshak. Around 61.1 % male and 66.2 % female respondents were having a very positive attitude towards the viability and sustainability about Arka Rakshak.

Introduction

The tomato ranks 7th in worldwide production after maize, rice, wheat, potatoes, soybeans and cassava, reaching a worldwide production of around 160 million tons on a cultivated area of almost 4.8 million hectares in 2011. It is one of the most important vegetable crops grown in the state of Odisha and cultivated in an area of more than 1 lakh ha round the year in various agro-climatic situations with an average productivity of 13.3 t ha^{-1}. The yield is considered as mediocre as some factors or constraints like unavailability of suitable disease resistant seed material, sub-optimal farming practices and prevalence of diseases and pests limit the yield of the crop. Among several diseases of tomato, Bacterial Wilt (BW), Alternaria Leaf Blight (ALB) and Tomato Leaf Curl Virus (TLCV) are considered as the most devastating diseases prevalent in the state. All these pathogens survive well either in soil or in collateral and alternate host plants. These diseases flare up

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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 many are limited in application, either being site specific or limited by socio-economic conditions (Haywards, 1991). 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 (Hanson *et al.,* 2000). 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. In this study, attempt was made to assess the performance of a hybrid developed from Indian Institute of Horticultural Research (IIHR), Bangalore namely "Arka Rakshak" for its reaction to three major diseases like Bacterial Wilt, Alternaria Leaf Blight and Tomato Leaf Curl Virus in Jagatsinghpur district of Odisha during the Rabi season of 2016-17. Furthermore, the yield of the hybrid was also assessed and compared with the ruling hybrids in the farmers' fields. The study was also directed towards assessing the farmer and market preferences of the district towards the quality, size and shape of the fruits. The present investigation was undertaken to assess the reaction of the hybrid "Arka Rakshak" towards three major diseases prevalent in the district and thereby find an eco-friendly and simple solution to manage all these devastating diseases for which farmers are spending lots of money and time.

Materials and Methods

A total of 13 numbers of trials were conducted in Kujanga, Tirtol and Jagatsinghpur blocks during Rabi seasons of 2016-17 and 2017-18

in a total of 1.0 ha area. Nursery beds of the seedlings were raised in the KVK, Jagatsinghpur seedling production unit with a seed rate of 250 gm/ha in 1st fortnight of October 2016 and 2017. Seeds were treated with Vitavax Power (Carboxin + Mancozeb) @ 2g/kg of seed and sown in the raised nursery beds of 1 m x 5 m size. The soil of nursery beds was treated with Cartap Hydrochloride 4G @ $1g/m^2$ area at the time of sowing. The beds were also sprayed twice with Metalaxyl + Mancozeb (Master) @ 2g/lit of water at 10 and 20 DAS to suppress seedling damping-off disease. The 30 day old seedlings were supplied to the farmers for planting in their trial plots. Each beneficiary farmer was supplied with 2,500 numbers of seedlings of "Arka Rakshak" hybrid for transplanting in his trial plot. The transplanting was undertaken in the 1st fortnight of November 2016 at a spacing of 75 x 60 cm, as a result, the plant population was around 25,000 per ha. The beneficiary farmers also grew their regular varieties and hybrids in nearby plots for comparison.

The crop was supplemented with 20 MT of FYM and a total of 120:100:120 kg $N:P_2O_5:K_2O$ per ha. All the Phosphorus, $1/3^{rd}$ of Nitrogen and $1/3^{rd}$ of Potash was given at the time of transplanting. The rest fertilizers were given in two equal splits at 30 and 60 days after transplanting. Two sprayings of micronutrient mixtures were also done at 30 and 60 days after transplanting for better result. In each trial plots, hoeing, weeding and other intercultural operations were frequently done. The farmers' practice or check plots with regular varieties or hybrids were also given the same treatments. There were no plant protection measures taken for both check and trial plots.

The disease incidences or severity for Bacterial wilt (BW), Alternaria leaf blight (ALB) and Tomato leaf curl virus (TLCV)

were observed and documented by using the following formulae.

Percent Disease Incidence (PDI)

$$= \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100$$

Percent Disease Severity (PDS)

$$= \frac{\text{Score taken in the observation}}{\text{Highest no. in the rating scale}} \times 100$$

The yield in the check and trial plots were taken from 3 places each of 10 m^2 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 harvesting 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 rate of adoption of the technology among gender, age groups and educational status were also evaluated by categorizing the respondent farmers of 200 people into different classes and collecting their responses about the viability and sustainability of the technology.

Results and Discussion

The results on average fruit weight, numbers of fruits per plants and crop yield were compared between the hybrid "Arka Rakshak" and other check varieties are depicted on Table-1. The results clearly revealed that, 40.4 % higher fruit size, 38.8 % more numbers of fruits per plant and an average of 103.9 % more crop yield was recorded in the assessed hybrid "Arka Rakshak" than the check hybrids. These yield parameters may be attributed to much better physiology of the assessed hybrid as it may have better water and nutrient uptake capacity as well as higher nutrient use efficiency than the other check hybrids.

As the comparisons were made on various other characters of plant and fruit in table 2, it was found that, the fruits were uniform sized in assessed hybrid than all other check hybrids, where the fruits were not uniform sized. However, the shape of the fruits of check hybrids were more preferred as they were flat round with green shoulders. An average of 3 more pickings was possible in the assessed hybrid "Arka Rakshak" than the check hybrids showed its greater yield potential. Acid content of the fruits of the assessed hybrid was found to be medium, which signified that, these fruits can be used both for table purpose as well as making value added products like sauce, puree and can be a better product for urban as well as rural markets.

The evaluation of keeping quality of fruit, the most important post-harvest factor was done for both assessed and check hybrids. The result revealed that, the fruits of assessed hybrid can be stored a week time more than the check hybrids, which clearly signified that, the fruits of assessed hybrid have more transportability and thus can be taken to far away places for marketing.

In the trials, work was also directed for recording the reaction of the assessed hybrid "Arka Rakshak" towards various prevalent pests and diseases during the cropping period as compared to the regular hybrids in table 3. The observation showed that, there was no BLB incidence in the assessed technology as

compared to the farmers' practice where an average of 26 % incidence of the disease was encountered at the time of flowering and fruit setting. Similarly, the severity of ALB was as low as 10 % in assessed technology as compared to a high disease severity of 60 % in farmers' varieties during late season. The TLCV incidence was negligible and found to be just 1 % in assessed technology as compared to a high degree of disease incidence up to 17 % in various farmers' varieties.

Calculations were made for determining the economics of the assessed hybrid, where the gross cost, gross return, net return and B:C ratio were derived for ascertaining its profitability in table 5. The results revealed that, by replacing the ruling hybrids and HYVs with "Arka Rakshak", the farmers invested only Rs. 13,000/- more per ha and at the same time they could able to earn an additional profit of more than Rs. 1,77,000/- per ha which could get them a very high B:C ratio up to 3.82.

Farmers' responses were also recorded after the study to find out the extent of adoption of the technology as well as the viability of the intervention intable-6. The sample size was 200 which included both male and female respondents with different age groups and educational qualifications. The result shows that, around 61.1 % male and 66.2 % female respondents were having a very positive attitude towards the viability and sustainability of this technology.

Similarly, the male and female respondents of different age groups in table-7 as well as education in table-8 were categorized for their willingness towards adopting the technology in future. The results depicted in the tables revealed that, irrespective of the gender, the rate of adoption or conviction decreased as the respondent grow older and in contrast, increased when they are having more educational qualification.

The results clearly revealed that 40.4 % higher fruit size, 38.8 % more numbers of fruits per plant and an average of 103.9 % more crop yield was recorded, there was no BLB incidence, the severity of ALB was as low as 10 %, TLCV incidence was negligible and found to be just 1 % in Arka Rakshak. Around 61.1 % male and 66.2 % female respondents were having a very positive attitude towards the viability and sustainability about Arka Rakshak.

Table.1 Fruit weight, number of fruits per plant and crop yield comparison

Attributes	Unit of measurement	Assessed Technology	Farmers' Practice (FP)	% difference over FP
Average fruit weight	Gram (g)	73.0	52.0	(+) 40.4
No. of fruits per plant	Number	68	49	(+) 38.8
Crop yield	t/ha	42.0	20.6	(+) 103.9

Table .2 Comparison of the crop and produce

Attributes	Assessed Technology	Farmers' Practice (FP)
Plant type	Semi-determinate	Semi-determinate
Canopy type	Vigorous and Bushy	Less vigorous and Bushy
Days to flowering	31 Days after transplanting	30 Days after transplanting
Days to 1st picking	62 days after transplanting	54 days after transplanting
No. of pickings	08 times	05 times
Fruit size	Medium and uniform	Medium to small (Variable)
Fruit firmness	Very firm	Moderate to low
Fruit Shape	Square round	Flat round to oval
Fruit colour	Deep red	Red with green shoulder
Acid content in fruits	Medium	High
Keeping duration	17 to 19 days	9 to 10 days

Table.3 Comparison of the incidence/severity of different diseases

Disease	Incidence/ Severity	Assessed Technology	Farmers' Practice (FP)
Bacterial Wilt (BW)	Incidence %	00	26
Alternaria Leaf Spot (ALB)	Severity %	10	60
Tomato Leaf Curl Virus (TLCV)	Incidence %	01	17

Table .4 Preferences of the respondents for the crop and quality of the produce

Attributes	Plant type	Size of the fruit	Shape of the fruit	Taste of the fruit	Keeping quality	Transportability	Market price	Disease resistance	Total score
Assessed Technology	5	5	5	4	5	5	5	5	39
Farmers' Practice (FP)	4	5	4	5	3	3	5	1	30

Table.5 Comparative study of the economics of the trials

Treatment	Yield (Qtl/ha)	Cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	B:C Ratio
Assessed Hybrid	420	1,10,000	4,20,000	3,10,000	3.82
Farmers' Practice	206	97,000*	2,40,000**	1,33,000	2.47

* Less number of pickings and less duration caused less labour engagement
** More price of the hybrids in farmers' practice due to their shape and acidic fruits in local markets

Table.6 Responses of farmers towards the technology

Responses	Viable in the locality	Skeptical about the consistency of the technology	Not viable in the locality	Will not change the existing practice	Total
Male	82 (62.1 %)	18 (13.6 %)	10 (7.6 %)	22 (16.7 %)	132 (100 %)
Female	45 (66.2 %)	06 (8.8 %)	04 (5.9 %)	13 (19.1 %)	68 (100 %)

Table.7 Willingness to adopt the technology within various age groups

Age group and Sex	25 – 35 years		36 – 45 years		46 – 55 years		> 55 years	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Agreed	35 (97.2 %)	16 (100 %)	33 (89.2 %)	28 (87.5 %)	20 (52.6 %)	06 (46.2%)	05 (23.8 %)	00 (0.00 %)
Not Agreed	01 (2.8 %)	00 (0.00 %)	04 (10.8 %)	04 (12.5 %)	18 (47.4 %)	07 (53.8 %)	16 (76.2 %)	07 (100 %))
Total	**36**	**16**	**37**	**32**	**38**	**13**	**21**	**07**

Table.8 Willingness to adopt the technology dependent on education

Educational status and Sex	Illiterate		Under Matriculate		Intermediate degree		Bachelor's degree and more	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Agreed	09 (36.0%)	08 (47.1%)	33 (64.7%)	24 (72.7%)	33 (89.2%)	16 (100.0%)	18 (94.7%)	02 (100.0%)
Not Agreed	16 (64.0%)	09 (52.9%)	18 (35.3%)	09 (27.3%)	04 (10.8%)	00 (00.0%)	01 (05.3%)	00 (00.0%)
Total	**25**	**17**	**51**	**33**	**37**	**16**	**19**	**02**

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